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Introduction/Overview

The UC Agricultural Health and Safety Center, based at the University of California, Davis (UC Davis), is a comprehensive, multidisciplinary program dedicated to the understanding and prevention of illness and injury in Western agriculture.

The Center is unique among the NIOSH-funded agricultural centers; it is co-located in an internationally renowned research university that is also a land grant university. The Center also has strong collaborative ties with the Schools of Medicine and Veterinary Medicine, the Colleges of Engineering and of Agricultural and Environmental Sciences, various state agencies, stakeholders, and non-governmental organizations (NGOs). The state capital in Sacramento, 12 miles from Davis, is home to the State's Departments of Health Services, Food and Agriculture, and Environmental Protection. These diverse, multidisciplinary assets and expertise provide a wealth of resources, opportunities, and experience to the Center. The Center began in 1990 under the direction of Marc B Schenker, M.D., M.P.H who brought 20 years of experience as an exert in occupational health, preventive medicine, respiratory disease and epidemiology. The Associate Director, Kent E. Pinkerton, Ph.D., Professor of Anatomy, Physiology and Cell Biology in the School of Veterinary Medicine, also provides more than 20 years of experience in the areas of air quality and respiratory health from a mechanistic and basic science perspective." Stephen McCurdy, M.D., M.P.H. has directed our highly effective and interactive seminar series which draws upon local and national experts in Agricultural Health and Safety. This seminar series over the years has served as an important forum for disseminating information to the academic, state and federal agencies as well as to the community in general. This seminar series has also served to foster research collaborations among academic and public policy stakeholders.

The 1990 NIOSH cooperative agreements provided funding for agricultural centers to promote preventive research, education and outreach activities. Research across the spectrum of scientific methods is necessary, from basic laboratory work to survey and evaluation studies. Research is imperative for identifying and characterizing health risk factors, understanding mechanism, developing potential interventions, implementation of interventions, and evaluation of their efficacy. Thus, research, in concert with outreach activities, is an essential aspect of prevention.

The Center's high priority was to improve the health and safety of farmers, farm family members and farmworkers in western agriculture. A team of 13 scientists plus co-investigators and support staff was assembled to address these issues. Center collaborations existed in Arizona and Hawaii, and an annual conference was rotated between Davis and the Northwest Ag Center in Washington. Western agriculture represented practices and a workforce population different from the rest of the country. Specific areas of interest included respiratory disease in dry climate farming, ergonomic hazards of farm labor work, acute and cumulative trauma injuries, biomarkers and neurotoxicity of pesticide exposure, health status of hired farmworkers, and economic and policy issues pertinent to agricultural health and safety. The Center was organized into research, intervention/prevention, education and administrative cores. Communication and synergism between investigators in the different cores was a key function of the Center and was

facilitated by monthly seminars, annual conferences, quarterly newsletter (print and electronic), an international listserver, media interactions and WWW homepages at http://agcenter.ucdavis.edu.

The Ag Center blended the needs of the agricultural community with the expertise of UCD health scientists ranging from experimental laboratory science through descriptive epidemiological studies of the agriculture communities. The Center's largest epidemiological project involved the health of California farmworkers. In 1990, this large cohort study randomly selected participants from the Ag Stat Service database of California farmers to complete a health & occupational questionnaire addressing various outcomes of health and safety. The cohort has been studied since its inception resulted in subsequent pilot studies and several publications.

Pesticide related research was also an area of interest for the UC Ag Center. Major research projects dealt directly with occupational pesticide exposure. The Center's largest surveillance projects included significant attention to occupational pesticide hazards among others. Similarly, outreach projects were explicitly focused on pesticide safety. This priority for pesticide issues reflects the general level of both popular and occupational concern in the state, as well as a volatile policy climate. For the results of these various projects to be adequately recognized for their policy potential and context, some ongoing work was undertaken to analyze current policy activity and issues, and to help sensitize policy makers to the potential utility and context for emerging research results.

A major activity of the administrative core was to greatly increase the size and scope of electronic communications. This activity received cooperative funding from the other NIOSH Agricultural Health Centers, and was expected to further increase in size. This activity became a national activity of the NIOSH Agricultural Health Centers that was based at the UC Davis Center. The "Agricultural Health and Safety Discussion group" was on the internet, based at Davis. This discussion group allowed communication among Center investigators and anyone else interested in these topics. Announcements, queries, job listings, health and safety alerts, bulletins from NIOSH or other federal agencies, and a variety of other information may be posted to the discussion group, and responses received from any subscriber. A second electronic activity is the creation of a "home page" for the Davis Center on the World Wide Web (http://www-oem.ucdavis.edu/), based at UC Davis. We developed a national Agricultural Health and Safety Home Page that directly connected NIOSH with the Centers, plus other relevant resources. The third new electronic communication activity is an expanded "on-line NIOSH Center newsletter." The cooperative funding allowed us to expand on-line version of our quarterly Center newsletter to a nationwide newsletter with information, news, calendar and other updates from all six NIOSH Centers and NIOSH investigators in Morgantown. Funding arrangements were completed in Spring, 1995, and this exciting new communications instrument started in April 1995.

The advances and accomplishments achieved in communications by the Center serve the dual function of communicating Center activities and results to interested parties as well as

receiving feedback to the Center from outside individuals. Expansion of the newsletter to a national audience with input from all the NIOSH Centers greatly increased the effectiveness of this effort. The Davis Center's very successful newsletter has continued to be published on a quarterly basis with a distribution list of over 1,700. The printed newsletter focused on items relevant to California and Western agriculture.

In 2003 the Center was renamed to the "Western Center for Agricultural Health and Safety (WCAHS)." The mission and goals of the Center remained the same. The multidisciplinary expertise of the Center faculty enabled varied largely field-oriented research projects and interventions. Several areas of Center efforts have been noted for bilingual/biculture health and safety efforts among hired (immigrant) farmworkers, respiratory disease from exposures in dry farming environments, and engineering better ergonomic solutions to reduce acute and cumulative trauma injuries.

The Center has been effective in applying research findings into practical and effective field solutions. This translational research has been achieved by "technology transfer" for engineering solutions, communication of research findings to the diverse agricultural community via multiple routes, and collaborative efforts with the state legislature, state agencies, cooperative extension, and various stakeholders. Our major effort has been to improve the health of hired farm workers, largely Hispanic immigrants.

Major Accomplishments 1990-1995

Research

The Agricultural Health and Safety Center maintains an active research core that is a vital part of the overall Center. Projects represent a range within the general preventive health research model of basic research leading to development of preventive strategies and thence to efficacy trials of preventive interventions. Basic research to identify and characterize problems within important agricultural communities include the cross-sectional health studies of the California farmer population and among California farm workers (Schenker). Research focused on improving biologic measurements of exposure to pesticides (Project and in characterizing the epidemiology of pesticide illnesses in California. In the realm of developing interventions, Dr. John Miles continued his work in developing safer fruit-harvesting systems. With respect to testing interventions, Dr. Jay Beaumont is studied the effect of incentive pay on reducing occupational injury rates.

Prevention/Intervention

The Industrial Hygiene/Exposure Core (IH) provided expertise in exposure assessment to Center investigators, collaborates on research projects and assisted with the development and evaluation of measures. Core investigators have expertise in chemical and dust exposure assessment and safety. They play an integral role in the assessment of exposure for epidemiologic investigations, and in the evaluation of engineering or regulatory changes on exposure. This program has continued to develop and attract positive attention during the past

year. Dr. Mark Nieuwenhuijsen joined the program in 1994, and the program has attracted students from the U.S. and abroad to the Center. The laboratory was further enhanced in the past year.

We selected a sample of 1,062 farmers (cases = 359, controls = 703) from the original cross-sectional study of 1,947 farm operators to serve as subjects for the nested case-control study. We developed a computer aided telephone interview (CATI) which includes detailed questions concerning respiratory health as well as questions to crop and task-specific activities and exposures to various potential respiratory toxins such as chemicals and dusts. Exposure assessment is being done in conjunction with field sampling (See IH Core). The CATI instrument has been pilot tested and interviewing began in April, 1995.

Field technicians have completed a NIOSH approved spirometry course, and spirometry is currently being performed at the farmer's residence for farmers in the Sacramento and San Valley regions (in collaboration with John Hankinson, NIOSH). At each visit the technicians also take a blood sample for a CBC and immunologic studies by Dr. Dan Lewis (NIOSH), and leave a peak flow meter with instructions for 3-times daily PEF measurements for two weeks. The daily will also be repeated for two weeks during the the growing season. To date 90 field visits have been completed.

The basis of respiratory symptoms (allergic vs. non-allergic) will-be evaluated by analysis of reported symptoms, PEF diaries for increased daily variability (correlated with airway hyperresponsiveness) and analysis of blood studies for standard markers of immunologic disease (eosinophilia, total and specific immunoglobulins, C3, C4, RAST for to common environmental allergens.) Additional research assays also will be performed ECP, LPB, RAST for agricultural allergens). Immunologic studies are performed in the lab of Dr. Dan Lewis at NIOSH.

Agricultural risk factors for respiratory disease will be related to specific exposure matrices developed by the industrial hygiene core project. This will allow future directed efforts at reducing exposures that are associated with the highest risk of respiratory disease. Such efforts might include various types of interventions including educational, engineering, and personal protection devices.

We analyzed reproductive health among the women in the original cross-sectional sample. During the next year we will begin development of a survey instrument and sampling scheme to evaluate reproductive and family health status of this sample, supplemented by a larger sample of wives of male farmers and other women in California agriculture. This sample will assess the reproductive health of these women, their exposures to various hazards on the farm, and the health of children living on the farm. Women represent a preferable sample for evaluating practices and hazards related to children in the farm environment, and for subsequent preventive interventions. We will also of a follow-up instrument for the original cohort. Many studies have documented a "healthy farmer" effect, and incidence data are critical for a more accurate picture of disease incidence in this population. These two surveys will not be completed during the next year.

Studies on respiratory disease identified dust exposure in dry western climates as a major contributing cause to the increased respiratory morbidity and mortality of farmers and farmworkers in western agricultural states. Additional studies with pulmonary pathologists identified the location and nature of dust deposition and changes in the lung due to agricultural exposures of farmworkers.

In collaboration with EPA scientist Stephanie Padilla, and a number of clinical laboratories that submitted data to the EPA on pesticide levels in food, we studied the reliability of the Cholinesterase testing performed to establish permissible levels of antichyolinergic pesticides. The results revealed inadequacies in the monitoring assays and led to specific suggestions of how the problems could be remedied.

Ergonomic problems and potential interventions have been identified in the harvesting of broccoli, bell peppers, cilantro, citrus, and lettuce. The objective of this research has been to improve working conditions without negative impact on productivity and worker wages. Alternative ladders and fruit handling systems were developed and tested. Numerous alternative clippers were designed and tested to reduce the force required to clip citrus. The Center is collaborating with the major manufacturer of citrus clippers; the manufacturer is now redesigning the orange clipper to address this issue.

Outreach

The Center's outreach program is made up of five formal on-going projects, four "mini-grant" projects and a variety of supplementary activity by virtually all projects. The outreach program is strongly characterized by external priority direction and emphasis of educational strategies at both community and individual scales. The five ongoing projects address a diverse range of needs and audiences representing the complexity of California agriculture. Two Cooperative Extension sponsored projects and delivery of effective safety training and information The majority of these cultural barriers. These two projects address the need for effective communication about hazards and safety. This material is also of priority interest to agricultural employers. Worker's needs for effectively delivered information on a broader range of employees rights are addressed by a contracted project with the independent California Institute for Rural Studies. A project sponsored by Center for Occupational and Environmental Health staff focuses on development of a coalition of diverse groups and organizations for the purpose of furthering health and safety information exchange and increased cooperative effort. The last formal element involves continuing medical education by Occupational Medicine staff at UC Davis and is concentrating on development of study packages for medical professionals.

The outreach program demonstrated very effective multi-constituency participation and service, a necessary impact given the size and diversity of California agriculture. The projects have also provided for a significant increase in effective agricultural safety and health information and educational materials. This has been important in both increasing community awareness of the extent and seriousness of needs and in motivating and supporting early adoptive behavior by both groups and individuals. Projects have recorded evidence of impacts on both

practice and awareness. It is promising that California agriculture is sharing in the overall slight downturn in incidence of reported occupational injury and illness. Given the extraordinary rate of injury and relative failure of current control programs, a comprehensive injury control effort appears needed. Also, as awareness increases within the agricultural community, discussion of a shift of emphasis from general educational strategies to disease and injury specific intervention demonstrations is taking place. These changes are reflected in a new Center working group on strategies for injury control contributed to the 1996 renewal proposal.

Innovative approaches to Extending Agricultural Health and Safety Information to Non-English Speaking Workers: The agricultural workforce in the western region is comprised of several ethnic groups and many people who do not read or speak English. This created unique challenges for employers and educators who must provide agricultural workplace health and safety training and hazard awareness information. The center investigators pioneered various approaches to bridging language, cultural, and educational barriers in order to extend health and safety information to agricultural workers. This included: using a board game, patterned after the Latin American game La loteris, to help Hispanic workers understand pesticide and motor vehicle safety; using the Mexican fotonovela concept to provide information on monitoring for pesticide exposure; and developing specialized booklets and videos in the Hmong, Lao, and Cambodian languages as part of concerted efforts of outreach into communities of southeast Asian immigrants. Center investigators have incorporated evaluation components into each of their projects to help determine the effectiveness of the materials and methods in changing behaviors or heightening hazard awareness among agricultural workers.

A large and growing segment of the agricultural workforce in the western region is provided through farm labor contractors. This emerging group of employers, which ranges from individuals to sizeable corporations, has been largely unrecognized as a significant force in extending health and safety information and training to farmworkers. Recently, Center investigators have begun identifying and characterizing labor contractors and assessing their roles and potential in addressing agricultural health and safety issues. These studies provided new and efficient avenues for expending training and information programs and are creating new opportunities for collaborations between state and federal regulatory agencies, health researchers, and educational institutions.

Reaching Agricultural workers through Training Programs for Farm Supervisors, Employers, and Trainers: The agricultural workforce in the western regions is very large. In California alone, there are over one million workers employed to perform cultural and harvesting operations on agricultural crops. Reaching these workers with health and safety information is a challenging task. Center investigators, using the Federal Worker Protection Standard employee training requirements as a model, have developed Spanish and English language train-the-trainer programs that leverage efforts of a few UC educators. It is estimated that over 800,000 workers will receive training during the coming year from approximately 2500 instructors who have participated in this Center-supported program. Investigators implemented an extensive evaluation effort to measure the effectiveness of this project and to determine its impact on the trainers and fieldworkers.

Electronic Communication Support and Innovations: The Center has been a leader in developing internet resources and material in the area of agricultural health and safety. These have included electronic dissemination of the Center newsletter and a newsletter from all the NIOSH Agricultural Health and Safety Centers, support of a list server that provides communications between individuals fro around the globe with an interest in agricultural health and safety, and support of World Wide Web homepages and linkages to many groups involved in this area.

Major Accomplishments 1996-2001

The UC Agricultural Health and Safety Center at Davis had made strides in areas of research, prevention/intervention and education/outreach. The Center, with the help of the NIOSH Cooperative agreement, and by its own reputation, had taken a leadership role in addressing western agricultural health and safety issues. The important area of health among migrant and seasonal (hired) farm workers has been a very challenging and important area in which the Center has made major contributions. Other important Center accomplishments included ergonomics of labor intensive crop work, respiratory hazards in dry climate farming, health of women and children in agriculture, and pesticide safety. The Center funding from NIOSH has resulted in over $9 million in additional extra-mural and in-kind funding between 1996 and 2001. Students at all levels from undergraduate to professional and post-graduate have actively been involved in research activities initiated by the Center, and the public (general and agricultural) have been recipients of Center educational programs. Our electronic communications (newsletter, listserver) have expanded educational efforts of the Center internationally. NIOSH's investment has been multiplied several fold in its effectiveness in addressing this important occupational health issue.

California agriculture was the largest and most diverse in the country, producing $28+ billion/year, which is 16% of all U.S. crop production (by value) on only 2.5% of the farmland. The state produces over 250 major agricultural commodities, and leads the country in production of 60 commodities. It produces 39% of the nation’s vegetables and melons, 53% of the nation's fruits, nuts and berries, and 24% of the greenhouse and nursery products. California agriculture differs from agriculture in other regions of the country in many ways including climate (dry), production methods (labor intensive), organization (management-farm labor), and regulatory issues.

The size, diversity and uniqueness of California agriculture is a challenge to the Center’s work, and has helped shape its programs. There are approximately 80,000 farms in California, ranging from small owner-operated to large corporate farms. More importantly, California agriculture is labor intensive, employing up to 1.5 million people per year with approximately 18 farmworkers for every farmer. Farmworkers provide ~85% of farm labor in California, and have the most need of attention to their health and safety (Mobed, 1992).

The magnitude of known illnesses and injuries among California farmers and farmworkers further points to the need for the Davis Center. Mortality data confirm a higher rate of overall

and cause specific mortality in California farmers and farmworkers (Beaumont, Singleton et al. 1992). Over 20,000 disabling injuries are reported annually among agricultural workers in California, and it is estimated that the actual number may be twice as high (Villarejo and Baron 1999). Excess mortality has also been documented for agricultural workers who have filed compensation claims for respiratory disease, pesticide illness or injury. The true magnitude of illnesses due to agricultural work is unknown, since these are not captured by worker's compensation or other surveillance systems. Finally, the desperate health condition of California's hired farmworkers has recently been documented in a report co-authored by center investigators (Villarejo, Lighthall et al. 2000). This survey found that almost every measured health parameter was worse than in reference populations. Health care services were infrequently used, particularly for preventive care. For example, 70% had never had an eye care visit, and almost 50% reported never having had a dental visit. Seventy percent had no health insurance, and 30% of men and 12% of women reported never visiting a doctor or clinic. Several measures of health such as elevated blood pressure or cholesterol, and anemia, were higher among the farmworkers than among U.S. reference populations.

By 2001 the range of research, intervention/prevention and education projects and activities in the Center had already reflected the depth of expertise, the diversity of health and safety problems in California agriculture, and the breadth of approaches to disease prevention and health promotion (Schenker 1996). Research projects are weighted to field-oriented efforts, but are also vertically integrated to include bench science addressing the mechanisms and biologic markers of disease from agricultural toxins. This is particularly the case for respiratory and neurologic health outcomes. Research projects had covered a spectrum of health outcomes including respiratory disease, cumulative trauma disorders (improving ergonomics), acute injuries, pesticide illnesses, and general health status of hired farmworkers. Health policy is also a focus of the Center, with one current project addressing the cost of occupational injuries in agriculture. Center programs follows the classical public health model of disease characterization, hypothesis testing for identification of significant mechanisms, risk factors or other determinants of disease, and intervention/prevention modalities to reduce morbidity and mortality. Several research projects have a very direct and identifiable connection to prevention, e.g. safety education and agricultural injury prevention among high school students, improving cost-effective and accurate blood cholinesterase determinations, exposure assessment for control strategies.

The Educational projects of the Center were important component of our efforts. Under the direction of Dr. O'Connor-Marer, 177 "Train-the-Trainer" Workshops have been conducted with 4,462 community members participating. It is projected that this information will result in pesticide safety skills being extended to over 820,000 agricultural workers. Other educational efforts have focused on rural health care providers. A unique educational effort supported by the Center has been educational efforts for pesticide and microbiological hazards focused on minority farmers and farmworkers, including Hmong, Cambodian and Lao.

Intervention/prevention projects have similarly covered a breadth of important interventions to reduce agricultural illness and injury. Dr. Kiyoung Lee has focused on reducing exposure to

respiratory toxins. He also collaborates with other investigators focused on etiologic studies. Dr. Miles' work addresses ergonomic interventions to reduce cumulative trauma disorders. This is of particular value because of the large number of labor intensive commodities grown in California. Dr. Miles and his group have developed several interventions that have improved the efficiency of farm labor AND reduced the risk of cumulative trauma injury.

The Center was fortunate to utilize the resources of various state agencies. For example, the statewide pesticide illness registry has been used for studies on the epidemiology of pesticide illness in California (Weinbaum, Schenker et al. 1997). Surveillance by the State Health Department had been utilized in this proposal to analyze statewide respiratory disease due to agricultural exposures.

Evaluation of all Center projects, and in particular intervention/prevention efforts, was an intrinsic part of the Center. Programs also address policy, economic and cultural issues as they related to agricultural health and safety. It is the Center's belief that the complexity and variety of health and safety problems in agriculture require such a diversity of approaches. Center programs include collaborative efforts in Hawaii, Arizona, Nevada and Washington. This application also proposes an alternating annual conference with the Pacific Northwest Agricultural Health and Safety Center, with which the Davis Center has much in common. Collaboration with these western states is appropriate because of similar agricultural conditions and practices.

Finally, the Center maintained a strong commitment to teaching at all levels of instruction. This includes many graduate students who have been attracted to work in the field of agricultural health and safety, lectures and courses to undergraduate, graduate, medical student, fellow and continuation education audiences. Center faculties also are active in educating the public in agricultural health and safety issues via a variety of popular press and public forums. Collectively the Center has had an enormous impact on improving health and safety in Western agriculture.

Major Accomplishments 2001-2006

The range of past research, intervention/prevention and education projects and activities in the Center reflected the depth of expertise, the diversity of health and safety problems in California agriculture, and a breadth of approaches to disease prevention and health promotion. Past research projects not only were weighted to field-oriented efforts, but also were vertically integrated to include bench science addressing the mechanisms and biologic markers of disease from agricultural toxins, particularly demonstrated in the case for respiratory and neurological health outcomes (Schenker). Research projects have covered a spectrum of health outcomes including respiratory disease (Schenker, Pinkerton), cumulative trauma disorders and ergonomic injuries (Miles, Fathallah), acute injuries (McCurdy), pesticide illnesses (Wilson, Shan), and general health status of hired farmworkers (Mines, Villarejo). Center programs have followed the classic public health model of disease characterization, hypothesis testing for identification of significant mechanisms, risk factors or other determinants of disease, and intervention/prevention modalities to reduce morbidity and mortality. Several research projects

have had a direct and identifiable connection to prevention, including safety education and agricultural injury prevention among high school students (McCurdy), improving cost-effective and accurate blood cholinesterase determinations (Wilson), and exposure assessment for control strategies (Shan). One Center study focused on investigating the costs of agricultural injuries and diseases, highlighting the high cost of agricultural injuries to the country (Leigh).

The educational projects of the Center have been an important component of our efforts. Under the direction of the past deputy director, Dr. O'Connor-Marer, hundreds of "Train-the-Trainer" workshops have been conducted with more than 5,000 community members participating. It is projected that this information will result in pesticide safety skills being extended to over 820,000 agricultural workers. Other educational efforts have focused on rural health care providers. A unique educational effort supported by the Center has been educational programs on pesticide and microbiological hazards focused on minority farmers and farmworkers, including Hmong, Cambodian and Lao (Jolly). Intervention/prevention projects have similarly covered a breadth of important interventions to reduce agricultural illness and injury. One of the funded intervention projects focused on ergonomic interventions to reduce cumulative trauma disorders (Miles). This has been of particular value because of the large number of hired farmworkers and labor-intensive commodities grown in California. Dr. Miles and his group have developed several interventions that have improved the efficiency of farm labor and reduced the risk of cumulative trauma injury.

The Center has been fortunate to have access to the resources of various state agencies. For example, the statewide pesticide illness registry has been used for studies on the epidemiology of pesticide illness in California (Schenker). Surveillance data by the State Health Department has also been used to analyze statewide respiratory disease due to agricultural exposures (Harrison). Evaluation of all Center projects, and in particular intervention/prevention efforts, is ongoing and is an intrinsic part of the Center. Programs also address policy, economic and cultural issues as they relate to agricultural health and safety. It is the Center's belief that the complexity and variety of health and safety problems in agriculture require such a diversity of approaches.

WCHAS has shown a strong commitment and facilitated seed funding to support promising graduate students and their research. Some of the successfully executed graduate research projects and the students and mentors associated with the research include: *Pesticide Safety Education And Standardizing Cholinesterase Monitoring for Agricultural Workers in Washington (*Daniel Arrieta, Wilson); *Farm Work and the Epidemiological Paradox of Low Birth weight Delivery Among Hispanic Women In California* (Jeff Bethel, Schenker); *Design Of A Prototype Winegrape Picking Container Handling System For Commercial Use* (Andrew Holtz, Miles); *Particle Effects on an Allergic Model of Asthma* (Jeffrey Sherman, Pinkerton); and *Development and Evaluation of Foliar Dust Exposure Assessment* (Jodi Smith-Davis, Lee).

Our overall objective was to investigate the multifaceted health and wellness of farmers and agricultural workers, their families, and their communities, particularly those issues unique to Western agriculture, and to prevent disease and injury among these groups by translating

research findings into engineering solutions, policy initiatives, and culturally-sensitive outreach.

The diverse expertise of the Center faculty enables varied, largely field-oriented research projects and interventions. Several areas of Center efforts have been of particular note, including bilingual/bicultural health and safety efforts among immigrant farm workers, respiratory disease from exposures in Western dry farming environments, and engineering better ergonomic solutions to reduce acute and cumulative trauma injuries in agriculture.

A major goal of the Center has been to apply research findings into practical and effective field solutions. This goal has been achieved by numerous methods, including "technology transfer" for engineering solutions, communication of research findings to the diverse agricultural community via multiple routes, and collaborative efforts with the state legislature, state agencies, cooperative extension, and various stakeholders. Our endeavors to improve the health of hired farm workers, largely Hispanic immigrants, have been a major effort.

B. Changes to the Center that occurred during 2001-2006

2001 – 2006					**2006 – 2011 (Proposed)**			
Title	**PI**	**Co-PI's**	**Full Proj.**	**Pilot Proj.**	**Project Number & Title**	**PI**	**Co-PI's**	**Full Proj.**
Incident Disease and injury among a Cohort of CA Farmers and Farm Operators	Schenker	Lee, Beckett, Hnzido McCurdy	X		1. Farm Worker Family Health Cohort Study	Schenker	Bennett, Butler, McCurdy, Liu	X
Agricultural and Environmental Health for Latino and Indigenous Farm Workers	Schenker	McCurdy	X					
Pilot Study to Measure Exposure to Air Particles on CA Dairies	Mitloehner			X	2. Respiratory Health and Exposures on Large Californian Dairies	Mitloehner	Bennett, Vogel, Yang, Schenker Reynolds	X

Health Effects of Ambient Airborne Particles from the Sacramento/San Joaquin Valley	Pinkerton	Sioutas	X		3. Health Effects of Airborne Agricultural Particles from the Sacramento/San Joaquin Valley	Pinkerton	Kleeman	X
Developing, Improving and Applying Cost-Effective and Accurate Human Blood ChE Determinations	Wilson	O'Malley, Shen McCurdy	X		4. Rapid Assays for Human and Environmental Exposure Assessment	Hammock	Gee, Bennett, Gonzalez-Sapienza	X
Development and Implementation of Pyrethroid and Paraquat Immunoassays for Human Exposure Monitoring	Shan	Hammock		X				
Evaluation of the NAGCAT Tractor Guidelines	Fathallah		X		5. Efficacy of Weight Transfer Devices in Reducing Low Back Pain in Stoop Labor	Fathallah	Miles, Meyers, Faucett	X
Prevention of Musculoskeletal Disorders in Hand Harvest of Vegetable Crops	Miles			X				
Evaluation of the Ergonomics of an Alternative	Miles			X				

System for Harvesting Pears								
Safety Education and Agricultural Injury Among CA Rural High School Students	McCurdy	Lee	X		6. Needs Assessment and Outreach to Minority Agricultural Communities in CA and HI	McCurdy	Swift	X
Best Management Practices for Pesticide Use and Food Safety Among CA's Small Farmers with Particular Reference to Limited English Speaking an Cultural Minority Farmers	Jolly	O'Connor-Marer		X				
An Intensive, Regional Approach to Occupational Research Priorities for CA Farm Workers	Lighthall	Mines		X				
Extending Pesticide-Related Health & Safety Programs to Underserved Agricultural Populations in the Western US	O'Connor-Marer	Weber		X				
Extending the California Worker	Baker			X				

Occupational Safety and Health Training and Education Program (WOSHTEP) to Agriculture								
Costs of Occupational Injuries in Agriculture	Leigh		X					

Overall Unique Challenges in the Study of Western Agriculture

California agriculture is the largest and most diverse in the country, producing $30+ billion/year (16% of all U.S. crop production) on 2.5% of its cropland. The state produces over 250 major agricultural commodities, leading the country in the production of 60 of them. It produces 39% of the nation's vegetables and melons; 53% of the nation's fruits, nuts, and berries; and 24% of the greenhouse and nursery products. California agriculture differs from agriculture in other regions of the country in many ways, including climate (drier than average for the U.S.), production methods (labor intensive), organization (management-farm labor), and regulatory issues.

The large and increasing number of farm workers in California necessitates a center for agricultural safety with the ability to address the needs of this underserved population. There are 70,000+ farms in California, ranging from small owner-operated to large corporate farms. Farm workers provide ~85% of farm labor in the state; in 2004, there were as many as 1.5 million hired farm workers. Mortality data confirm a higher rate of overall and cause-specific mortality in California farmers and farm workers. Over 20,000 disabling injuries are reported annually among agricultural workers in California, and it is estimated that the actual number may be twice as high. Excess mortality has also been documented for agricultural workers who have filed compensation claims. The true magnitude of illnesses due to agricultural work is unknown, since these are not captured by worker's compensation or other surveillance systems. Finally, the desperate health condition of California's hired farm workers was recently documented in a report co-authored by Center investigators (Villarejo, 2000). This survey found that almost every measured health parameter was worse than in reference populations. Health care services were infrequently used, particularly for preventive care. For example, 70% had never had an eye care visit, and almost 50% reported never having had a dental visit. Seventy percent had no health insurance, and 30% of men and 12% of women reported never visiting a doctor or clinic.

Future Plans 2006-2011

The Center's proposed program over the next five years is integrated and comprehensive, highlighting the strengths embodied by WCAHS investigators. Four research projects, one

intervention/prevention project, and one outreach/translation project, have been selected to connect basic and population research with outreach The interaction of proposed center projects will provide complementary efforts to ultimately improve agricultural health and safety. We view improving agricultural health and safety as a continuum among (a) problem identification, (b) research to identify underlying causes and effective interventions, (c) outcome assessment, and (d) outreach/translation efforts to have a real-world impact on the affected populations. For example, air samples collected in large California dairies (Project 2) are analyzed in assays used to analyze particle samples from a variety of California environments (Project 3). Knowledge of the behaviors and tasks associated with increased risk of repetitive stress injuries (Project 5) are utilized to evaluate the health status of a population-based sample of farm worker families (Project 1). All projects will interact with Project 6 to improve methods for the translation of research findings into improved practices to reduce illness and injury.

The proposed projects for the next funding period are:
1: Farm Worker Family Health Cohort Study (M. Schenker, PI)
2: Respiratory Health and Exposures on Large Californian Dairies (F. Mitloehner, PI)
3: Health Effects of Airborne Agricultural Particles from the Sacramento/San Joaquin Valleys (K. Pinkerton, PI)
4: Rapid Assays for Human and Environmental Exposure Assessment (B. Hammock, PI)
5: Efficacy of Weight Transfer Devices in Reducing Low Back Pain in Stoop Labor (F. Fathallah, PI)
6: Needs Assessment and Outreach to Minority Agricultural Communities in CA and HI (S. McCurdy, PI)

Broader Impact of the Western Center for Agricultural Health and Safety

Many agricultural practices relevant to health and safety begin in California and then spread to other parts of the country. This is significant due to the increasing reliance on immigrant, Hispanic hired farm workers. Understanding the causes of illness and injury in this large and important human agricultural resource is essential to disease prevention and health promotion in the fields of 21st century American agriculture. Efforts of the WCAHS have begun to understand the contribution of agricultural work, poverty, acculturation, stress, and other factors on their health. This is essential to implementing appropriate interventions, including behavioral, environmental, engineering, and policy efforts. Research, interventions, and education/outreach of the WCAHS promise to influence agricultural health and safety across the country as the face of agricultural labor changes. Paradigms developed for small family farms are not appropriate for an agricultural workplace populated by immigrant farm workers and their families. Because the health of this population is critical to the health of our agriculture, we are proud to have played a leading role in this effort. We look forward to providing leadership across the country to reduce the health disparities of all agricultural populations.

Administrative, Planning, and Outreach Core

The Western Center for Agricultural Health and Safety (WCHAS) Administrative, Planning, and Outreach Core provides general oversight and management of the Center. It consists of the Center Director and Associate Director and administrative staff. The objectives of the Core are to: 1) Coordinate and facilitate interactions between program investigators; 2) Provide accounting and human resources support for all projects; 3) Maintain the data sharing Web site and organize data from all projects for incorporation into the Web site; 4) Promote training and education of all program participants, especially young researchers, and disseminate the results of the research to the scientific community, stakeholders (industry, farm workers, government) and to the public as a whole via newsletter, web, public speakers and other media; 5) Make available and oversee seed and feasibility funding to graduate students and new investigators; 6) Serve as a liaison to NIOSH, campus administration, and other campus units. This includes the preparation of annual reports and other materials. The Center Communication and Outreach for Research and Education (CORE) programs are coordinated by the Administrative, Planning, and Outreach Core, and work closely with the Center Director and Manager. The CORE goals include promoting two-way communication between the WCAHS and populations served. This includes organizing and staffing meetings and presentations of WCAHS investigators and of community and stakeholder groups. These meetings serve the functions of information seeking, dissemination of findings and education. All meetings of the internal and external advisory committees are coordinated and staffed by the administrative unit. The Internal Advisory Committee consists of representatives from the center investigators and from the Schools of Medicine, Veterinary Medicine and Agriculture and Environmental Sciences. The External Advisory Board consists of representatives from various stakeholder groups including farmers, farm workers, government agencies, commodity groups and industry representatives. Conference planning, including the joint conference with PNASH, is coordinated by the Core personnel. The Feasibility/Pilot Projects Program, also administered by the Administrative, Outreach, and Planning Core, encourages the development of creative research, prevention/intervention, translational, and outreach projects. It supports short-term research and outreach projects addressing agricultural health and safety needs, especially those with a high likelihood of leading to further funding from extramural sources. It provides a means for involving graduate students and investigators new to the Center to study agricultural health and safety, and it provides support for new and innovative directions in agricultural health and safety.

Projects for the Proposed Funding Period and their Interactions

The Center’s proposed program over the next five years is integrated and comprehensive, highlighting the strengths embodied by WCAHS investigators. Four research projects, one intervention/prevention project, and one outreach/translation project, have been selected to connect basic and population research with outreach

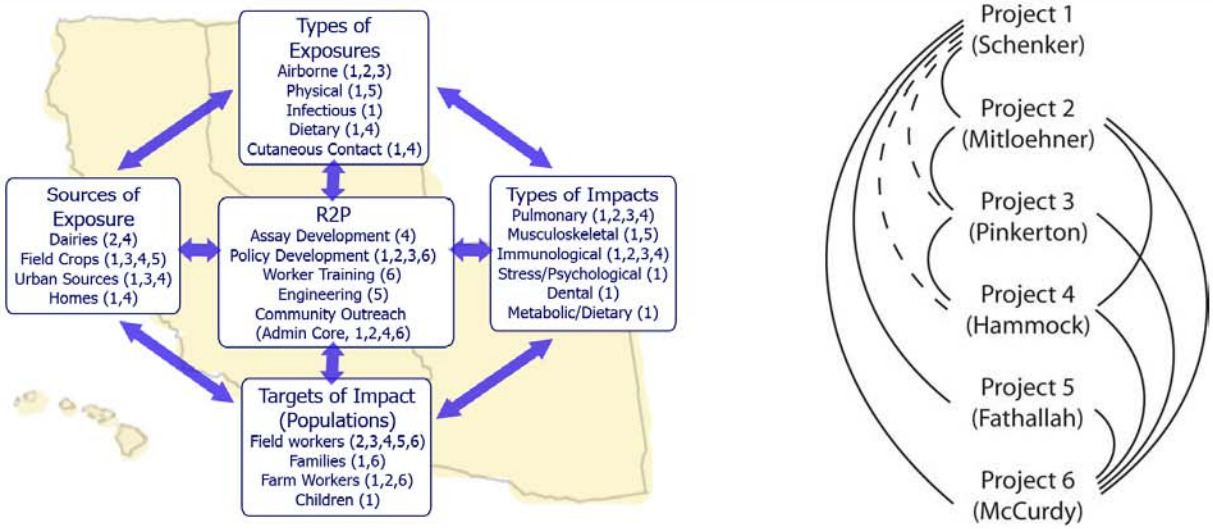


Fig. 1 WCAHS Project Interactions. Left: The scope of the WCAHS covers numerous types and sources of hazardous exposures, as well as many types and targets of impacts. Overall, there is substantial "research to practice" (R2P) application of the proposed research and activities (project numbers in parentheses). Right: The projects will have substantial interactions, including the sharing of activities, populations, materials, and ideas. Formal interactions are indicated by solid lines; potential interactions are indicated by dashed lines.

The interaction of proposed center projects (Figure 1, right) will provide complementary efforts to ultimately improve agricultural health and safety. We view improving agricultural health and safety as a continuum among (a) problem identification, (b) research to identify underlying causes and effective interventions, (c) outcome assessment, and (d) outreach/translation efforts to have a real-world impact on the affected populations. For example, air samples collected in large California dairies (Project 2) are analyzed in assays used to analyze particle samples from a variety of California environments (Project 3). Knowledge of the behaviors and tasks associated with increased risk of repetitive stress injuries (Project 5) are utilized to evaluate the health status of a population-based sample of farm worker families (Project 1). All projects will interact with Project 6 to improve methods for the translation of research findings into improved practices to reduce illness and injury.

Institutional Commitment To The Agricultural Center

Since its inception, the Western Center for Agricultural Health and Safety (WCAHS) at UC Davis has received substantial support from the campus as a whole and from the individual colleges involved with the program, specifically the Schools of Medicine and Veterinary Medicine, the College of Agriculture and Environmental Sciences, and the College of Engineering. The University's commitment and esteem has been reflected at the highest level by allotting faculty recruitments that address agricultural health and safety. Two recruitments are worth noting. Fadi Fathallah is a new faculty position in agricultural engineering with a specific focus on reducing acute and chronic injury among agricultural workers. A second recruitment is Dr. Deborah Bennett, who does work on exposure assessment with a particular

focus on indoor environments.
The primary route of institutional commitment to the Center has been through matching equipment funds and support for graduate student fees; additional support is provided by existing centers on campus. For this proposal, and other large campus proposals, support is now coordinated through the Academic Coordinating Council for Life Sciences (ACCLS), a body composed of the Deans of the various life science colleges, the Vice-Chancellor for Research, and the Dean of Graduate Studies. For this renewal the ACCLS has committed $100,000 per year for five years, or $500,000 total. The $500,000 will provide a $24,100 stipend plus $9,226.50 in resident fees for three students per year for five years.

Additional institutional commitment has been received by in-kind support from the UC Davis General Clinical Research Center (GCRC). This NIH-funded Center under the direction of Lars Berglund, PI, is located in an 8000 sq. ft. facility at the Sacramento VA Medical Center. The GCRC provides infrastructure support for clinical and field-based research activities at UC Davis. It will support clinical services in the Hispanic Farmworker Cohort Study (MICASA, Project 1). Specifically, the GCRC will support staff and equipment at the field location for phlebotomy, sample processing, and transportation and storage.

The NIEHS Center for Environmental Health Sciences (CEHS) at UC Davis (F. Matsumura, PI) has also provided valuable institutional support for the WCAHS. Specifically, pesticide assays of our field samples have been analyzed at reduced or no cost by NIEHS investigators (Buckpitt, Hammock). WCAHS research has also benefited by the close interaction with CEHS investigators studying respiratory disease (Pinkerton, Plopper) and reproductive health (Lasley).

The new San Joaquin Valley Aerosol Health Effects Research Center (SAHERC) funded by the U.S. Environmental Protection Agency at UC Davis will form strong ties with the WCAHS to study the health effects of airborne particles in the San Joaquin Valley over the next 5 years. The University has committed significant support for equipment and graduate training to assist this research effort. The institutional support provided for the SAHERC and WCAHS will be highly complementary, enabling both to study air quality-based health and safety research in the agricultural setting. Shared faculty members (Bennett, Gee, Hammock, Kleeman, Mitloehner, Pinkerton, Schenker) will coordinate common research. Institutional resources that can be readily shared are already in place throughout the San Joaquin and Sacramento Valleys, such as the mobile unit for air monitoring and animal exposures, the concentrator for airborne particles, etc. and will provide powerful leverage to assist in data acquisition and basic research at a number of field sites

The Center’s close relationship with various state agencies provides us with access to their resources, which reflects another source of institutional commitment to the Center. For example, the outstanding and unique statewide pesticide illness registry has been used to study the epidemiology of pesticide illness in California (Schenker). Surveillance data by the State Health Department has also been used to analyze statewide respiratory disease due to agricultural exposures. Staff members from various state agencies provide service to the center by serving on our Internal (Schreider) and External (Krycia) advisory panels.

Resources

University of California, Davis

The University of California, Davis (UC Davis) is one of the nine campuses of the University of California, which was chartered as a land grant college in 1868 and now constitutes the pre-eminent system of public higher education in the country. UC Davis is the largest of the nine University of California campuses, with 5,300 acres, second in total expenditures and third in enrollment. UC Davis is among a select group admitted into the prestigious Association of American Universities. Membership in this group of 61 institutions of higher learning is by invitation only. The university is ranked 11th among public universities nationwide by US News and World Report. UC Davis offers 103 undergraduate majors and 80 graduate programs. Current student enrollment is approximately 30,000.

UC Davis has one of the fastest-growing and largest university research budgets in the nation at $426 million. The National Science Foundation ranks UC Davis 14th in research funding among U.S. universities.

The UC Davis Medical Center ranks among the U.S.'s best hospitals in cancer, respiratory disease, kidney disease, hormonal disorders, digestive disorders, geriatrics and rheumatology, emergency medicine, and pediatrics. The UC Davis Cancer Center is Inland California's only National Cancer Institute-designated cancer center and has one of the nation's largest clinical trials programs.

Major research departments and programs of the UC Davis Health System include Cancer Center Research, AIDS Clinical Trials Unit (ACTU), Biomedical Informatics Research and Consulting Service (BIRCS), Center for Health Services Research in Primary Care, Center for Healthy Aging, Center for Nursing Research, Center for Tissue Regeneration and Repair, Children's Hospital Research, Clinical Nutrition Research Unit, Clinical/Translational Research Investigator Services (CRISP), General Clinical Research Center (GCRC), Imaging Research Center, M.I.N.D. Institute, North-Central California Center for AIDS Research (NCCFAR), Neurological Surgery, Obstetrics and Gynecology, Ophthalmology, Pain Medicine, Psychiatry Research, Transplant Center Research, and Violence Prevention Research Program.

Computer Facilities

The Division of Information Technology (I.T.) provides computing, communications and media resources and services in support of research and instruction. I.T. provides to each student, staff and faculty an email account, and consults about the various information technologies on the UC Davis campus. The University of California, Davis, has a computer service facility, which provides full capabilities for data handling and statistical comparisons. Two VAX 8600 (clustered VMS), 3 VAX 8500 (Dec Ultrex), and 30 Sun 3/50 9served by Sun 3/26) computers comprise the general campus facility.

Library

The General Library at UC Davis is one of the premier research libraries in North America. In addition to Peter
J. Shields Library, there are four other General Library Facilities: the Physical Sciences Library, the Loren D. Carlson Health Sciences Library, the Agricultural and Resource Economics Library and the Medical Center Library in Sacramento. The combined collects of the various General Library facilities total more than 2.6 million volumes, and more than 41,000 periodical and journal titles are received annually. The MELVYL @ System, an online catalog of books and journals, can be used to access the collections of UC Davis and the other eight UC campuses. The libraries also offer access to databases and numerous other electronic resources, both on-site and via UCD Network.

UC Davis Health System: School of Medicine and UC Davis Medical Center

The UC Davis Health System, comprised of the UC Davis School of Medicine and UC Davis Medical Center, is nationally recognized and excels at translating scientific discoveries and new technologies into improved patient care and community-wide health. Faculty in the School of Medicine specialize in a wide range of basic and applied research. More than 350 research studies are currently underway in the School of Medicine facilities in Davis and at the Medical Center in Sacramento, funded by federal, state, foundation, and pharmaceutical/biotechnology sources. The UC Davis School of Medicine also collaborates with several affiliated research institutions, such as Shriners Hospital for Children, Veterans Affairs Northern California Health Care System, USDA Western Human Nutrition Research Center, and Lawrence Livermore National Laboratory. In addition, School of Medicine faculty are engaged in innovative collaborations with the California Regional Primate Research Center, School of Veterinary Medicine, Division of Biological Sciences, College of Agricultural and Environmental Sciences, and College of Engineering.

Department of Public Health Sciences

The Department of Public Health Sciences is a clinical and basic research department in the UC Davis School of Medicine. Our mission is to improve the health of people through population-based approaches by carrying out educational programs, epidemiologic research, public service and policy development. The focus of our effort is on health promotion and disease prevention, occupational and environmental health, health care delivery, gerontology, ethical issues, reproductive, rural, minority and international health. The Department of Public Health Sciences has a core computing facility consisting of 2 DEC Open-VMS Alpha servers, a Sun Solaris server, 3 Dell Windows NT servers, and 5 network laser printers. The servers provide centralized file storage and backup, research data management and analysis, and web-based services to the research and administrative components of the department as well as Internet services to department members when off site and to the general public. The Department locations are fully networked with high speed Internet access. The Department also owns 28 flatbed scanners, optical mark reader, and laser slide maker. The Department has approximately 4,000 square feet of office space on the UC Davis campus, and an additional 4,000 square feet off campus.

Division of Biostatistics

The Division of Biostatistics in the Department of Public Health Sciences supports basic and

clinical research in the School of Medicine and conducts research on biostatistical methodology. We provide support to investigators throughout the School of Medicine. The Division of Biostatistics occupies 2000 square feet on the Davis campus, adjacent to the Genome Center and other basic science buildings, including space for faculty, staff, graduate students, and servers. In addition, Division faculty share the use of a small suite of offices with use of conference room and additional work spaces in the CRISP research support facility on the Sacramento campus of the School of Medicine, for meetings with Sacramento-based faculty. All division faculty have high-speed desktop and laptop computers. Statistical software available to Division of Biostatistics researchers includes SAS, S-Plus, R, NQuery, and Stata.

Division of Epidemiology

The Division of Epidemiology conducts research in areas ranging from women's health, cancer, children's health and development, and agricultural health risks, to behavioral sciences and economic impact of occupational illness and injury. We develop and use research methods to understand patterns and etiology of disease, developmental disorders, and injury and disability in populations. We currently have research projects assessing lifestyle and environmental factors related to endocrine changes and symptoms of menopause in a multi-ethnic cohort, environmental exposures affecting childhood development, dietary intervention for early stage breast cancer, adverse hormonal and reproductive effects of environmental contaminants, occupational exposures adversely affecting hormonal function and reproductive health, and dietary effects on cancer risk, and health and labor economics.

Division of Environmental and Occupational Health

The Division's unique strengths lie in environmental and occupational health research including exposure assessment, environmental and occupational epidemiology, clinical studies and toxicology. Research addresses a wide range of disease including respiratory, cancer, neurologic, reproductive, developmental, dermatologic, and traumatic outcomes. Specific occupations or industries of interest include agriculture (farmer, farm-worker and family member health) and the semiconductor industry. Research addresses environmental exposure to air pollution, asbestos, pesticides, environmental tobacco smoke, heavy metals and other toxins. In addition, the Division provides expert diagnostic and therapeutic clinical services through its Occupational and Environmental Medicine Clinic, located at the UCD Medical Center in Sacramento. Our physicians provide diagnosis and treatment of occupational and environmental conditions, consultative services, medical-legal evaluations, and occupational health surveillance.

Center for Health and the Environment

The Center for Health and the Environment (CHE) is a center of excellence within the John Muir Institute of the Environment (JMIE). The focus of research in CHE is the effect of environmental agents, including chemicals and radiation, on the health of humans, animals and other organisms. To investigate these issues, researchers at the CHE conduct epidemiologic studies in human populations, and experiments are performed with animals, organisms, cells, and molecules to measure environmental exposures as well as health outcomes associated with them. In addition,

research on the development of agents for population control of humans and wildlife seeks to mitigate the adverse effects of overabundance on the environment.

CHE is located on the Southern boundary of the UCD campus on 15.75 acres of land. The laboratory complex consists of sixteen buildings with a total of 57,614 square feet. CHE has a local area network that is tied into the campus UCDNet and the Internet. The main building has a secure 700 square foot computer room for network hardware and departmental servers. There are 75 network connections scattered across 7 buildings. All network connections on site are 100Base-T. The link to the campus network and the Internet is gigabit Ethernet. A staff Information Systems Manager is responsible for the network and computer facility.

Two laboratory buildings provide specialized facilities at CHE. The cell biology building has three laboratories that are designed and equipped for tissue culture. Air flow in the building is designed to provide positive pressure in the laboratory and, thereby, reduce the risk of outside contamination.

The Toxic Pollutant Health Research Laboratory (TPHRL) consists of 5,000 square feet of specialized and total containment laboratory space including 600 square feet of animal holding space equipped with metabolism cages. Individual exposure rooms have a variety of inhalation exposure systems including small chambers for rodent exposures, and nose-only exposure systems for rodents, rabbits, or guinea pigs. Specialized facilities have been constructed in this building for the study of environmental tobacco smoke. Also in the TPHRL are a multi-function sample chemistry laboratory where the various analytical functions are performed, a necropsy room for in-house postmortems, and a tissue processing and digest room where biological samples are processed for assay. Procedures involving concentrated forms of toxic materials are performed in the toxic materials preparation room and decontamination of equipment in the decontamination room. TPHRL has a ventilation/filtration system which prevents releases of radiolabeled or organic vapors into the environment. Supplied breathing air is available throughout the building for the protection of the researchers. The facility also has 1,500 square feet of general office and non-containment support areas, and 3,850 square feet of mechanical support spaces. The inhalation facilities in TPHRL which provide exposure to environmental tobacco smoke are available to campus investigators on a recharge basis.

College of Agricultural and Environmental Sciences

The College of Agricultural and Environmental Sciences (CA&ES) of UC Davis consists of approximately 400 faculty members located in 22 departments. The college remains internationally recognized for the excellence of its programs, generally being ranked as the best in the world in food and agricultural sciences and among the best in environmental sciences.

The college is actively engaged in outreach to farmers, families, children and communities in California. Much of this effort takes place through the University of California Cooperative Extension (UCCE). Other programs focus on working with international students and scholars, publicizing the benefits of CA&ES research, and strengthening relationships with industry. CA&ES is dedicated to working with California's citizens and communities to address

important societal needs, provide leadership in developing science-based solutions and assure a prosperous, sustainable future.

Small Farm Center

The Small Farm Center, part of the University of California's Division of Agriculture and Natural Resources, and located on the UC Davis campus, was established to respond directly to the needs of farmers, researchers, organizations, farm advisors, and consumers by providing research results, publications, and educational programs on small farm topics. The Center serves as a clearinghouse for questions from farmers, marketers, farm advisors, trade associations, government officials and agencies, and the academic community; maintains a library of books, scientific and popular journals, reports, directories, and periodicals covering production, marketing, and policy issues; publishes manuals, proceedings, pamphlets, leaflets, and a quarterly newsletter, *Small Farm News*, that includes news of upcoming events, publications, topical issues, and profiles of farmers and farm advisors; organizes and coordinates statewide conferences, workshops, tastings, and symposiums, and supports advisors, farmers markets and farm organizations in regional and local programs; and provides leadership and coordination for the Small Farm Program. The Small Farm Program was created by the California Legislature in 1979 to enhance the viability of small- and moderate-scale agricultural producers by stimulating research and extension education in production systems, marketing, and farm management. Many of the farms served by the Small Farm Program are not reached by traditional extension activities. They represent many cultures and many different types of farming operations, and are located in all areas of California.

General Clinical Research Center

The UC Davis GCRC is a joint venture between the University and the Veterans Affairs Northern California Healthcare System (VANCHCS). The GCRC, which opened in August 2003, is located in an 8,000-square-foot area on the fourth floor in the new inpatient tower at the Sacramento VA Medical Center at Mather, about 10 miles east of the UC Davis Medical Center in Sacramento.

The mission of the General Clinical Research Center is to provide a central resource for clinical research and to serve a mentoring function in patient-oriented research for investigators from the VA Northern California Health Care System and UC Davis. The GCRC strives to promote the highest standards in clinical research and patient safety, and provides the resources necessary for investigators to conduct clinical studies. It operates as a central facility to promote mentoring of young clinical investigators, and serves as a conduit for education initiatives related to patient-oriented research.

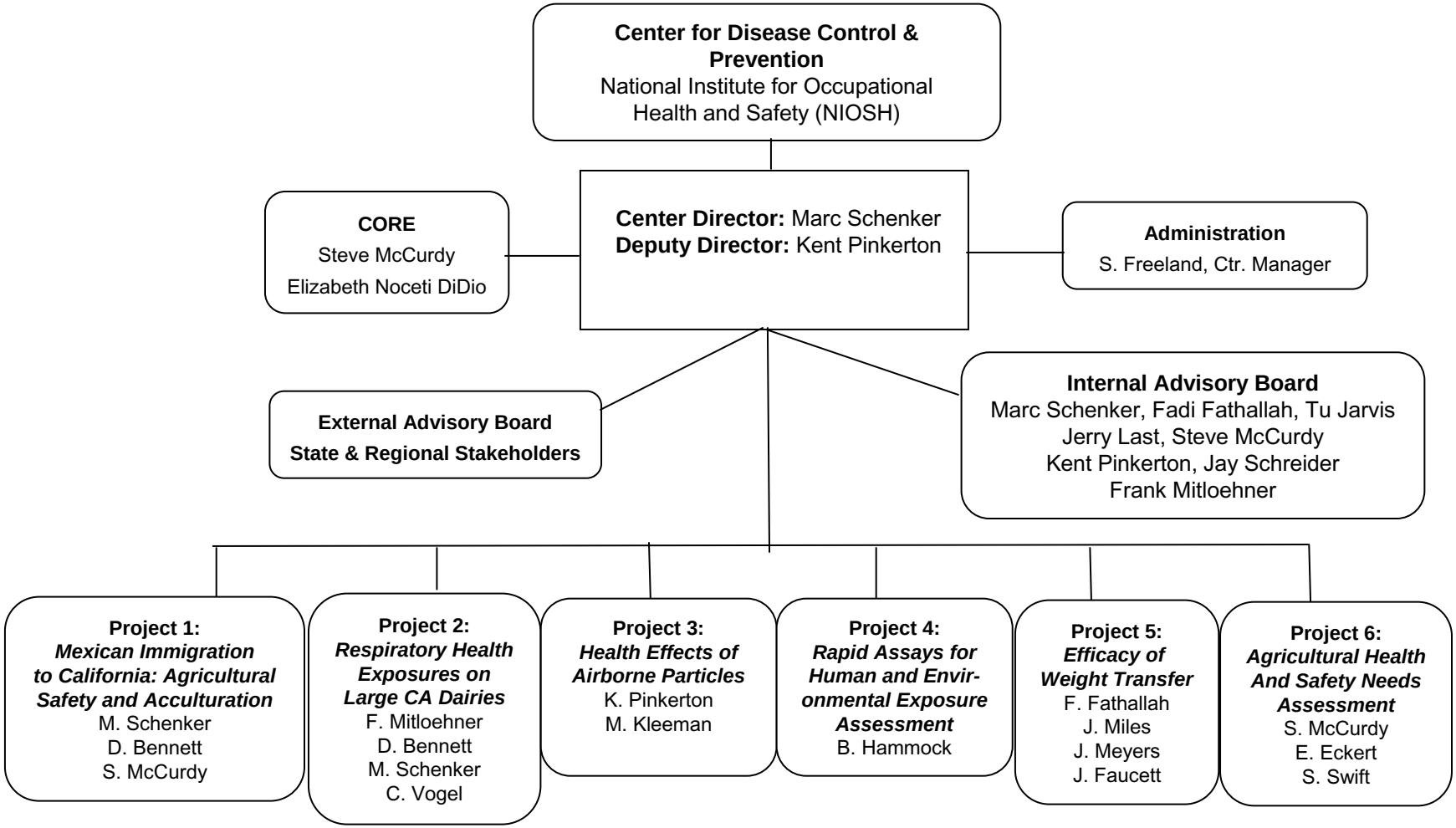
The nine-bed facility consists of three double and three single-patient rooms, a designated metabolic kitchen, a core laboratory, a body composition unit, videotaping facilities and offices for biostatistics, informatics and the administrative staff. In addition, the center has all the resources required for an inpatient facility, including a communication center, utility rooms, diagnostic area, storage facility and patient day room. The patient rooms are flexibly designed to allow for inpatient and outpatient activities. Adjacent to the GCRC is a state-of-the-art imaging

facility including PET, MRI and standard radiology equipment available to GCRC users.

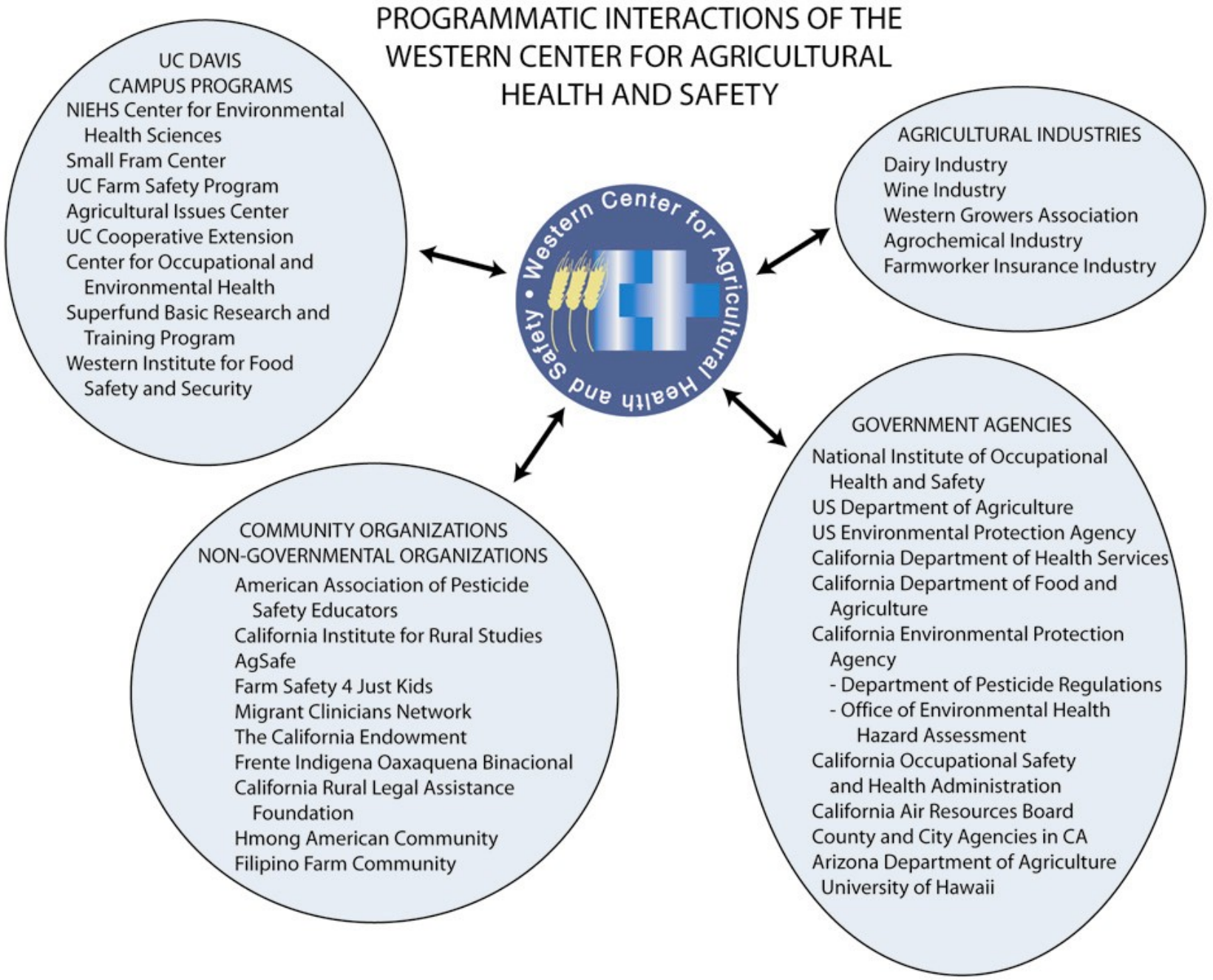
College Of Veterinary Medicine

The UC Davis School of Veterinary Medicine is the largest veterinary school in the nation, conducting an integrated, statewide mission of teaching, research, and service benefiting animal, human, and environmental health. It ranks first nationally in terms of research funding. Its services and programs are supported by a highly trained staff, a sophisticated array of diagnostic equipment (including MRI, x-ray CT, and ultrasound), and treatment equipment.

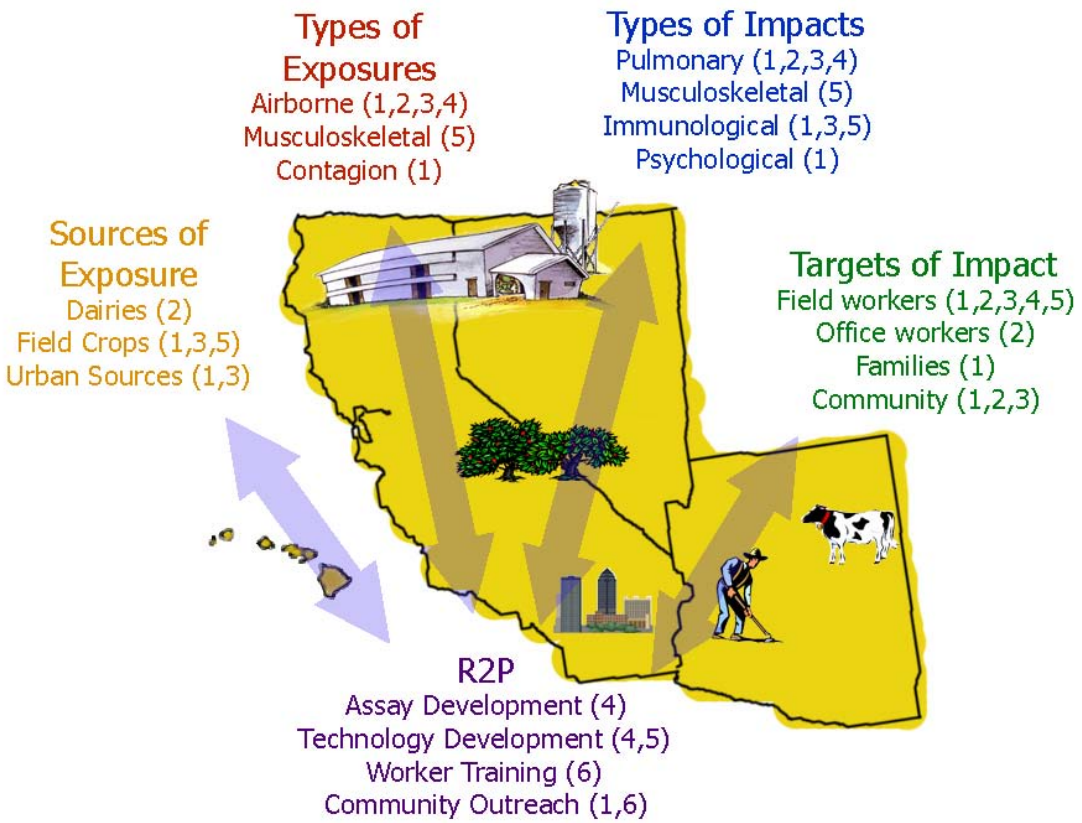
WCAHS Organizational Chart



PROGRAMMATIC INTERACTIONS OF THE WESTERN CENTER FOR AGRICULTURAL HEALTH AND SAFETY



WCAHS Projects Interaction Diagram



Western Center for Agricultural Health & Safety

Research

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Major Accomplishments 1990-1996

Incidence of Injury Among a Cohort of California Farmers and Farm Operators: Health Status of California Farm Operators

Principal Investigator: Marc B. Schenker, M.D., M.P.H., Director, UC Agricultural Health and Safety Center; Professor of Medicine and Department Chair, Department of Community and International Health, School of Medicine, UC Davis.

Objective: The objective to this study is to identify important health and safety problems among a representative sample of California farmers. A cross sectional survey has been conducted on a random sample of approximately 2000 California farm operators. Subjects completed a questionnaire on agricultural exposures, personal habits, and acute and chronic health problems including: hearing loss, respiratory conditions, dermatitis, stress, perception of health and safety risks, traumatic injury, musculoskeletal conditions, and reproductive outcomes. Follow-up investigation currently underway addresses respiratory disease in the population, including physiological measurements and on-site industrial hygiene evaluations. Subsequent studies will include follow-up of the entire population for incident injury and illness assessment. Information gained form this study will be helpful in directing future research geared toward improving health conditions of farm operators.

Accomplishments: A random sample of 1947 California farm operators have completed a cross-sectional telephone survey of agricultural exposures, personal habits, and acute and chronic health problems including: hearing loss, respiratory conditions, traumatic injury, musculoskeletal conditions and reproductive outcomes. This data has been analyzed with respect to risk factors for respiratory disease and reproductive health of female farmers. A follow-up investigation of respiratory disease in the population is currently underway.

The 1993 survey found that farmers are predominantly older (54 $\pm$ 13.4 yrs) white (84%) males (90%), educated (90% high school graduates) who smoke less than the general population (11.5% current, 33.8% ex, 54.3% never). .As expected, cigarette smoking was strongly associated with chronic respiratory symptoms. After adjustment in a logistic regression, the percent time spent in a dusty job was independently associated with persistent wheeze, chronic cough and chronic bronchitis. The association and dose response was strongest for persistent wheeze (low dust exposure OR=1.3, 95% CI = 0.8-2.0; high dust exposure OR = 1.9, 95% CI = 1.1-3.3). Additionally, living on the farm (OR = 1.6, 95% CI = 1.1 - 2.5) and male gender (OR = 3.3, 95% CI = 1.5 - 7.6) were independently associated with persistent wheeze. (Determinants of dust exposure in these California farmers have been characterized by studies closely coordinated with this cohort study, and described in project P1.)

The 1995 case-base survey selected a sub-sample of farmers interviewed in 1993 to further investigate respiratory disease symptoms. This investigation included a questionnaire follow-up, spirometry, blood sample for immunologic markers, and a two week 3x/day peak flow record. This study thus provided several additional pieces of data to better characterize the nature of respiratory symptoms and their causation. The association of persistent wheeze with dust exposure persisted. In addition, subjects reported worsening or onset of wheeze more often while performing farming tasks involving exposure to hay or straw and operating tractors or mechanical harvesters. PW was significantly associated with atopy (OR = 3.6, 95% CI 2.2, 5.6),

a history of asthma (OR = 3.6, 95% CI 2.4, 5.5), cigarette smoking (OR = 3.5, 95% CI 2.4, 5.0) and living on a farm (OR = 1.8, 95% CI 1.1, 3.0).

Health Among Female Migrant Farmworkers

Principal Investigator: Ellen B. Gold, Ph.D., Associate Professor, Department of Community and International Health, School of Medicine, UC Davis.

Objective: The objective to this study is to identify and determine the prevalence of reproductive health problems among farmworking and non-farmworking migrant women living in California. 340 women, aged 18 to 44 years, living in four Migrant Housing Centers in three California agricultural counties have been studied. Detailed information on occupational activities and exposure has been obtained for one randomly chosen pregnancy, occurring within the last 5 years. A limited (seasonal) prospective study of menstrual cycle characteristics has also been conducted in these women. An interviewer-administered questionnaire gathered detailed information on demographics, occupational activities and exposures, and reproductive health; a daily menstrual calendar over the 3-month harvest period, and pre- and post-season urine samples were collected. Major reproductive outcomes to be assessed are: variation in menstrual cycle length, miscarriage rates, pregnancy complication rates, and rates of premature delivery. Information gained from this study will assess the frequency of specific reproductive health problems in this underserved occupational population. It is hoped that information from this study will help to establish priorities for the health needs of female migrant farmworkers and their families and in guiding future preventive health efforts for them.

Accomplishments: A total of 340 women aged 18-44 years from 5 migrant housing centers in Northern California have been studied with detailed interviews and brief daily menstrual calendars over the summer agricultural season to investigate the relationship agricultural work activities and exposures to adverse reproductive health outcomes. 336 women in 5 migrant housing centers completed a baseline interview about reproductive and medical history and work activities. 92% of women completed menstrual calendars and provided a baseline urine sample, and 63% provided a post-season urine sample. 60% of women provided a baseline fingerstick blood sample. All data have been entered, verified, and range and logic-checked. Preliminary crude and bivariate of data analyses have been completed. mean age = 30.4 years (standard deviation = 7.5 years). mean educational level = 7 years (sd = 3.25). mean annual household income = $91 10 (sd = $4960). mean consecutive years returned to this center = 5.2 (sd = 5.8). 90.2% were born in Mexico, and 68% were Mexican residents. 98.8% were married or living as married. 57.7% were employed in field work, 10.7% in non-field work. Field workers worked a mean of 5.9 (sd = 0.8) and a of 9 (sd = 1.6) with a mean of 8.7 (sd = 1.9) standing. 2) 48.8% of field workers worked with tomatoes, 14.5% with cherries.
total pregnancies = 890, mean = (sd = 5% resulted in low birth weight, 8.3% in miscarriage, and 2.3% in stillbirth. of those who had pregnancies, 72.9% did not work during pregnancy; of those who did, 91.8% stopped work during pregnancy, with the mean month of stopping = 4.9 (sd = 2.1 months). the proportion of pregnancies ending in miscarriage, stillbirth or low birth weight did not differ between those performing field work and those not working during pregnancy, although the number of women employed in field work during pregnancy was small (n=39)

mean age at was 12.8 years (sd = 1.55); mean menstrual cycle length did not differ among women performing field work and women employed in other work or not employed, although the mean days of menstrual bleeding was slightly lower in field workers (1.4 days) than in those not employed only 4.6% of women were current smokers and on average smoked less than 5.8% were past smokers; mean body mass index 78% of women reported having no health insurance, and 32.4% no access to a health care provider; 8.9% reported having health impairments. mean pre-season cholinesterase level = 14.1 (sd = mean post-season cholinesterase level = 14.7 (sd = 1.9); mean pre-season cholinesterase levels did not differ significantly between field workers, non-field workers and unemployed women.

Improving and Developing Assays for Detection of Worker Exposure to Agricultural Chemicals

Principal Investigator: Barry Wilson, Ph.D., Professor of Environmental Toxicology and Avian Sciences, Department Chair of Avian Sciences, UC Davis.

Objective: The objective of this project is to develop more sensitive ways to assess the hazards from exposure to pesticides in the agricultural work place, making possible refined studies of and designs to minimize pesticide exposure. In collaboration with CDFA, the investigators will compare and develop techniques of determining exposure of agricultural workers to pesticides, using organophosphates (OPS) and organocarbamates (OC') as models. Biomarkers and indicators of effects of exposure include standardized blood cholinesterase (ChE) tests, immunoassays for blood enzymes and other pesticide-binding proteins, and determination of pesticide urinary metabolites. Methods of determining blood enzymes that monitor exposure to OP and OC pesticides and general state of health using a drop or two of blood are under study. One portable device, "The Test-Mate" kit, has been tested. A 96 well optical plate reader method is in the final stages. Several field studies of orchard workers were undertaken with Cal EPA and NIOSH, indicating that blood sample handling, and perhaps other factors, may cause discrepancies between ChE activities determined by clinical labs and Wilson's lab based assays. Biomarkers that have been studied include blood ChE tests and urinary metabolites. Immunoassays for OP agents and cell culture techniques of monitoring and studying toxic chemicals are under development. Work is underway to isolate, purify, and study neuropathic target esterase, the protein in nerves and lymphocytes believed to be a target for OPs that cause organophosphate delayed neuropathy (OPIDN). This research will pave the way for future studies on pesticide exposure and will aid in the development of improved pesticide application equipment, techniques, and protective devices to reduce worker exposure to pesticide.

Accomplishments: Include developing standards for measurement of blood cholinesterases (required of farmworkers in California) in collaboration with Cal EPA, determination of rat blood and brain cholinesterases for setting safe levels of pesticides in foods in collaboration with the US EPA, and studying blood cholinesterases of farmworkers and their families with an assay that uses one drop of blood, rather than the usual blood draw, resulting in less expense and good compliance.

Research on this project demonstrated that widely used commercial kits and procedures to measure ChEs in the rat and the human are not conducted under optimum conditions and that,

in some situations, they may yield grossly inaccurate results. This can confound a comparison of workers' blood levels over time, as they move to different regions of California and different clinical laboratories make the determinations. Conditions optimizing the colorimetric assay have been determined and the State of California is including them in Guidelines to be followed by clinical laboratories. We also tested and validated a determination kit that measures one blood sample at a time. It is suitable for use in emergencies when pesticide exposures are suspected. The approach used by the designers of the kit was modified by us to work with a 96 well optical plate reader increasing the throughput of the assay. Both approaches calorimetrically determined blood enzyme activities on a drop of blood drawn from a finger prick without need for a phlebotomist, materially reducing the cost of the assays. We have used the assay in Dr. Gold's study on the health of California female farmworkers (Project RI-B).
Expected for Current work: The next step in our research will provide correction factors for the current commercial to put results obtained from them on a common and biochemically justified basis. We expect our current work to lead to standard operating procedures for cholinesterase determinations of state and federal agencies, better ways to identify neurotoxicity of organophosphate chemicals and improved training of pesticide applicators and farmworkers.
Expected for future work: Our plans are to study reducing variability of blood determinations to provide better base line data, collaborating with Dr. Steve Clinic)who has developed sensitive antibodies to human In addition, we are considering developing a "pesticide sensitivity index" in which several enzymes important to organophosphate toxicity will be measured in blood, and their pre-exposure levels evaluated to see whether some people are more at risk to effects of OP exposures than others.

Epidemiology of Agricultural Pesticide Illness in California

Principal Investigator: Marc B. Schenker, M.D., M.P.H., Director, UC Agricultural Health and Safety Center; Professor of Medicine and Department Chair, Department of Community and International Health, School of Medicine, UC Davis.

Objectives: Initial work in this project identified risk factors for organophosphate and paraquat illness among California agricultural workers. The current objectives are to develop estimates for the numbers of pesticide illnesses seen by physicians but not reported as required by law. Independent sources of case identification will be compared to reports received by the surveillance program. If the outside source provides no additional cases, that constitutes evidence for the completeness of surveillance. If each source includes cases that the other misses, that demonstrates that both are incomplete, and suggests that additional cases are likely to have been overlooked by both. The degree of overlap permits computation of an estimate of the number likely to have been missed. Analysis will focus on the severity of the illness and the circumstances of exposure. Preliminary work has compared fatalities reported to the surveillance program to death certificates selected by codes that indicate pesticide involvement. This indicated that reporting of deaths from structural fumigants was nearly perfect (same cases on both lists), while reporting of suicides was much less predictable. Evaluation of information from hospital discharge summaries, Medi-cal claims records and poison control center logs is in progress. A reliable estimate of the number of people affected by pesticide toxicity will allow this problem to be considered in an appropriate public health context. This investigation will also attempt to identify those

circumstances in which people are most at risk, both of suffering toxic effects and of failing to receive appropriate attention.

Accomplishments: California's pesticide illness data have been recognized by the General Accounting (GAO) as "the most effective and well-established monitoring system in place", which noted that "EPA relies heavily on the pesticide illness data collected by the California monitoring system,"; but the reporting efficiency of the system has never been assessed. This study will provide the best available estimate of the system's completeness, which will be of value for risk-benefit and other policy assessments of pesticide use, public health planning, agricultural health resources and Three data sources will be analyzed for independent assessment of pesticide illnesses in California, and cases will be matched to normally collected cases in the PISP. Three sources are death certificates, hospital discharge records and poison control center contacts. A cross-sectional survey will be performed using these three to identify cases of suspect pesticide illnesses. Death certificates will be obtained for 1989. Preliminary analysis of hospital discharge data indicates a very large number of unreported cases; arrangements are being made to verify the relevance of the hospital cases.

Major Accomplishments 1996-2001

Pulmonary Fibrosis and Mineral Content of Lung Tissues from Deceased California Farm Workers

Principal Investigator: Kent Pinkerton, PhD

Objective: We have examined the relationship between mineral dust exposure, intrapulmonary dust distribution, and remodeling of the airways along anatomically distinct airway paths in the lungs of farmers and other residents from the Central California Valley.

Accomplishments: In this study, 117 lung autopsy specimens from the Fresno Medical Coroner's Office were prepared by intratracheal instillation of 2% glutaraldehyde at 30 cm H_2O pressure. Two distinct airway paths into the apico-posterior and apico-anterior portions of the left upper lung lobe were followed (Figures 1-2). Tissue samples for histological analysis of 42 cases were taken from the second, fourth, sixth and ninth airway generations (Figure 2). Parenchymal tissues beyond the twelfth airway generation of each airway path were also analyzed. Microscopic evaluation demonstrated normal airway structure to the sixth airway generation. There was little evidence of mineral dust accumulation except in lymphoid tissues. In contrast, terminal and respiratory bronchioles arising from each pathway revealed varying degrees of wall thickening and remodeling. Walls with marked thickening contained moderate to heavy amounts of carbonaceous and mineral dusts (Figure 3). Wall thickening was associated with increases in collagen and interstitial inflammatory cells, including dust-laden macrophages. These changes were significantly ($p < 0.001$) greater in the first generation respiratory bronchiole (RB) compared to second and third generation RBs (Figure 4). The findings suggest that the accumulation of dust in human lungs is significantly affected by lung anatomy with greatest retention in centers of lung acini. Furthermore, we have demonstrated significant remodelling of this transitional zone in humans exposed to ambient airborne particles (Pinkerton et al., Environ Health Perspect 108:1063-1069, 2000).

Additionally, extramural funding in the amount of $40,000 was secured from the U.S. Environmental Protection Agency to document the nature of silica in the lungs of farm workers and non-farmworkers with pulmonary fibrosis and other pathological changes from particle exposures,

and to conduct an historical review of idiopathic pulmonary fibrosis (IPF) cases at Stanford University Medical Center, with specific attention to agriculture and other sources of inorganic dust exposure. Work was completed on this project in 1999.

Future Plans: "Health Effects of Ambient Airborne Particles from the Sacramento/San Joaquin Valley" The goals of the proposed research will be accomplished through the completion of the following tasks:

1. To construct and deploy at Fresno, CA and Davis, CA the following portable Particle Concentrators:
   a. Coarse Particle Concentrator (2.5-6 μm)
   b. Fine Particle Concentrator, including its ultrafine component (0-2.5 μm)
   c. Ultrafine Particle Concentrator (0-0.15 μm)
   d. 0-0.3 μm Particle Concentrator. This Concentrator will be used to conduct inhalation studies to ultrafine PM plus the elemental and organic carbon content of the accumulation mode, but without its sulfate and nitrate constituents.
2. To determine the lung toxicity of short-term (3 day) exposure in rats to each size fraction of concentrated particles described in Task 1.
3. To measure those biological endpoints (cell permeability, cell proliferation, and DNA damage) that define a significant response and have the potential to explain mechanisms of particle toxicity following exposure to concentrated ambient PM of the Fresno, CA area.
4. To test the hypothesis that epithelial cells of the lung airways and alveoli serve as a direct and highly sensitive measure of particle toxicity. Through the use of each Particle Concentrator to expose rats to different sizes of particles, target lung cells will be analyzed along anatomically distinct sites of the respiratory tract from the trachea to the alveolus.
5. To compare the outcomes of our proposed real-life ambient PM studies to those of ongoing health studies at UC Davis using artificial preparations of carbonaceous and ammonium nitrate aerosols (supported by California Air Resources Board grant K.E. Pinkerton, P.I.)

All of the Concentrators outlined in Task 1 have already been developed and their performance evaluation has been described in the peer-reviewed literature (Sioutas et al., 1999). Each Concentrator will be used at a different season in Fresno and Davis to take advantage of the seasonal variation in the characteristics of PM in this area. The two seasons also reflect differences in agricultural activities and their contribution to ambient particles. The Concentrators will enrich the concentration of PM in the previously mentioned size ranges by a maximum factor of 25 and supply them to whole-body animal exposure chambers at 10 liters/minute (LPM).

Pilot Study – Epidemiology of Agricultural Pesticide illness in California

Principal Investigator: Marc B. Schenker, M.D., M.P.H., Director, UC Agricultural Health and Safety Center; Professor of Medicine and Department Chair, Department of Community and International Health, School of Medicine, UC Davis.

Accomplishments: Preliminary analysis of hospital discharge data indicates a very large number of unreported cases; arrangements are being made to verify the relevance of the hospital cases.

Future Plans: Initial work in this project identified risk factors for organophosphate and paraquat illness among California agricultural workers. The current objectives are to develop

estimates for the numbers of pesticide illnesses seen by physicians but not reported as required by law. Independent sources of case identification will be compared to reports received by the surveillance program. If the outside source provides no additional cases, that constitutes evidence for the completeness of surveillance. If each source includes cases that the other misses, that demonstrates that both are incomplete, and suggests that additional cases are likely to have been overlooked by both. The degree of overlap permits computation of an estimate of the number likely to have been missed. Analysis will focus on the severity of the illness and the circumstances of exposure. Preliminary work has compared fatalities reported to the surveillance program to death certificates selected by codes that indicate pesticide involvement. This indicated that reporting of deaths from structural fumigants was nearly perfect (same cases on both lists), while reporting of suicides was much less predictable. Evaluation of information from hospital discharge summaries, Medi-cal claims records and poison control center logs is in progress. A reliable estimate of the number of people affected by pesticide toxicity will allow this problem to be considered in an appropriate public health context. This investigation will also attempt to identify those circumstances in which people are most at risk, both of suffering toxic effects and of failing to receive appropriate attention.

Incident Disease and Injury Among a Cohort of California Farmers and Farm Operators

Principal Investigator: Marc B. Schenker, MD, MPH

Accomplishments: The California Farmer Cohort Study has made substantial progress in characterizing the demographics and health status of farm owners and managers in California. Prior to this study there was little information on the characteristics of this population in the most productive agricultural state in the country. The study has also begun to characterize farm spouses and children, for future investigations of health status and risk factors for injury and disease in this population. Beyond characterization of farmer health status, the study has identified occupational risk factors for illness and injury, and the impact of occupational and non-occupational illness on the farmers. We have focused on a limited number of health outcomes because they are more common, have a substantial contribution (attributable risk) from occupational factors, and are preventable. We have also focused on health problems more common in western agriculture. Specifically, the cohort has identified the prevalence and risk factors for respiratory disease, allergic disorders, dermatitis, musculo-skeletal disease and occupational injuries. We have also explored the impact of respiratory disease on workability and functional status.

The entire cohort was followed-up with a questionnaire in 1998 (92% contact of eligible). In addition to analysis of respiratory status in relation to farm work and other factors, we evaluated functional status and its association with respiratory symptoms in the cohort. No functional limitation was reported by 55.8%, and 5.5% reported limitations on 4+ items. Poor work ability was reported by 7.3%, and 40% reported good work ability. The prevalence of respiratory symptoms was 34.4% for any respiratory symptom, 19.7% for short of breath uphill, 12.2% for wheeze causing shortness of breath, 12.2% for persistent wheeze, 9.8% for asthma, 9.4% for chronic bronchitis, and 8.5% for chronic cough. Functional status was examined with multivariate models that included age, sex, smoking status, alcohol consumption, and body mass index as covariates. The results showed that any respiratory symptom ($p=0.0001$), asthma

(p=0.01), chronic cough (p=0.0001), chronic bronchitis (p=0.0001), persistent wheeze (p=0.0001), shortness of breath (p=0.0001) and wheeze with shortness of breath (p=0.002) were significant independent predictors of declining functional ability.

We found a cumulative annual incidence of 9.3% occupational injuries in the 1998 cohort. The trunk was the most common site of injury (28.6%), followed by the lower extremities (27.8%), upper extremities (23%), head (12.7%), and multiple or systematic injuries (4.8%). Sprains and strains were the most common injury, (42.9%), followed by fractures (15.1%), open wounds (11.1%), contusions (8.7%), unspecified and superficial injuries (5.6%), nerve injuries (4.8%), eye (4%), concussion (2.4%). Significant independent risk factors for an occupational injury determined by logistic modeling included a previous injury (OR = 4.1, 95% CI 2.7, 6.2), medium or high exertion level, workshop activity, small field farm, and work with horses.

Future Plans: Increased morbidity and mortality from all causes has been well documented in many agricultural settings, but there have been relatively few studies of morbidity and mortality among California farmers and farmworkers. California is the largest agricultural state with production of $28+ billion in farm commodities annually produced on 81,000 farms by up to 1.5 million people. This project involves an ongoing series of health studies among a cohort of California farmers aimed at identifying the prevalence and risk factors for acute and chronic disease, and ultimately at the prevention of disease in this population. The major focus is on hazards predominantly occurring among California and other Western farmers. The follow-up component allows us to measure disease incidence and its risk factors and to determine changes in work practices as this cohort ages. This cohort is closely connected to the exposure assessment studies of the Center. We hypothesize that agricultural work increases the risk of acute and chronic injury and illness, and that these occupational diseases result in increased disability and mortality.

The cohort was initially contacted in 1993, consisting of a representative statewide sample of 1947 California farm operators. In 1995-96, we selected a stratified sub-sample of farmers to further investigate respiratory disease and symptoms. In 1998 we located 1652 of the participants for a questionnaire follow-up that addressed incident disease, and several new outcomes including musculo-skeletal symptoms and disease. In addition we obtained baseline health and work information on 802 spouses (81% response) and enumeration of 600 children $\leq$18 years of age living on the farms of the study subjects. In years 1 and 2 we will identify a subset of up to 100 farmers with and without respiratory symptoms from the 1995 case-base sample and conduct an intensive investigation of respiratory function and structure, focusing on the effects of agricultural dust exposure. This will involve extensive pulmonary function testing and HRCT scanning to characterize pulmonary fibrosis and obstructive changes. In year 3 we will conduct a follow-up survey of disease and symptom incidence and prevalence among the full sample of California farmers whom we surveyed in 1993 and spouses identified in 1998. We will also request death certificates and analyze cause-specific mortality for those individuals in the cohort who have died. In year 4 we will conduct additional case-base analyses of the cohort to identify specific risk factors for disease in the population. We specifically expect to study causes of musculo-skeletal symptoms or disease, although the final case definition will depend on findings of the cohort follow-up conducted in year 3. The existence of this representative

sample of California farmers and farm managers provides a powerful tool for hypothesis generation and testing, focusing on agricultural risk factors for disease in California farmers.

Developing, Improving and Applying Cost-Effective and Accurate Human Blood Cholinesterase Determinations

Principal Investigator: Barry W. Wilson, PhD

Cal EPA ChE Guidelines: The current Center ChE project was kicked off by the finding that conditions of the commonly used clinical ChE testing kits were below optimum (Wilson *et al*., 1997). The results led to modifications of California guidelines for sampling, storage and assaying blood (Title 3. California Code of Regulations). The work, partially supported by the facilities of the NIEHS Center for Environmental Science, was chosen by the NIH (NIEHS Letter, June 8, 1998) as a Story of Discovery for presentation to Congress. The NIEHS noted the studies showed many clinical laboratories were using a commercial AChE assay that underestimated enzyme activity by as much as 40 percent, and that the Center was working with State regulatory agencies to bring practice in line with the public health intent of the law (Wilson *et al*., 1997). Fingersticks: Inexpensive fingerstick blood samples are readily obtained without a phlebotomist. To study their utility, samples were obtained from more than 900 residents of migrant housing centers in California in collaboration with Dr. McCurdy on his injury study. Similar ChE values were obtained from blood samples taken via fingerstick from the housing residents (presumably pre-exposure samples) and from fingerstick and venous draw samples from laboratory personnel. Later in the season, mean values were decreased from the migrant centers, indicating exposure to organophosphates (OPs) may have occurred. Spray Applicators: Blood ChE levels of aerial spray applicators in Arkansas examined in collaboration with Dr. Howard Frumkin (Emory University) showed pre and post exposure venous blood draws from more than 50 spray applicators measured at UCD were similar to UCD laboratory staff and migrant housing study controls. The results showed that variability in ChE measurements can be much reduced if care is taken in the sampling, storage and assaying of the samples. Test-Mate Kit: There is a need for a reliable portable ChE device to monitor possible exposures to OPs and carbamates. Studies with the portable Test-Mate Kit revealed problems with replication and with temperature compensation. The manufacturer will be working with us to devise a better instrument. Red Blood Cell Ghost Standard: A bovine red blood cell ghost preparation was developed as a standard for clinical laboratories to compare methods and instruments. Long-term storage tests showed that activity remained constant for approximately 5 months at 4 ^{o}C and for at least 11 months at –70 ^{o}C. Clinical Laboratories: The finding that ChE values from clinical laboratories were using conditions below optimum and that results from one laboratory were not readily convertible with another, led CA DPR to ask the laboratories to run tests comparing their assays with one run under optimum conditions. They also asked us to be a “gold standard” reference laboratory for the clinical laboratories as they worked to conform to the new guidelines. Several laboratories had difficulty complying with the regulation, correlations were better with plasma assays, not as good with RBC tests. DOD Collaborations: A project with the Department of Defense (DOD) to establish a conversion of ChE values between laboratories and methods is underway. Approximately 25 thousand blood samples are monitored annually by the DOD using the slow but accurate delta pH assay method. The project will generate a conversion factor to the faster colorimetric Ellman assay. The large DOD data base will be used to establish reliable normal ranges for adult RBC AChE and plasma BChE values, in collaboration with Center epidemiologist Dr McCurdy. New Assay: Drs. Guomin Shan and Bruce Hammock have developed a technique to prepare fluorescent esterase

substrates of potential use in new cholinesterase assay tests with less interference from the hemoglobin in RBCs.

Future Plans: Cholinesterase (ChE) measurements are an important biomarker for establishing levels of exposure to some pesticides and chemical warfare agents. Nevertheless, their levels have been considered variable and there are no agreed upon standards. This proposal continues a field and laboratory research project to improve clinical cholinesterase (ChE) testing such as that required of pesticide applicators, farm workers and growers by the State of California. In collaboration with Cal EPA Department of Pesticide Regulation (DPR) and Office of Environmental Health and Hazard Assessment (OEHHA), the project has been optimizing conditions for sampling, storage and assay of blood for red blood cell acetylcholinesterase (RBC AChE, EC 3.1.1.7) and plasma butyrylcholinesterase (BChE, EC 3.1.1.6). Improved tests are being validated by field studies, standard operating procedures are being refined, problems inherent in the clinical laboratory assays are being identified, laboratory standards and new assays are being developed. Outreach activities associated with the project undertaken with the outreach section of the Center include informing clinical laboratories, state and federal agencies, growers, spray applicators and field workers of the importance of the measurements and the need to determine them accurately. Recently, work has begun with the Lawrence Livermore National Laboratory on reactivation techniques suited to clinical use to improve assessment of inhibited ChEs, and with the US Department of Defense blood monitoring unit, the US Army Center for Health Promotion and Preventive Medicine (CHPPM). CHPPM's large database of blood ChEs measurements will be utilized to establish improved normal limits for blood ChEs. One of the hypotheses is that accurate, reliable, and well-validated blood ChE assays are necessary to accomplish meaningful field studies of workers exposed to potentially neurotoxic agricultural chemicals. A corollary is that the methodologies in use increase the variability of blood ChE assays, reducing the ability to detect ChE depressions.

Pilot Study - Development and implementation of pyrethroid and paraquat immunoassays for human exposure monitoring

Principal Investigator: Guomin Shan, Ph.D.

Accomplishments: A one-year seed project (2000-2001) entitled 'Development of a Class-specific Immunoassay for the Detection of Pyrethroids in the Environment and Humans' is currently underway in this laboratory. In the last few months, we have successfully synthesized proposed immunizing haptens and potential coating haptens (see the structures below). Ozonalysis was used for double bond oxidation of intermediate esters. The immunizing haptens were conjugated with carrier protein thyroglobulin and KLH for antibody production, while coating hapten were conjugated with BSA. The immunization of six rabbits using two antigens is currently being conducted in the UCD Animal Resources Service. The titer of antisera will be tested this month.

Future Plans: One goal of this proposal is to develop, validate and implement rapid immunochemical-based analytical methods to monitor human exposure to pesticides in farmworkers. Our focus pesticides are paraquat and pyrethroids. There are more than 20 pyrethroids frequently used in agriculture, most of them contain a phenoxybenzyl group in their structures. Although selective metabolite assays for each pyrethroid are important when exposures are known, a class specific assay to metabolite *m*-phenoxybenzoic acid (PBA) is very

useful and efficient for epidemiology studies and human exposure monitoring. Thus, validation of an immunoassay for PBA in human urine is included in this proposal. Paraquat, a heavily used herbicide, is a toxicological and epidemiological important compound. A more sensitive and selective assay is needed for human exposure monitoring. Finally, we will explore a new detection system using novel fluorogenic enzyme substrates toward increasing sensitivity and sample throughput.

Specific Aim I. Validate class-specific pyrethroid immunoassays for human urinary monitoring.
Optimize immunoassays for the pyrethroid metabolite *m*-phenoxybenzoic acid.
Validate the optimized assays in human urine samples.

Specific Aim II. Develop a compound-specific immunoassay for paraquat.
Design and synthesize haptens.
Generate antibodies and screen haptens.
Optimize assays and validate them in human urine.

Specific Aim III. Develop and apply fluorogenic alkaline phosphatase (AP) assays for ELISA.
Design and synthesize novel alkaline phosphatase (AP) specific substrates.
Screen AP substrates with model enzymes.
Optimize and evaluate the selected AP substrates for application to enzyme immunoassays
Investigate fluorogenic AP substrate assisted immunoassays for human exposure monitoring to pyrethroids and paraquat.

Changes/Challenges for 1996-2001

During the 1996-2001- period there were several personnel changes on this study. The primary study research staff member, Jeffrey Shire, left the study in June, 2000. Maria Stoeklin is a graduate student working on some of the respiratory disease and functional status analyses. Cathy Saiki, a graduate student doing thesis work on this study, was on sick leave for much of the year. Dr. Steven Samuels will be leaving the university in spring, 2001. He will be replaced by Dr. Laurel Beckett, a new faculty member in the Department. A collaboration has been established with Dr. Eva Hnizdo of NIOSH. Dr. Hnizdo's experience and interest in silica induced lung disease is a nice fit to some of the major hypotheses being evaluated in this study. This will undoubtedly change as the cohort continues to age and should eventually provide sufficient power to perform meaningful mortality analyses. The intensive study of pulmonary function in farmers will require pilot testing for feasibility, etc. Dr. Jack Parker (U. W. Virginia Medical Center) will join the study as a consultant to assist with reviewing pulmonary function and CT reading protocols. It is presently unknown how many farmers will agree to travel to Sacramento for a full day of testing. Adequate participation fees will be required for this component of the study because may be difficult to get this hard working population to take time off from work. Our prior experience with the cohort and the high response rates of previous contacts suggests that we will be successful in obtaining good cooperation.

Major Accomplishments 2001-2006

Incident Disease and Injury Among a Cohort of CA Farmers and Farm Operators

Project Leader: Marc B. Schenker, MD, MPH

The Farmer Health Study involves an ongoing series of health studies among California farmers aimed at identifying the prevalence and risk factors for acute and chronic disease, and ultimately at the prevention of disease in this population. The major focus is on hazards predominantly occurring among California farmers, including risk factors for common diseases that may be specific to farming in this state (e.g. dry climate farming as a risk factor for respiratory disease). We hypothesized that agricultural work increases the risk of acute and chronic injury and illness, and that these occupational diseases result in increased disability and mortality. The results of a questionnaire indicate conditions limiting work, musculoskeletal, neuritis/nerve problems, and accident or injury were the most common, and not associated with age. In comparison to the general population of the same age, chronic health conditions that were more prevalent in farmers included musculoskeletal conditions lung problems and injury. However the farmers appeared to be healthier than the rest of the population with respect to diabetes and heart disease. Farmers were still vulnerable to new respiratory symptoms even after many years in farming; the prevalence of asthma, chronic bronchitis, chronic cough and persistent wheeze had increased in 2004 and incidence of new symptoms ran between 5% and 8%.

Pilot- The Study of Agricultural Lung Disease (SALUD), 01/2001 – 06/2004: SALUD was a cross-sectional study of pulmonary function and paraquat exposure among agricultural workers in Costa Rica. The study included two components: (1) exposure assessment, and (2) an epidemiological study with interviewer-administered questionnaires and pulmonary function testing, including single breath diffusion capacity and oxygen desaturation testing. Our hypothesis was that chronic paraquat exposure causes impairment of respiratory function, and specifically causes restrictive lung function with impairment of gas transfer among exposed workers. Pulmonary function tests at rest and during exercise showed no association of paraquat exposure with the primary measures of restrictive lung disease (interstitial thickening) as measured by spirometry, single breath diffusion capacity, or maximal oxygen uptake. There was a marginally significant association between chronic paraquat exposure and oxygen desaturation with exercise that is of unknown clinical significance.

Pilot- Determinants of Health and Disease Among Mexican Migrants to California, 07/2003 – 12/2004: We conducted a cross-sectional survey of women in a Mexican sending state (Chavinda) and a corresponding receiving community in California (Madera) where large numbers of recent Hispanic migrants reside. Our goal was to conduct an investigation of behavior and illness profiles in the sending community that would allow us to separate the effects of "selective migration" from social-cultural changes associated with migration. We compared risk behaviors that may influence health outcomes. Medium/high acculturated women living in the U.S. were more likely to have reported drinking and to have had more than one sexual partner compared to both low acculturated women in the U.S. and women living in Chavinda. Women living in the U.S., regardless of acculturation level, were more likely than women from Chavinda to have worked in agriculture at some time in their lives. While this study does not allow us to make any definitive statements about the trajectory or speed of this process, nevertheless, our findings can suggest directions for successful prevention programs that would target women at greatest risk for adopting unhealthy behaviors.

Pilot- Agricultural and Environmental Health for Latino and Indigenous Farm Workers, 09/2004 – 09/2006: The purpose of this study is to examine occupational and environmental exposures and health in 400 hired farm workers in Mendota, California. The

sample includes men and women between the ages of 18-55 who self-identify as Mexican, Honduran, or El Salvadorian; have been engaged in farm work for at least three months in the last year; and are residing in Mendota, California. Twenty census blocks in Mendota were randomly selected for enumeration and mapping. Enumerators visited each enumerated dwelling and obtained information on the individuals residing there. At each address, all individuals in the household were counted, and we determined their relationship to the head of household (spouse, adult child, parent, sibling), age and gender, those who were engaged in farm work, nationality, and number of children under 18 years living in the household. Households with no hired farm workers were mapped, but not enumerated. Interviewers are currently in the process of administering questionnaires demographic information, occupational and environmental risk factors, acculturation, smoking status and health outcomes. This information will be especially pertinent to the proposed research for Project 1 during the next funding period.

Future Plans – '<u>Farm Worker Family Health Cohort study</u>": Hired farm workers provide the majority of the workforce for California's labor-intensive agriculture, yet they also suffer the greatest health burden. While we suspect that California's hired farm workers face increased risks of morbidity and mortality from respiratory disease, musculoskeletal problems, infectious diseases and lifestyle-related diseases such as hypertension and obesity, t here has been very little research on the health status of this population. The overall goal of this project is to assess agricultural and environmental exposures and health outcomes in a population-based sample of 400 hired farm worker families in Mendota, California. The community has a large proportion of immigrants from Mexico, and a high proportion of agricultural workers. We are in the process of conducting a baseline interviewer-administered assessment of families. The follow-up health assessments proposed here would allow longitudinal examination of exposure-health outcome associations. We will also collect additional information through physical examination and biologic specimen collection. The specific aims of the study are to: 1) Conduct two questionnaire follow-ups of the MICASA study population (from the last funding period) and to conduct spirometry, measure vital signs and anthropometry, and collect biologic samples; 2) Assess the relationship of exposure to dusts and other toxicants from agricultural activities to respiratory health; 3) Assess the contribution of agricultural work to musculoskeletal problems and injuries; 4) Assess the relationship between lifestyle factors (i.e. diet, obesity and smoking) with chronic health outcomes; 5) Disseminate results to individuals, the farm worker community and policy makers to increase awareness of factors affecting health among farm worker families and to suggest approaches to improve health. This cohort is being established to improve understanding of important health risks and to provide a basis for the design of effective public health and clinical interventions, and ultimately to improve the health of this underserved population. This approach allows us to address a wide range of factors affecting health including work, home environment, and personal health behaviors. This research has direct relevance to public health in that it will aid our understanding of the diverse causes of disease in this population and assist in developing strategies to prevent complications from acute and chronic diseases. It would also provide a natural progression from research to intervention and prevention efforts.

Research-to-Practice Implications This project has several research-to-practice implications. The field coordinator for the study, Kathleen O'Connor, is based in the community

of Mendota and interfaces with various levels of the community on a regular basis. She attends City Council, Rotary Club, and other community meetings to inform the community about the research purposes and goals. As the study progresses, these are valuable avenues for disseminating study results. The project also has a Community Advisory Board, composed of local officials and key community leaders that meets regularly and is informed of the study progress. The project also has relationships with local medical and dental health practitioners, and regular contact with them provides opportunities to disseminate practice-related findings. Research findings with policy implications will be disseminated via local, county, state, and national forums, as appropriate. Dr. Schenker has made presentations to the County Health Departments of Merced and Fresno,and he will continue to inform them of results relevant to the health of hired farm workers in their communities. Drs. Schenker and Villarejo recently gave a policy briefing at the California State Capitol on "Policies to Improve the Health and Well-Being of California's Hired Farm Laborers" (Villarejo and Schenker, 2005). This presentation to a large audience of legislative staff and advocacy groups was based on recent findings from the most recent NAWS, and provided suggestions for policy changes to improve the health of hired farm workers. They have also made presentations to national and international forums with similar recommendations based directly on findings from this study and our field research. Dr. Schenker also serves on the Rural Community Assistance Corporation board on health and housing, which is an important forum for advancing the health needs of the hired farm worker population. He has presented results from his studies of hired farm workers in numerous national and international forums, such as Binational Health Week, increasing awareness and providing direction for interventions to address health needs in this population. Other components of the study, such as the pulmonary function testing and pesticide exposure sub-study provide opportunities to directly educate participants and the community at large. The investigators have experience communicating results to Hispanic farm workers from their previous investigations. Our research on the impact of inorganic dust exposure and the lack of protective equipment use among farmers has been disseminated through a variety of scientific and lay publications, with the ultimate goal of improving knowledge and reducing exposure to dust that was previously thought by many to be no more than a nuisance. In brief, there is an enormous potential to improve the health of farm workers based on findings from a population-based, prospective cohort study of health. No such study has previously been done, though, in part due to the lack of awareness about the health status of this population or the necessary interventions to improve health.

Pilot Study to Measure Exposure to Air Particles on California Dairies

Project Leader: Frank Mitloehner, PhD:

Aims: The aims of this pilot project were to (1) determine in what range the levels of exposure to particulate matter and endotoxins would be for dairy workers on the newer large commercial dairies being established in California, and (2) test sampling equipment and protocols in advance of submitting a larger, more comprehensive study proposal. This project demonstrates both the feasibility and relevance of exposure data collection, and establishes sample sizes and interviewing techniques for dairy workers.

Methods: The pilot study was conducted in August and September 2005. Air quality and exposure measurements were taken first at the UC Davis dairy and subsequently at a private dairy with over 1,000 lactating cows. Workers wore two (personal) samplers. One sampler collected inhalable particles (small enough to enter the nose, but penetrates no further that the upper respiratory tract) and the other sampler collected respirable particles (small enough to penetrate deep into the lungs). In addition at least two stationary area measurements were conducted. All monitors ran for at least 4½ hours and the procedure was repeated at least on two different days at each location; quality control blanks and duplicates were also collected. Samplers were worn both by workers in the milking parlor and workers in the outside areas of the dairy. Samples were weighed according to standard procedures, and analyzed for endotoxin contents at the laboratory of S. Reynolds, Colorado State using the Pyrogene rFC fluorogenic assay (Cambrex Bio Science).

Results: We found that the particulate matter concentration in the milking parlor was considerably lower in both the inhalable (50% cutoff at 100 μm) and respirable (50% cutoff at 4 μm) fractions (See Table 1) than areas outside animal housing. However, the concentration of endotoxin was similar in both locations in the inhalable particle range. Although we plan to collect particles in the inhalable range for endotoxin analysis, we additionally analyzed a very limited number of matched samples in the respirable range. Interestingly, our limited results suggested endotoxins fractionated with larger particles (>4 μm) in the milking parlor, but with respirable particles in the outside areas. In the proposed study we will analyze a limited number of respirable samples for endotoxin to determine if this is a consistent trend. A limited number of duplicate samples were collected to determine the efficiency of the particle samplers. We found the mean difference between the pairs for respirable mass was 19.5%, and the difference in mass for the inhalable samplers was 6.3%. This pilot testing also confirmed that the workers were able to complete their jobs while wearing the samplers.

Table 1: Geometric means of particle and endotoxin collected by personal sampling

Particle Fraction	**Sample and number**	**Mean Particle concentration ug/m3 (standard deviation)**	**Mean endotoxin concentration EU/m3 (standard deviation)**
Personal samplers			
Inhalable particles	All Dairy Workers n =9	2057.3 (5371)	200.2 (89.44)
	Milking Parlor only n =3	585.2 (312.1)	172.1 (47.81)
	Outside Dairy workers n =6	3857.2 (5708)	216 (102.78)
Respirable particles <4μM	All Dairy (mass n =11 EU n =4)	80.73 (305.9)	15.13 (80.87)
	Milking Parlor only (mass n =4, EU n =3)	20.11 (8.53)	6.76 (5.53)
	Outside worker (mass n =7, EU n =2)	178.61 (318.9)	137.9 (169.5)

Conclusion: The data collected indicate that a larger scale study would be both feasible

and warranted. Only two samplers collected material below the limit of detection for endotoxin, and these were both for samples in the respirable range where larger particles have been filtered out. There were no samples collected with masses as low as the blanks. The sampling times were about 4½ hours, whereas in the proposed study we expect to collect for at least 6 hours, which may give a better idea of the range of concentration of particles in the dairy air. In addition, replicates were reasonably similar. As we surmised, there is a clear difference between the milking parlor and the outside workers in both masses and endotoxin concentrations, and some indication that the distribution of endotoxins differs between the size fractions depending on location.

Future Plans: Respiratory Health and Exposures on Large Californian Dairies: California ranks first in the USA for milk production. In the San Joaquin Valley, herd size is dramatically increasing (>800 lactating cows/dairy). Indoor confinement barns are not used, but the dry, hot climate allows outdoor housing of cows in open sided free stalls or open dirt-floored corrals. The large operational size of the dairies and some management practices may pose a respiratory health hazard for workers. This proposal aims to define the concentrations of airborne pollutants highly associated with respiratory problems and study the respiratory health of the dairy workers compared to a control group of creamery employees and also to dairy workers under different management practices in a collaborator's study in Colorado. This cross-sectional study will monitor personal exposure to particulate matter, endotoxins, and ammonia over a work shift in 200 dairy workers (from dairies with over 1,000 lactating cows) and 50 creamery workers. We will conduct a questionnaire to collect data on health including symptoms, personal characteristics, and allergic status. We will also conduct both pre- and post-shift measures of pulmonary function. The hypotheses to be tested are: Exposure to elevated concentrations of airborne pollutants will result in increased respiratory symptoms and changes in pulmonary function over the work shift; specific dairy tasks will be associated with different pollutant concentrations. Long-term exposure to elevated pollutants will result in increased prevalence of respiratory symptoms, reduced lung function and more respiratory problems in dairies than in creamery workers. Facility environment including endotoxin composition will vary between California and Colorado dairies, resulting in different respiratory outcomes. Dairy air samples will activate macrophage cultures designed to assess inflammatory potency. Information on exposure and health effects will be essential to evaluate the health consequences of modern Californian dairy practices. This information is the basis for studies on mitigation of potential risks to the dairy workers. This present project will include a strong outreach and extension component primarily toward the dairy industry in the San Joaquin Valley. Outreach will also be extended to those individuals who deal with health, safety and other regulations pertaining to the dairy industry.

Impact to Populations: Research to Practice The population of dairy workers in California is above 16,000, and over 12,000 of them work in the geographical area of this proposal (see Background and Significance, section B). This number will increase as dairies continue the present trend of relocating from Southern California into the San Joaquin Valley. Meanwhile, the general population in the San Joaquin Valley is increasing twice as fast as in the rest of the state (11% versus 6%, respectively, over a four year period). If there is a respiratory health risk experienced by occupationally exposed dairy workers, then there is also a potential health risk for residents in neighboring communities. This is especially relevant as the San

Joaquin Valley is classified among the worst culprits of non-attainment for both particulate matter (PM10) and ozone (smog). Dairies are believed to significantly contribute to these problems. This present project will include a strong outreach and extension component primarily directed toward the dairy industry in the San Joaquin Valley. Outreach will also be extended to those individuals who deal with health, safety, and other regulations pertaining to the dairy industry. Our proposal aims to construct a realistic estimate of worker respiratory health problems encountered on dairy farms. We will collect data to asses how much air pollution is generated of significance to human respiratory health in the environment of the dairy. We will track the respiratory problems dairy workers experience and whether workers' pulmonary function is affected over the course of a day's work. If there are no or few detectable health effects found in this most exposed population, by extension, the nearby community dwellers should not be concerned about their health being affected by dairies. If there are findings of significant impacts to worker health, then the PI is in an ideal position to discuss the information with the dairy community leaders and devise with them ways to moderate the creation of the airborne pollutants through management and practice changes, thus reducing pollutant generation and transport off the dairy premises, mitigating any adverse effects in neighboring communities. The Principal Investigator of the present proposal, Dr. Mitloehner, is the Cooperative Extension Specialist for Air Quality at UC Davis and has extensive contacts in the dairy industry. Besides research, his responsibilities include educating dairymen regarding air quality regulations as they apply to the dairy industry. He also provides information on air emission mitigation and how to modify practices to meet the new air quality regulations. In 2004, he conducted 24 workshops throughout the San Joaquin Valley on air quality in dairies, where a large portion of California's dairymen (50%) was educated on air emissions, mitigation, and new regulations. In this role, he has a unique ability and opportunity to communicate any findings of the proposed study to a large section of the industry and serve in an outreach capacity to the owners and managers of dairies. However, the PI's outreach and extension efforts will not be conducted in a vacuum. The University of California has an extensive county-based network of cooperative extension centers throughout the state (University of California Cooperative Extension, UCCE). At the county level, extension dairy farm advisors work in close contact with dairymen. These dairy farm advisors conduct workshops in which they convey university research findings to their clientele. Faculty extension personnel (CE specialists) on the UC campuses communicate on a regular basis with county-based dairy farm advisors to ensure the effectiveness of the research-to-practice approach. The present project will make use of this most effective extension network that connects campus and county to convey research results to end users and eventually ensure that dairymen will be informed on pollutant concentrations and resulting exposure risks for their work force. The UCCE network has worked for decades to ensure that research from the UC campuses is conveyed to the actual stakeholders in the counties. This network will be of great importance to this project, and we are fortunate to have such an effective way to make a positive impact on worker health in Californian dairies. The Principal Investigator of the present proposal, Dr. Mitloehner, is the Cooperative Extension Specialist for Air Quality at UC Davis and has extensive contacts in the dairy industry. Besides research, his responsibilities include educating dairymen regarding air quality regulations as they apply to the dairy industry. He also provides information on air emission mitigation and how to modify practices to meet the new air quality regulations. In 2004, he conducted 24 workshops

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Health Effects of Ambient Airborne Particles from the Sacramento/San Joaquin Valley

Project Leader: Kent Pinkerton, PhD

Accomplishments: Efforts for the 2001-2006 period have involved four areas of research: (1) an in-depth study to examine the relationship between mineral dust exposure in the farming industry and histopathological changes occurring in the lungs of the California farmworker (Fresno County); (2) studies in Davis, Sacramento, and Fresno to measure the respiratory health effects of short-term exposure to inhaled concentrated ambient particles using an animal model; (3) controlled laboratory studies to examine the health effects of combustion particles in the lungs of neonates and adult rats, and (4) mechanistic studies to examine the role of soluble epoxide hydrolase inhibitors to reduce lung inflammation associated with particle and oxidant gas inhalation. During this period (2001 to present), a total of 39 papers have been published from our laboratory covering these areas of research. Of these publications, 18 are directly related to agricultural issues for workers and their families.

The Fresno farmworker study was designed to examine the health effects of inhaling ambient particles derived from agricultural and urban sources on the respiratory tract of deceased young male Hispanics. Our findings to date are based on morphometric analysis of site-specific, anatomical regions of the lungs. Histopathological changes have been documented and correlated to the deposition and retention of particles in the lungs for each region. We have found in the lungs of farmworkers, significant correlations to mineral dust small airways disease, chronic bronchitis and lymph node fibrosis, compared to the lungs of non-farmworkers. Dust particles present in the lungs of farmworkers were typically less than 1 μm in diameter. Mean crystalline silica concentration was 17% with silicates at 71%, a composition similar to soil analyses in California agriculture. Retention of carbonaceous and dust particles were highest in those regions undergoing the greatest lung

remodeling. Respiratory bronchioles, the most distal airways opening into the alveoli and gas exchange regions of the lungs were most affected.

A primary objective of our studies has been to elucidate whether short-term exposure to Central Valley particles leads to an adverse respiratory response. Studies in the laboratory focused on conditions for the Sacramento/San Joaquin Valley using state-of-the-art technology to concentrate ambient particles from Davis and Fresno, CA. To date we have examined the effects of short-term inhalation in rodents to concentrated ambient particles of the San Joaquin/Sacramento Valley for a total of 16 studies. Fine and ultrafine particles have been examined in 12 studies, while coarse particles have been examined in 4. These studies have confirmed particle size to be an important determinant in adverse health effects. Particles less than 2.5 μm in diameter are considered to be the most deleterious, while particles with a mean aerodynamic diameter between 2.5 and 10 μm, referred to as coarse particles, are thought to produce less injury to the cardiopulmonary systems. Since the dominant PM fraction in the San Joaquin/Sacramento Valley is coarse particles, especially in the summer and fall seasons, we extended our studies to examine the effects of exposure to ambient particles in the coarse mode on the lungs of healthy adult rats.

To complement studies done with ambient airborne particles, we have completed work to design a system for the aerosolization of well-characterized, archived particle samples for short-term inhalation studies. A dry powder aerosol generator was designed that is capable of producing well dispersed dust suspensions using only a small quantity of PM2.5-enriched powders. This system was developed to allow for dust resuspension for inhalation experiments with limited amounts of particulate matter collected and size-fractionated from source sampling. Scanning electron microscope examination of filter samples show the aerosol contains well-dispersed particles resuspended from the test powder with no evidence of glass bead fragments.

Combustion particles represent an important source of exposure to workers in agricultural settings. We have established a state-of-the-art system to generate soot and metal particles under controlled combustion conditions. We have found short-term exposure to these particles leads to oxidative stress, elevation of pro-inflammatory cytokines, alterations in metabolic function in adults, and altered lung development in neonates.

We have made advances to better understand the role of inflammation and cellular change in the lungs of laboratory animals following particle exposure. These studies used environmental tobacco smoke as a source of particulate matter to better elucidate those mechanisms leading to injury. This research has been extremely successful in identifying particle-induced changes associated with alterations in cell signaling, proliferation and differentiation of critical target cells in the lungs, brain, heart and blood vessels. Critical pathways controlling the inflammatory response, cell cycle and programmed cell death have also been shown to be directly and indirectly affected by inhaled particles. Particles have also been shown to increase the risk of chronic infection.

Future Plans: The unique working environment of the California farmer places him/her at increased risk for exposure to airborne particles. Dry farming techniques used in the Central Valley of California expose farm workers to high levels of airborne particles produced by a variety of operations including field preparation (plowing), rice stubble burning, and crop harvesting of tomatoes, grapes, and citrus fruits. Herd production and dairy operations also generate a mixture of particles, organic and inorganic in composition. The distribution of size and composition of particles generated by each of these activities are unique. We anticipate health outcomes from inhaling particles generated by each one of these activities will also be unique. This hypothesis can be tested by performing animal inhalation experiments at sites dominated by different airborne agricultural particles. This project will address the following questions: (1) Do differences in particle

concentration, size distribution, and composition that occur as a function of agricultural activity result in different health outcomes that can be detected during inhalation exposure experiments? (2) Will exposure to agricultural particles be associated with measurable pulmonary responses following short-term to sub-acute exposure intervals? (3) Does the season of the year have a significant bearing on respiratory responses observed? (4) Are specific components of agricultural-based particles more toxic than others? Each question will be addressed using real-time, inhalation exposure experiments. Physical and chemical characterization of agricultural particles dominant in Davis, Parlier and Tulare, CA as well as laboratory-generated particles that mimic features of agricultural particles suspected to cause negative health effects will be examined. The use of an animal model suitable for field studies (i.e., rats) provides unique opportunities to explore the relationship between particle composition and pulmonary response. Our goal is to demonstrate health effects of agricultural aerosols can be directly related to size and composition of the particles. A concerted effort among our research team with expertise in respiratory structure/function, combined with those experienced with particle monitoring and characterization will seek to answer these questions. The findings of our studies will provide critical new information to establish potential correlations of particles that may have important implications on respiratory health. Our findings will also have a beneficial impact on educational outreach, intervention and environmental justice programs for the public, agriculture and key stakeholders.

Outreach Implications: We anticipate the findings of our studies to have a direct impact on a number of stakeholders in the agricultural community, air quality regulation, legislation, and education. As an example, the research we will conduct in Parlier, CA is complementary to an ongoing environmental justice program for Californian rural communities that may have higher concentrations of pesticides in ambient air compared to urban communities, due to their proximity to agricultural fields. Although we will not study pesticide effects directly in our experiments, with laboratory animals on-site in Parlier, CA at the Kearney Agricultural Research Center, we will have ongoing particle studies during the same seasons pesticide monitoring is being done in Parlier. Dr. Pinkerton serves on the Technical Advisory Committee to this environmental justice pilot program in Parlier, CA which meets to discuss and provide advice to the California Department of Pesticide Regulation (DPR) on air quality matters. Pubic meetings are also planned as an outreach component with the residents of Parlier, the agricultural community and surrounding areas, as well as other interested stakeholders to share the findings of these studies.

Our relationship with DPR is mutually beneficial, because we are both collecting data for similar ends. For example, DPR evaluated 83 rural communities in California, 81 of them in Merced, Madera, Fresno, Kings, and Tulare counties. One community from Kern County and one community from Stanislaus County were also evaluated. Their selection of Parlier for the environmental justice project over the other 82 communities was based on (1) its large population of children (less than 18 years old); (2) the low socioeconomic status among a predominantly non-white population; (3) the potential for high particle exposure and pesticide drift illnesses; and (4) regional use of pesticides. Letters of collaboration are included from Randy Segawa, the project leader for this environmental justice pilot program, and Dr. Fred Swanson, Center Director for the Kearney Research and Extension Center, in Parlier, CA.

Tulare County is an ideal location for our experiments near dairy and cattle settings. Tulare County has the world's highest concentration of dairy cows (over 1 million). This area is the largest milk producing county in the world, and it requires enormous support systems (e.g., silage and hay production, nutrient management systems, and transportation) that may play a role in your investigation. Our work should have implications to Projects 1 and 2. Educational outreach as well

as new findings that may impact on intervention could be derived from these studies to examine particles in each agricultural setting of dry farming practices and dairy operation. Such information can be used to provide new information to owners and workers as well as key stakeholders. Such interactions will be facilitated by the outreach function of the administrative core and Project 6 to the benefit of the farmer and agricultural community.

The findings of our studies will provide critical new information to establish potential correlations of particulate that may have important implications on respiratory health. These data can be used to help guide further policy statements about air quality in California and elsewhere.

Impact on Public Health: California's Central Valley is the agricultural center of the state with a current population of approximately 6 million people. This burgeoning population faces tremendous growth pressure in future years as cities in the Sacramento and San Joaquin Valleys expand to accommodate the demand for affordable housing. The increased urban population will be exposed to agricultural particles, potentially leading to serious health consequences. The research described in the current proposal will seek to identify important health issues related to the inhalation of agricultural particles before these issues become a major health threat to the agricultural community or to a significant fraction of the urban population making up the Central Valley population.

Particulate matter (PM) is a complex mixture containing organic compounds, soot, transition metals, sulfates, nitrates, and other trace elements (Hughes, et al., 1998). Agricultural practices contribute to approximately 50 percent of ambient airborne particles present in the Central Valley of California. Identifying the toxic component(s) in PM responsible for particle-associated health effects is an area of active investigation (Dreher, et al., 1997; Saldiva, et al., 2002). Specific particle compositions, such as transition metals, have been implicated in particle-induced pulmonary effects (Broeckaert, et al., 1997, 1999; Pritchard, et al., 1996; Rice, et al., 2001). Interactions between various components, including bioaerosols, may also account for PM-associated adverse effects. Hence, studies are needed to address the effects of particles of known composition and concentration. The elucidation of those potential mechanisms represents an important area of research that needs to use particles that are generated under well-characterized and controlled conditions.

Transition metals contribute to the ultrafine (< 0.1 μm) size range of particles. Iron is commonly found in ultrafine PM, especially when the source is agricultural. Soot is also an important component of ultrafine and fine (<2.5 μm) PM. Soot and diesel exhaust are primarily composed of elemental carbon ranging from 3.517.5% of the total particle mass (Hughes, et al., 1998; Cass, et al., 2000). Recent field studies have confirmed iron to be the most prevalent metal found in ambient particles within the 50-300 nm size range, with soot being the most common constituent in this size range (Kim Prather, UCSD, personal communication). Coarse particles (> 2.5 μm, but <10 μm in size) are also an important component of airborne particles, especially mineral dusts generated during field preparation as well as during other agricultural processes. Our previous studies show significant retention of mineral dusts in human lungs (Pinkerton et al. 2000) as well as acute respiratory responses in the lungs of rodents (Smith et al., 2003) exposed to airborne dust particles of the Central California Valley.

The proposed studies in this project will significantly advance our past research with unique real-time, on-site exposure of animals to airborne particles in different agricultural settings and in different seasons. The importance of particle size and particle composition in agricultural and dairy settings will be directly measured and correlated to seasonal differences in these environments. Such findings will have a direct impact for providing novel and unique information for public outreach and education relative to airborne particles found in the agricultural setting.

Special Projects

Farm Safety 4 Just Kids. Principal Investigator: Patrick J. O'Connor-Marer, IPM Education and Publications, University of California, Davis, CA.

Short-Term Interventions. Principal Investigator: Marc B. Schenker, Department of Epidemiology and Preventive Medicine, University of California, Davis, CA.

Regional Interactions. Principal Investigator: Patrick J. O'Connor-Marer, IPM Education and Publications, University of California, Davis, CA.

SEED GRANTS

Assessment of Agricultural Injuries and Illnesses in the Gila River Indian Community. Principal Investigator: Eric Faisst, Environmental Health, Gila River Indian Community

Monitoring Field Worker Infections by Sampling at Their Residence. Principal Investigator: Dean O. Cliver, Department of Population Health and Reproduction, University of California, Davis, CA.

Detoxifying Pesticide Protective Clothing for Farm Workers. Principal Investigator: Gang Sun, Department of Textiles and Clothing, University of California, Davis, CA. Co-Investigator: Francis Greene, Department of Pathology and Laboratory Medicine, University of Calgary, Alberta, Canada.

Feasibility of the PimexPlus Video Capturing System in Agricultural Settings. Principal Investigator: Fadi Fathallah, Department of Biological and Agricultural Engineering, University of California, Davis, CA.

Western Center for Agricultural Health & Safety

Prevention/Intervention

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Major Accomplishments 1990-1996

Improving Health & Safety of Field Workers by Redesigning Tools

Tool Modification to Improve the Health and Safety of Field Worker

Principal Investigator: John Miles, Ph.D., Associate Professor of Agricultural Engineering, Department of Biological and Agricultural Engineering, UC Davis.

Objective: The objective of this study is to help make working conditions less hazardous to agriculture and forestry field workers. Agricultural jobs are analyzed to determine the hazards and ergonomic conditions related to each task. Alternative hardware and systems are designed in an attempt to address both the health and safety concerns and the normal constraints of production agriculture. Improved designs should: provide a less stressful environment for agricultural workers, reduce the number and severity of injuries, maintain jobs by addressing issues related to total production cost and product quality, simultaneous with attempts to improve worker health and safety.

Accomplishments: Citrus ladders have been modified to improve balance, traction, and provide a degree of protection from inadvertent contact with electrical power lines. In addition, alternative fruit handling systems have been fabricated and are being tested to address the serious ergonomic problems associated with pickers using very heavy (60 to 80 pounds) picking bags.

Preliminary results in indicate that our interventions will reduce the biomechanical stress in the lower back of the citrus workers to current NIOSH recommendations without significantly increasing the cost of harvesting the fruit. Tests which are scheduled to be conducted in the next three months will be more conclusive about the specific value of the interventions. The same general intervention strategy will now be applied to a very different kind of crop to test our ability to generalize what we have learned.

Agricultural Epidemiological Study of Farm Workers Injuries

Study of Worker Injuries

Principal Investigator: James J. Beaumont, Ph.D., Associate Professor of Medicine, Department of Community and International Health, School of Medicine, UC Davis.

Objectives: Our project has two objectives: 1) to identify critical needs for agricultural injury epidemiology research, and 2) to perform epidemiologic studies to identify populations at high risk and evaluate interventions.

Activities: We are working with compensation insurance carriers, commodity groups, labor representatives, the Farm Bureau, and academic researchers to identify injury interventions that have broad applicability in the agricultural community. An intervention that currently has widespread appeal to producers and farm workers is incentive pay, whereby workers and work groups receive extra pay for remaining uninjured. We are currently conducting studies of the effectiveness of incentive pay in reducing injuries in citrus orchards a mixed produce orchard, and a fruit cannery. The outcome measure is the rate of injury. Rate numerators are based on the number of reported injuries, and denominators are based upon payroll man hours. Since severe injuries may be reduced less than non-severe injuries if incentive pay encourages under-reporting, the injuries are being assessed for severity based on work days missed. In our research

on interventions we found that many producers have implemented incentive pay as an intervention, despite lack of statistical evidence of efficacy. We also found that insurance carriers believe that there is a strong need for statistical evaluation of the effectiveness of incentive pay. Incentive pay is controversial because it may encourage under-reporting of injuries, and it may violate OSHA rules that prohibit discrimination against injured workers. Effectiveness and under-reporting are being addressed in our studies.

Accomplishments: Injury data and safety program training information has been collected from a San Joaquin orchard/vineyard operation. The data spans 18 years and includes OSHA 200 records, copies of Employer's First Reports, and Doctor's First Reports. A second fruit packing operation in the valley which has a successful safety incentive program has allowed our research group to conduct interviews with all employees regarding personal injury histories and attitudes toward work safety.

Epidemiologic Assessment of Incentive Pay for Reduction of Agricultural Injuries

We identified incentive pay as an injury intervention with widespread appeal to both producers and farm workers. Many agricultural producers in California have adopted incentive pay programs in hope of reducing injury rates. The effectiveness of incentive pay has not been documented, however, and it is controversial because it may encourage under-reporting of injuries and it may violate OSHA rules that prohibit discrimination against workers who report injuries. We have secured the participation of a fruit packer, a combined orchard and vineyard operation, and a cooperative of citrus growers.

Our study has two primary objectives: 1) to show whether incentive pay is effective in reducing the rate of compensated injuries using rigorous epidemiological design to control for potential confounders, and, 2) to differentiate the effectiveness of incentive pay by severity of injury. The second objective is based on the hypothesis that severe injuries will be reduced less than non-severe injuries if incentive pay encourages under-reporting. Other objectives include examination of effectiveness by type of injury. We will survey the workers at one site to determine their attitude regarding the pay incentive, and their observations regarding injury reporting. We are currently analyzing the survey data.

To date, we have documented injury rate reductions at Suma Fruit International (Suma) and Tejon Agricultural Products (Tejon). Both companies realized sharp declines in lost-time days and over-all injury by workers since implementation of company-wide Safety Programs. Both Safety Programs included management training and involvement, worker safety training and job orientations, discipline actions for violations of safety rules, and an incentive system providing various prizes and monetary rewards to workers. We are in the process of characterizing the injuries that did occur for severity based on the number of days missed from work.

Analysis of the Injuries among Agricultural Workers in the California Occupational Mortality Study: Over a three-year period there were 76 machinery deaths (SMR 10.21, in the agricultural occupations. Thirty six (47%) of the machinery deaths were associated with tractors, and 21 of these were due to overturn. Machinery fatalities were found to be significantly in excess for farm operator managers, farm workers, and logging workers (SMRs of 7.48, 12.95, and 21.29 respectively). SMRs for drowning were significantly elevated for farm operator managers, farm workers, and forestry logging workers (SMRs of 4.04, being struck, crushed or

jammed beneath objects were found to be significantly elevated for forestry and logging workers (4.10 and 10.19, respectively) and for all agricultural occupations combined (SMR=3.68). However, only 8 of the 57 drownings were work related. Farm workers additionally had significantly elevated SMRs for animal injuries (SMR=35.79), accidental poisoning (SMR=5.76, with all poisonings due to self-ingested ethyl alcohol), and firearms (SMR=3.74). SMRs for white grounds-keepers and gardeners were significantly elevated for falls. The study highlighted the need for injury prevention in California agriculture and the need for post-1981 coding occupation on California death certificates.

Supplementary Data System: External funds were obtained to purchase data tapes from the National Center for Health Statistics containing Workers' Compensation cases associated with lost work time from the national Supplementary Data System (SDS) for The data were entered into the computer and formatted into SAS datasets. We developed meaningful categorizations for occupation: other agricultural workers, agricultural workers combined, and all other occupations combined. Similarly, meaningful categorizations for industry were developed: five crop production groups, five livestock groups, agricultural services, all agriculture combined, and all other industries combined. For each of these occupation and industry categories, we identified the ten most common injury categories for nature, source, type, and body part involved.

For farm workers, sprains were the most common injury, comprising 35.2% of cases, yet this was lower than the frequency seen for all other occupations combined, for which sprains comprised 44.4% of injuries. Lacerations occurred more frequently among farmworkers than among all other occupations combined (15.4% vs. 11.2%). Fractures were also more frequent among farm-workers than among all other occupations combined (1 2.1 % vs. 9.3%). Fractures were most common among large-animal livestock industry categories. Back injuries comprised 19.5% of farm worker cases (vs. 24.9% for all occupations combined). Eye injuries contributed 5.1% of farmworker cases, vs. 3% among all other occupations combined.

Industrial hygiene Component

Principal Investigator: Mark Mieuwenhuijsen, Ph.D., Industrial Hygienist Specialist, Department of Community and International Health, School of Medicine.

Activities: This component provides industrial hygiene service and expertise to other projects and conducts industrial hygiene research projects. Industrial hygiene research projects have included: development of a sampling and analytical method for amorphous silica fibers from rice farming and the documentation of exposures to rice farmers, measuring the dust exposures of grape workers and citrus workers and characterization of the variables in the work setting that make significant exposures likely to occur, and investigating the key variables influencing dust generation by nut harvesting activities. Also, we have an ongoing project to determine the extent and nature of exposures to airborne contaminants in almond processing. Future projects will include a longitudinal study of dust exposures in a poultry raising operation and a longitudinal study of dust exposures in farmers in the Yolo County area. Information gained from these studies is useful in helping identify farming operations which should be targeted for re-engineering or use of protective equipment to prevent hazardous exposures.

Accomplishments: Dust exposures have been studied for a variety of agricultural operations, including rice farming, table grape and orange harvest, almond harvest, and almond processing. This project follows the "seed grant" initiatives of the previous two years, and will seek to accomplish similar goals to that program in a different, more responsive, administrative structure. The overall aim of this interventions project is to support short-term efforts aimed developing products which can be disseminated and utilized by other in the agricultural workplace. This effort follows the recommendation of our External Advisory Panel to develop programs that are responsive to the various "stakeholder" groups--industry, labor and government--in such a way that the concerns of these groups are addressed. It also seeks to respond to comments of our Internal Advisory Panel to engage in more applied research and education.

The general structure of the Center has been for the creation of research and outreach projects that have long-term goals and time frame. Indeed, this is a strength of the University setting as opposed to the usual shorter time frame of government agency efforts. However, there are several areas in agricultural health and safety for which this long-term perspective is not appropriate. Many of these areas involve responsiveness to requests for assistance from different agricultural constituencies. Such requests might be for assistance with an educational effort, an industrial assessment, an engineering problem, a medical surveillance program, or design or execution of a short-term research project. The unique, multidisciplinary expertise of Center investigators and staff makes the Center an ideal, and appropriate, setting for providing these The common elements for an intervention project are that it be responsive to an identified need in agricultural health and safety, that it have a short time for completion (less than one year, and possibly months or even weeks), and that it be evaluable. Additional criteria to be considered, although not necessary, are that the project generates additional support from other sources, the investigators or staff have a successful record of accomplishing similar projects, and that the effort have demonstrated support from the relevant "stakeholders." Center investigators were requested by an almond processor to assist with the redesign of their processing facility to reduce dust exposure of employees in the "in-shell" processing area. A request was received from a tractor manufacturer in California to assist with evaluation of dust exposure in tractor cabs. The manufacturer had questions about the health effects of dust exposure, and the requirements for driver protection. A request was received from NIOSH for development of Ag Alerts conforming to the general requirements for that program. Identified agricultural hazards appropriate for Alerts included electrocutions from aluminum ladders and deaths from entering fumigated storage facilities. Support would be used for staff time to develop and produce such alerts.

The expected results from these short-term interventions will be creation of products that can be disseminated and utilized by others. These interventions may derive from the research, outreach or exposure hygiene components of the Center, but the benefit expected is visible utility of the effort for the recipient, and hopefully for the larger agricultural community. Examples of possible interventions are described above. Each of these efforts would result in a directly useful product for the recipient. The flexibility of this proposal is that the Center can promptly respond to new requests that are received during the year, without the previous requirement for a project proposal up to a year in advance.

Major Accomplishments 1996-2001

Industrial Hygiene/Exposure Assessment in California Agriculture for Development of Control Strategies

Principal Investigator: Kiyoung Lee, Department of Epidemiology and Preventive Medicine, University of California, Davis, Ca.

Activities: There were four primary areas of activity during this period in the industrial hygiene program. The first of these was continued analysis and manuscript preparation of dust exposure measurements and samples from various on-going field studies. Several manuscripts were published or are in preparation, further advancing knowledge of dust exposure in western dry climate farming. Importantly, these papers have also identified key determinants of increased (and decreased) dust exposure. These include equipment design (e.g. enclosed cab), work practices and atmospheric conditions. Attention to the factors increasing dust exposure is a first step towards reducing dust exposure in the agricultural workplace.

The second industrial hygiene activity involved focused reviews of exposure and safety hazards in selected commodities, with a specific focus on Western agriculture. This effort was under the direction of Dr. Katharine Hammond of UC Berkeley. The four types of farming operations reviewed were vineyards, poultry production facilities, rice farm and dairies. Knowledge on exposures and safety hazards in each of these commodities was reviewed by collection of information from the scientific literature and work with cooperative extension and other agricultural experts. Industrial hygiene students, under the direction of Dr. Hammond, coordinated data collection and report writing. Four reports were completed and results were presented at a scientific meeting open to investigators and members of the agricultural community addressing these issues.

The third activity was continued analysis of dust samples collected in the field. After analysis for respirable and total dust levels, crystalline silica was measured in samples for employees operating equipment during the study. This included both personal and area samples. The analysis of the crystalline silica content in inhalable and respirable dust field samples was completed. This information was used to derive exposure indices of inhalable and respirable crystalline silica exposure.

The fourth activity was assistance with development of exposure questions for the cohort follow-up of California farmers. The follow-up survey of this cohort, which was administered in 1998, included both health outcomes and exposure questions. Linkage of these two components plus critical analysis of the exposure data is an important function of the industrial hygiene core.
The initial focus of the Industrial Hygiene component has been on dust exposure and its constituents. Health studies conducted by center investigators have identified increased respiratory morbidity associated with dust exposure, as well as increased respiratory mortality among farmers in California. This latter finding is consistent with current work on ambient air pollution. Dust is also an excellent carrier for chemicals such as pesticides and disinfectants. All of these studies address an important concern that agricultural exposure, in effect, involves multiple agents. There is a large body of literature on adverse respiratory effects of “nuisance” dust exposure, but little of this was done in the agricultural workplace. Also, it is not clear that the dust itself or the chemicals carried by the dust cause the health effects. Undoubtedly, the analysis of specific dust components is important. In the past year, we measured dust, endotoxin and crystalline silica exposure during agricultural operations in California and started to evaluate agricultural chemical exposure in specific commodities. The final reports on the evaluation of

agricultural chemical exposure were finished. Six exposure indices were generated for epidemiologic studies to estimate annual cumulative exposure to inhalable and respirable components of dust, endotoxin and crystalline silica.

Pilot Studies

Principal Investigator: Marc B. Schenker, Department of epidemiology and Preventive Medicine, UC Davis

- Dust, Endotoxin and Crystalline Silica Exposure During Agricultural Operations In California
- Particle Size Distribution and Determinants of Dust Exposure in California Agriculture
- Characterization of Workers' Exposures to Multiple Agents at Vineyards: Dust and Endotoxin Exposure in the California Poultry Industry
- Agricultural Chemicals in California Agriculture
- Occupational Exposure Surveillance in California Agriculture
- Development of Control Strategies on Field Crop Operations
- Assessment of Residential and In-Field Pesticide Exposures in Farming
- Integration of Exposure Information Across California Agriculture

Future Plans: California is the nation's leading agricultural producer. Because of the diverse nature of Californian farming pursuits, the state's agricultural industries harbor a wide variety of health hazards. Several epidemiologic studies showed clear evidence of increased incidence and prevalence of respiratory symptoms and disease in agricultural population. Despite the existence of a large population potentially at risk from agricultural exposures, there has been little quantitative investigation of the magnitude of these hazards. Better characterization of exposure to the agricultural dust will improve our understanding of risk factors for respiratory disease in agricultural workers, and control of the risk factors. Our long-term objectives are to assess exposure for understanding health effects of air pollutants and control the health hazards in Western agriculture. This research will focus on characterizing agricultural dust exposure by systematic measurement and model estimation. The approach that will be used here is to collect agricultural mixed dust in samples from representative California agricultural working environments and determine chemical and physical characteristics of the dust. The expected outcome is identification of risk factors in agricultural operations that can lead to occupational surveillance and development of control strategies for prevention and intervention of occupational diseases. In addition, non-occupational exposure to agricultural dust and chemicals will be measured for identification of risk factors. We expect that this research can provide the agricultural-exposure information that would facilitate health risk assessment in epidemiological studies, identification of hazardous operations and populations at risk, and implementation of more effective control measures.

Pilot Study - Agricultural Surveillance of Respiratory Disease

Principal Investigator: Robert J. Harrison, MD, California Department of Occupational Health Services

Accomplishments: The surveillance system is needed to identify selected cases for potential investigation and development of prevention recommendations. The statewide surveillance system was designed to develop and implement - in collaboration with key stakeholders - broad-based interventions that address the principle causes of agricultural respiratory diseases. The surveillance system made significant progress in preparing the general respiratory dataset for analysis. About 200 reports of agricultural respiratory disease were received annually over 5 years of data collection (1993 – 1998). Major progress has also been made in coding exposures for all cases using the AOEC coding scheme. Various factors of the agricultural respiratory disease have been identified.
A system for the routine receipt and review of electronically transmitted workers' compensation data was established by collaboration between Occupational Health Branch and Workers Compensation Information System (WCIS). Two separate evaluation efforts will be implemented to determine the success of overall report capture of the new system, and also evaluate the effectiveness of proposed criteria for identifying cases for specific endpoints.

Future Plans: In collaboration with the University of California, Davis, we propose to establish and maintain a statewide agricultural respiratory disease surveillance system. The primary objectives of this surveillance system are to:

- Identify selected cases for potential investigation and development of prevention recommendations;
- Develop and implement, in collaboration with key stakeholders, broad-based interventions that address the principal causes of agricultural respiratory diseases; and
- Disseminate findings from our surveillance data, findings of case investigations, and intervention results.

The Research Associate will perform data abstraction, coding, and database entry of all agricultural respiratory surveillance data. She will assist the Principal Investigator with the analysis of the data, and prepare reports and scientific publications.

Collaborations: Public Health Institute, Berkeley, CA

Prevention of Musculoskeletal Disorders in Hand Harvest of Vegetable Crops

Principal Investigator: John A. Miles, PhD Department of Biological & Agricultural Engineering

Activities: Jacob Chapin began participating in this project in September 1997 and completed his masters thesis in February 2000. Chapin designed and tested a unique grape harvest aid which substantially reduced the ergonomic hazards related to manual wine grape harvest. He presented his results at the American Society of Agricultural Engineers Annual Meeting in Milwaukee this July2000.

Work on ergonomic improvements in harvesting cilantro by a postgraduate research student from Holland, Aart Van Zeidelhoff, led to a major proposal submitted to USDA in May 2000. This project is currently being rewritten for a new USDA request for proposals.
In August 2000, NIOSH funded a new project related to the ergonomic hazards associated with alternative trellis systems for wine grapes. This three year project grew at least partially from preliminary data collected under this grant.

Future Plans: This project relates directly to three high priority objectives in the Healthy People 2000 report: research on hazard surveillance, development of control approaches, and effective use of controls. In addition to meeting high priority objectives in Healthy People 2000 this proposed project also meets two specific priorities of the National Occupational Research Agenda. Specifically work-related musculoskeletal disorders and special populations at risk (i.e., nearly all workers involved are immigrants from Mexico or other Central American countries. The project's four main goal are: to improve prevention of high risk musculoskeletal disorders in hand vegetable harvest; to demonstrate the application of ergonomic engineering intervention in a field agricultural workplace; to increase the understanding of the risk factors for musculoskeletal disorders and ergonomic methods among owner/operators, workers, and the agricultural community in general; and to add to research knowledge about ergonomic engineering approaches to agricultural injury control. The project's specific aims include: 1.Recruit cooperating partners from among cilantro producers;2. Develop detailed ergonomic descriptions (including instrumented biomechanical, metabolic, and postural data) of identified risk factors for MSDs involved in hand harvest of leafy vegetables (cilantro);3. Assess the incidence of MSDs and related symptoms among workers performing hand harvest of leafy vegetables (cilantro); 4. Develop a field-ready prototype of existing model leafy vegetable (cilantro) harvest machine;5. Conduct cooperative field trials of prototype with producers; 6. Estimate the impact of the prototype interventions on the ergonomics of hand harvest work tasks;7. Estimate the impact of the prototype interventions on the health outcomes; 8. Assess productivity impacts and perceived "adoptability" of interventions; 9. Evaluate cooperative intervention trials and compare with pre-intervention analyses; 10. Communicate project findings to vegetable and other agricultural industry groups, to workers, and to community interests; 11. Report project findings in appropriate research and professional publications.

Major Accomplishments 2001-2006

Pilot Study - An Intensive, Regional Approach to Occupational Research Priorities for California Farm Workers

Principal Investigator: David Lighthall, PhD

1. Agricultural Health and Safety Task Force: To better understand the range of priority issues regarding agricultural health and safety and, equally important, how those sets of priorities differ between stakeholder groups, the California Institute for Rural Studies (CIRS) has conducted a formal needs assessment at the behest of the Agricultural Health and Safety Center (AHSC) of the University of California. The AHSC called upon CIRS to undertake a formal needs assessment for the purpose of identifying occupational research and intervention priorities based on input from the region's stakeholder organizations and farm safety experts. The scope of the assessment includes health and safety issues relevant to all farm workers, including farmers, unpaid family members, and hired farm workers. The evaluation has focused primarily on California but has also solicited stakeholder input from Arizona, two of the four states that comprise the AHSC's region of responsibility. The evaluation will help guide the research and intervention priorities of the AHSC in the years to come.

As part of the assessment, CIRS identified and recruited a fourteen-member Agricultural Health and Safety Task Force to help direct the project. This volunteer group consists of a wide range of industry stakeholders, including two farmers, a farm labor contractor, a union representative, a U.C. Cooperative Extension representative, a current farm worker, a retired farm worker, a rural physician, a public health nurse, a worker advocate, an anthropologist, and two insurance industry representatives. A secondary goal of the task force has been to create an open dialogue for sharing divergent viewpoints about the problems of health and safety in agriculture. During its initial meeting, Task Force members concluded that the incorporation of public input should be accomplished through two methods: (1) Telephone interviews and focus groups with key informants and constituencies (including farm workers) and (2) a public comment notice sent to a broad spectrum of agricultural associations and industry representatives. These elements were successfully completed with the project final report to the AHSC scheduled for April, 2001.

2. The California Agricultural Workers Survey (CAWHS): As part of its effort to conduct a multi-year comparative assessment of survey data drawn from several surveys of hired farm workers, CIRS has been engaged in a year-long process of cleaning, verifying, and analyzing a very large volume of occupational health and safety data generated by the CAWHS. This component of the larger project has been supported by the UC Davis AHSC during FY2000 Tthe survey is the first state-wide, randomized health study of farm workers conducted in the United States. The CAWHS dataset includes (1) levels of health care utilization by the participants' households, (2) current health status of the participant and children of female participants, (3) detailed work history of the past 12 months, (4) immigration status, (5) housing conditions, (6) wage rates and household income, and (7) occupational conditions, safety training, and injuries. In addition, the 968 participants were also asked to undergo complete physical exams and provide blood samples. As of March 1, 2001, CIRS has just begun its preliminary analysis of the occupational safety and health data.

Future Plans: The goal of the proposed pilot research is to conduct a set of regional, intensive case study investigations of occupational safety and health problems facing California hired farm workers. The empirical foundation for the regional case studies is two extensive health surveys of 1,435 current and former California farm workers conducted by the California Institute for Rural Studies (CIRS) in 1999. The California Agricultural Workers Survey (CAWHS) interviewed 968 current farm workers regarding a comprehensive range of occupational health issues as well as physical examinations and blood chemistry analyses. Interviews were conducted in seven communities representing the six agricultural regions of the state. The Binational Health Survey (BHS) posed a similar range of questions to 162 current farm workers and 305 former farm workers residing in sending villages in Mexico but did not include physical exams. Phase I of the project consists of a regional assessment of key occupational risk exposure and related trauma. The regional analysis will particularly focus on (1) correlations between crop/tasks and chronic trauma and (2) an evaluation of the Worker Protection Standard's (WPS) effectiveness in respect to training and minimizing pesticide exposure. This analysis will serve as the basis for causal hypotheses that will guide the intensive fieldwork of Phase II. The goal of Phase II is to systematically investigate the validity of these hypotheses in their regional contexts via semi-structured interviews with workers, employers, occupational health specialists, health providers, and others. Analytical objectives to be included in the final report include (1) process understanding regarding onset, treatment, duration, and

length of tenure impacts for common chronic injuries in each region, (2) worker-, care provider-, or employer-based barriers to treatment for occupational trauma, (3) explanations for WPS inadequacies in respect to training and compliance, (4) suggestions for improving access to occupational safety training and health care, (5) identification of gaps in the regulatory safety net for hired farm workers in the state, and (6) specification of emergent research hypotheses that merit follow-on research by specialists at the UC Davis AHSC and elsewhere.

Pilot Study — Prevention of Musculoskeletal Disorders in Hand Harvest of Vegetable Crops

Principal Investigator: John A. Miles, Department of Biological and Agricultural Engineering, UC Davis

Abstract: This project evaluated ergonomic risk factors in vegetable and tree-fruit crops to develop a list of possible interventions for each high-risk job situation. Stoop labor was found to be a common component of the work required in many vegetable crops. Hired workers in agriculture bear the brunt of injuries (73% as compared to family workers at 27%), and 67% of those injuries occur to Hispanic workers. Of all occupational illnesses or injuries for farm workers, musculoskeletal disorders are the most common. Among farm workers, back strain accounts for 39% of all strains and sprains. The heavy physical work, frequent bending and twisting, and awkward postures associated with agricultural jobs place farm workers at high injury risk. We found three general risk factors as both endemic and of highest priority throughout the agricultural industry: sustained or repeated full body bending (stoop); lifting and carrying heavy loads (over 50 lb); and very highly repetitive hand work (clipping, cutting).

The lack of feasible alternatives for these workers caused us to progress in two directions. First we began to develop labor aides to reduce the risk associated with the stooped work posture. This work has not been completed, but at this time we are evaluating the use of powered carts which can carry workers in a semi-prone position while they do tasks very near the level of the ground. It is clear that this approach will be very crop and task specific. For some tasks in some crops this may be a viable solution, while for other situations it is not feasible to carry workers in a semi-prone position. A key example of when it is not likely to be appropriate is for the hand weeding of crops, where the workers may have to apply substantial force in order to pull the weeds. The second direction taken was to jointly sponsor an International Symposium on Stoop Postures with NIOSH. This conference was Held on July 29-30, 2004 in the Elihu Harris State Office Building in Oakland. This was attended by about 100 people from across the United States, Northern Europe, and India.

Pilot Study - Evaluation of the Ergonomics of an Alternative System for Harvesting Pears

Principal Investigator: John A. Miles, Department of Biological and Agricultural Engineering, UC Davis

Abstract: A pear grower in Lake County as purchased a Spanish Mobile Platform as an alternative to the use of ladders and bags for picking pears. Initially, we attempted to determine whether the system (1) was safer and less stressful on workers, (2) saved labor and/or time, (3) increased productivity, (4) required changes to the tree and orchard configuration, (5) improved or hurt fruit quality, and (6) had additional costs associated with it compared to using 14-16 ft orchard ladders. As anticipated, a number of problems limited the actual use of the machine, including difficulty operating a machine which was completely new to both the crew and the managers,

difficulty in attempting to use the machine in orchards which had been trained to be harvested by crews with ladders, and those issues related to the specific markets for the crop that dictated field operations which were not friendly to the new machine. Surveys indicated there was no indication of work related injuries either before or after the trial.

We conducted a more realistic study in a neighboring orchard where the owner has trained his trees to grow as a "wall of fruit" for several years. The objective in this orchard was to pick all of the fruit, not just particular sizes. While too little data was collected to allow statistical evaluation, a number of issues have been identified that could improve both working conditions and safety. Some of the drawbacks of the system included:

The machine was not tall enough to pick the highest fruit on the trees.

The workers complained about the vibration of the machine, and while the duration of the tests was so short, no injuries resulted, vibration isolation needs to be a significant objective for future machines.

While the platforms telescoped in and out of the tree, it was not easy for the workers to make the adjustments.

The trees need to be trained to minimize branches which stick out into the isle between rows. Such branches interfere with the machine operation, and present potential injury problems to workers.

On the positive side, the machine workers were much less tired that the conventional crew, and the fruit from the machine showed less damage that that picked by the conventional crew. Highly trained crews of conventional workers pick at substantially higher rates than the machine crew. The machine crew rate was quite comparable to picking crews who only worked occasionally on ladders. Any labor shortage would provide a substantial incentive for growers to move toward machine harvest.

Future Directions

Efficacy of Weight Transfer Devices in Reducing Low Back Pain in Stoop Labor

Project Leader: Fadi Fathallah, PhD

Description: Frequent and/or sustained bending of the spine, often referred to as stooped postures, are dominant in several jobs having very high reports of low back disorders (LBDs). In agriculture, harvesting the majority of fresh fruits and vegetables still require workers to assume stooped postures. Finding feasible interventions to reduce the likelihood for developing LBDs among workers who are exposed to prolonged periods of stooped postures will result in substantial reductions in worker disability, lost work time, and medical and other compensation costs. A pilot laboratory study conducted by the Project Leader has shown that several personal weight transfer devices (WTDs; designed to transfer loads from the back to the lower legs) show a promise in reducing muscular load on the back and provided an indication that these devices may be an effective and feasible approach for reducing the high prevalence of LBDs among workers who assume prolonged stooped postures. In this project we will: 1) Conduct a simulated controlled harvesting study to investigate how WTDs affect the musculoskeletal system, 2) evaluate design and comfort issues, and various practical concerns related to the use of WTDs. Incorporate changes that address these issues and concerns into modified (field-ready) WTDs, 3) conduct a randomized cross-over controlled intervention study among strawberry harvesters to

evaluate the effectiveness of the modified WTD; demonstrate the devices feasibility in other crops, and 4) if the study shows that WTDs considerably reduce the prevalence of low back pain during stooped postures, disseminate the findings throughout the agriculture and construction industries to help in the efforts of controlling LBDs due to stoop labor. The study focuses on the agriculture/forestry/fishing sector identified in the National Occupational Research Agenda (NORA); however, stoop labor is prevalent in other industries, especially construction and mining. Hence, results of this study may be translated to help the construction and mining sectors. The aims of this study address several of the 17 priority research topics identified in the production agriculture/forestry/fishing sector, including: 1) reducing the number of unintentional injuries, 2) education/outreach to increase the knowledge of effective occupational safety and health interventions for agricultural workers, 3) development of better methodologies for exposure and morbidity surveillance in agriculture, and 4) intervention to reduce adverse safety and health events in migrant/seasonal farmworkers. Stoop labor is performed in almost every state, and therefore, the implications of this study should translate to other regions that have crops requiring stoop labor (e.g., tobacco in Southeastern states).

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Introduction

Since its inception in 1990, the WCAHS has engaged in many ongoing efforts that provide information and education opportunities for people involved in the issues of agricultural health and safety. These include a quarterly newsletter with up-to-date reports on Center activities, an attractively designed and useful website, a listserver, monthly seminars featuring invited speakers, and regional conferences organized around current agricultural health and safety issues. These resources are widely used. For instance, during one month individuals throughout the United States and 34 nations throughout the world visited the website. The newsletter has an extensive list of subscribers, mainly from the Western U.S. Monthly seminars attract students, researchers, and educators from the UC Davis campus as well as the public. Representatives from various private companies and from governmental agencies in San Francisco and Sacramento also attend many of these seminars. Regional conferences have attracted individuals from throughout the U.S.

Reaching agricultural workers through training programs for farm supervisors, employers, and trainers was our primary focus. The agricultural workforce in the western regions is very large. In California alone, there are over one million workers employed to perform cultural and harvesting operations on agricultural crops. Reaching these workers with health and safety information is a challenging task. Center investigators, using the Federal Worker Protection Standard employee training requirements as a model, have developed Spanish and English language train-the-trainer programs that leverage efforts of a few UC educators. It is estimated that over 800,000 workers will receive training during the coming year from approximately 2500 instructors who have participated in this Center-supported program. Investigators have implemented an extensive evaluation effort to measure the effectiveness of this project and to determine its impact on the trainers and fieldworkers.

The Center has been a leader in developing internet resources and material in the area of agricultural health and safety. These have included electronic dissemination of the Center newsletter and a newsletter from all the NIOSH Agricultural Health and Safety Centers, support of a list server that provides communications between individuals fro around the globe with an interest in agricultural health and safety, and support of World Wide Web homepages and linkages to many groups involved in this area.

Center Accomplishments
1996-2001

Newsletters

The Center published 20 issues of the quarterly newsletter “AgHealth News” to communicate Center activities and information about Center-sponsored research, intervention and educational activities, and other events to a wide range of subscribers who have an interest in agricultural health and safety. The newsletters also reported on presentations by invited speakers or Center investigators at monthly seminars. Besides the Center newsletter, investigators regularly submitted articles for publication in other newsletters such as the UC Small Farm Program’s “Small Farm News” and the UC Division of Agriculture and Natural Resources’ “ANR Report.” Press releases and articles of interest were also forwarded to the 51 UC

Cooperative Extension offices throughout California for inclusion in local farm advisor newsletters.

Website

The Center has developed and maintained a very active website that provides a source of easy-to-find information about the Center and Center activities. The website links to the other NIOSH-funded agricultural health and safety centers, more than 20 other agricultural health and safety sites, 7 government agencies with responsibility for agricultural health and safety programs, and 6 other useful agricultural health and safety sites.During a recent month the Center website received 31,415 "hits" and served 1,211 different individuals who viewed 4,080 pages of information. Although the largest percentage of visits to this website was from individuals or organizations within the United States, individuals from 34 other nations visited the site.

Conferences, Workshops, and Educational Seminars

During the reporting period the Center developed and hosted three major agricultural health and safety conferences for the Western US. Each conference had in attendance graduate students, university researchers and educators, representatives from state and national regulatory agencies, farmers, representatives from farm-worker advocacy groups, representatives from farm organizations, insurance company representatives, health care providers, representatives from agricultural equipment manufacturers, and others. In many instances the conferences stimulated successful collaborations among people in the Western states by identifying common issues on which researchers and educators were working. These conferences also helped the UC Center significantly expand its regional outreach efforts through the many contacts that were made with conference participants. The Center sponsored 43 educational seminars on the UC Davis campus, held monthly throughout the 1996-2000 academic years. In addition, Center investigators conducted over 160 workshops and training seminars for agricultural employers, farm labor contractors, farmers, farm workers, workers compensation insurance company representatives, and community members. The Center also co-sponsored two conferences for health care professionals and researchers, 5 hands-on pesticide applicator workshops, and two agricultural safety meetings.

Short Courses

Three short courses on recognizing and managing pesticide illness were conducted during this reporting period. These were held in Salinas, Merced, and San Luis Obispo. Faculty included local community pesticide authorities, state agency authorities, and Center investigators.

Children in Agriculture

The Center has taken an aggressive role in promoting educational programs designed to protect children from agricultural health and safety hazards, with emphasis on children of farm workers. We have been actively involved with the national Farm Safety 4 Just Kids organization and have assisted in establishing a California chapter. The Center sponsored a representative from this California chapter to attend the national Farm Safety 4 Just Kids yearly conference in

Ames, Iowa. Center investigators have participated in state and national forums on children's health issues in agriculture.

Regional Interactions

Center investigators have visited and established collaborations with individuals and organizations in Hawaii, Arizona, Nevada, and Washington to address mutual agricultural health and safety issues. Many of the materials used to train and educate non-English speaking farmers and farm workers that were produced by Center investigators have been provided to educators and regulatory agencies in these states. The Center has also funded an epidemiological study relating to the health status of Native Americans involved in farming in the Gila River Indian Community in Arizona. More recently, investigators have begun collaborations with the Inter-Tribal Council of Arizona, representing 22 Indian tribes, to provide training to tribal health care providers on recognizing and managing pesticide illnesses and injuries. Investigators are collaborating with several agencies in Hawaii to extend agricultural health and safety information to Laotian and Filipino farming communities in that state.

Publications and Other Products

During the recent reporting period, Center investigators have developed three books dealing with aspects of pesticide safety, several pamphlets dealing with pesticide and food safety, several audio tapes, and two videos. Many of these materials have been produced in Spanish, Lao, Hmong, and Cambodian. Copies of these books, pamphlets, videos, and audio tapes have been distributed throughout the US and worldwide.

Additionally, during this time, two of the Center's outreach and educational projects were highlighted in a report to the California Latino Legislative Caucus as model programs of the University of California for serving the needs of underserved Hispanic populations in the state. The UC Division of Agriculture and Natural Resources has funded and ratified an Agricultural Health and Safety Workgroup to serve as a liaison between Center activities and UC Cooperative Extension advisors and specialists throughout the state. Several Center investigators participate in this workgroup.The Center supported a feasibility study conducted by the American Association of Pesticide Safety Educators to explore the creation of pesticide safety education centers in the US. Based on the positive outcome of this study, the Center is collaborating with representatives from 13 Western states and 30 Indian nations to create a center that will be located on the UC Davis campus.

Major Accomplishments 1990-1996

Delivering Safety Training and Hazard Awareness Information to Agricultural Workers

Principal Investigator: Patrick J. Marer, Ph.D., Pesticide Training Coordinator, UC Statewide Integrated Pest Management Project, UC Davis.

Description: To develop and explore the effectiveness of culturally sensitive educational materials for agricultural workers. "La Loteria de los Pesticidas" (The Pesticide Safety Lottery), is an educational tool that was developed to help train agricultural workers to work safely around pesticides. It uses the format of a traditional Latin American game, together with interesting,

amusing drawings and sayings, to teach important safety messages. Since its introduction in early 1993, we have carefully followed its use in the field to determine its effectiveness and to develop additional ways it can be used to train workers. The Pesticide Safety Lottery is a highly useful training tool which makes the training process more interesting and enjoyable for both trainer and trainee. This assures that trainees will better retain the information they have received. Through our on-going investigation into its use and effectiveness, this project can serve as a model training tool to be used in other agricultural worker educational activities.

Accomplishments: Investigators have developed and are testing models for several safety education and awareness tools, training methods, and educational programs that are being used to bridge the language and cultural barriers which usually impede delivery of safety information to agricultural workers. Several new and innovative training tools have been developed and are being evaluated in various types of educational programs. The La tool has been widely distributed through the University of California Agricultural Personnel Management Program and we have consulted with organizations and individuals from several other states to help them develop similar tools for their agricultural safety programs. This tool concept is now being adapted to other areas of agricultural health and safety, the most recent being used for teaching motor vehicle safety. We are currently evaluating our success to rapidly disseminate safety information to a large population (ca. 750,000) of California farm-workers through an innovative program. We are also working with other Center researchers to develop outreach programs for pesticide exposure monitoring.

The goal of this project is to reduce agricultural illness and injury by improving the methods used to convey safety training and hazard awareness information. This is accomplished by: (a) developing training methods that address the cultural, language, and educational differences of workers; (b) assisting employers to provide effective safety training programs ;and (c) extending agricultural safety information into nontraditional areas such as rural health clinics and community social service agencies. Success in the various aspects of this project will benefit agricultural workers most because they will work safer and receive fewer injuries. Employers will benefit as well because they will have fewer workplace injuries or illnesses and will have a healthier, more productive work force.

Social Marketing: A Farm Safety Diffusion Tool

Principal Investigator: James Grieshop, Ph.D., Lecturer in Community Education, Department of Applied Behavioral Sciences, UC Davis.

Description: This project was designed to research, design, and deliver safety training and hazard awareness to agricultural workers through an organized social marketing educationloutreach campaign for and farmworkers. The social marketing approach is built on systematic research and needs analyses. All phases of the social marketing effort involve active exchanges between target audiences, training providers, and program planners to create the most effective and accepted combination of content and media to increase and promote work safety. Emphasis is also placed on evaluation of programmatic efforts.

To market socially relevant ideas and behaviors that pertain to safe work practices on farms and to identify and meet the needs of farm owners and workers, and to facilitate the efforts of agencies serving similar target groups. Systematic needs analyses are conducted that lead to “action planning” involving all markets (farmers, workers, farm labor contractors, service providers, etc.). This approach is based on the premise that products/efforts fail when a product or idea is not matched with audience needs or is imposed upon audiences without prior needs analyses. The social

marketing plan is based on existing "consumer" beliefs and behaviors. At each action step the plan is modified using new information, that is, the process is evaluated. Process evaluation is used to modify product, and design implementation strategies. Social marketing builds on the four P's of Product, Promotion, Price, and Place. Products include training materials, programs, ideas (i.e., acceptance of personal responsibility for safety), and practices (e.g., safe ways of lifting objects). Promotion entails the use of electronic media, preparation of PSAs, news articles, TV talk shows to complement our public presentations. Our audiences' willingness and ability to pay, in terms of money, time, and psychological costs are price considerations. The place aspect is related to the delivery points and accessibility of the products (e.g., at work vs. community sites). The key delivery sites where market segments are concentrated include Fresno, Kings, Tulare, and Madera Counties, but, mass media extends efforts to Sacramento, San Joaquin and Stanislaus counties and to Mexico. The social marketing of health and safety programs offers a systematic method for addressing critical issues in a creative way. The method and techniques used permit us to create culturally appropriate and powerful tools for improving the work lives of farmers and farm-workers in California.

Accomplishments: The initial aims continue. However, Year 6 will include a new element to conduct selected case studies and needs analyses targeting farm operations with model safety records and model safety programs. The selected farm enterprises have successfully reduced workplace injury as measured by low workers compensation experience modification rates.
In addition, pilot evaluation studies using La Loteria del Manejo Seguro will be conducted at three sites in California. Also the design and development of La Loteria del Manejo Seguro training guide will commence in Year 6. This project has maintain the mass media and local media campaigns, design and participate in ag health and work safety fairs, develop and implement ag trainings and safety workshops, as well as research, develop and produce model training systems.

The Social Marketing Farm Safety Diffusion Tool project has impacted farm operators and workers throughout the State of California as well as other sates which is demonstrated by the fact that nearly 300 copies of the multi-media tractor safety and field sanitation packets have been purchased and the Loteria del Manejo Seguro is being recognized not only in California but also Arizona by insurance companies and law enforcement agencies as an effective training tool for non-English speaking ag workers who drive. TV, radio, newspaper media campaigns have been well-received by English and Spanish speaking audiences as some 30 PSAs addressing on-farm safety (i.e., back, tractor, personal hygiene, heat stress, etc) and off-farm safety regarding motor vehicles have been continuously aired over the past 1-l/2 years.

Information Exchange and Interaction on Agricultural Health Issues

Principal Investigator: James Meyers, Ed.D., M.P.H., Extension Specialist, School of Public Health, UC Berkeley.

Description: The goals of this project are to increase information exchange, collaborative effort, and improve means of prevention of agricultural illness and injury through establishment of a coalition of the diverse interests involved in agricultural safety and rural health. The AgSafe coalition has some 300 participants and is sponsored by over 30 organizations representing agricultural industry groups, farm worker clinics, insurers, state and local agencies, community and non-profit organizations and others. AgSafe sponsors an annual series of seminars for involved practitioners, serves as a clearing house for information across

interest sectors, disseminates information and safety training materials, cooperates with the UC Farm Safety program in disseminating a practitioner focused newsletter, and organizes cooperative intervention programs. AgSafe has developed and disseminated materials and held training meetings on worker safety training and formal injury and illness prevention plans. AgSafe's current priorities include: Prevention of Equipment and Vehicle-Related Fatalities, Ergonomics in Agriculture, Agricultural Pesticide Issues, Agricultural Health & Safety Regulation and Policy Innovative Approaches to Injury Prevention.

Accomplishments: 1) Dissemination Network; Because it is a coalition of groups and organizations which have dissemination mechanisms of their own, AgSafe is in an unique position to provide for extended information dissemination throughout the agricultural community if it can develop coordinated access to the dissemination media of its participant organizations. This network has been preliminarily mapped (Milestone 1) and AgSafe has competed a set of pilot extended dissemination exercises (1994 Cal OSHA Ergonomics Initiative information; 1994 Farm Safety Week information; and 1995 Agricultural Health Safety Conference announcement) (Milestone 2). In 1995-96 AgSafe will expand the network directory and demonstrate network functioning through a cooperative program with on the EPA Worker Protection Standard and through a cooperative effort with Cal OSHA to disseminate a guide to ergonomics in agriculture. 2) Agricultural Health Promotion: AgSafe continues to disseminate its Tailgate Training Series (in both English and Spanish) in both hard copy and on diskettes. It also makes available a general Cal OSHA required model agricultural Injury Illness Prevention Program, a Tractor Safety Training Guide in Spanish and English, and references to both agricultural safety training resource materials and California Safety Orders affecting agriculture. In cooperation with Cal OSHA, AgSafe developed and disseminated a guide to the proposed ergonomic standard in Spanish and English along with a job evaluation check-sheet with definitions in 1994. In addition, AgSafe maintained publication of its quarterly newsletter (circulation 700) providing update information on ergonomics, pesticide issues, innovative safety practices, and safety policy. AgSafe is exploring co-publication with the UC Farm Safety newsletter. 3) AHS Professional Development: California General Industry Safety Order 3203 requires that employers have a written injury and illness prevention plan and that someone be assigned its implementation. This has greatly increased the number of supervisory employees in agriculture with assigned responsibility for workplace safety. Providing this group specific training, resources, and professional recognition can make a significant difference in the recognition of importance of prevention programs and in their effective implementation. AgSafe has set for itself a goal of developing a core membership of such safety officers in addition to its organizational members. Beginning in 1994, AgSafe began to accept memberships from individual professionals. The planned 1995 Agricultural Health and Safety Conference will be aimed specifically at this audience with sessions on policy implementation and workshops on specific issues and skills. 4) Agricultural Health Safety Priorities; A statement of agricultural community priorities for agricultural health and safety efforts will serve several important purposes. First, if sufficiently broad in source, it can stimulate and reinforce increased community awareness of the issue. Second, the exercise itself, as a of constituency building, can focus and build support for other outreach and research efforts. Finally, the priorities should serve to help guide and assess priorities and proposals among the various participants involved in AgSafe. A pilot priorities survey was implemented in 1994 by AgSafe using a mail instrument.

Response was quite low even with multiple telephone follow-up. For 1995, a two-step survey strategy is proposed. First, AgSafe will contact selected organizational and community participants for focused in-depth interviews, then a confirmatory instrument will be prepared for distribution in cooperation with participant groups. 5) Public Conferences: A pilot public conference was held in 1994 in cooperation with the California Farm Bureau Federation in Sacramento. It was a one day update conference featuring speakers from state federal agencies, research groups, and health providers and insurers. While attendance was less than 100, response was very positive and both interest and opportunity were well demonstrated. As a result, AgSafe has planned a two-day public conference for March 1995, again in Sacramento. This conference will more emphasize outreach to and training for agricultural safety professionals than to organizational participants. The conference will now become an annual activity, augmented by a continuing series of community-based presentations and workshops begun in 1994 around the proposed Cal OSHA ergonomics standard. The 1995 conference is co-sponsored by AgSafe and the Center, and a special workshop on ergonomics is supported by the UC Center for Occupational and Environmental Health. Participating organizations include major worker's compensation insurers, a variety of agricultural groups and organizations, and agencies including, US-EPA, Cal EPA, Cal OSHA, and others. Over one hundred participants were pre-registered at the time of this report.

Coalition Establishment: Now that the Coalition is established and has demonstrated a capacity to stimulate increased multi-sector cooperation and information exchange, the opportunity exists to both expand its functions and to begin to employ it as an information dissemination device and as an outreach action partner in its own right. The structure and administration of the AgSafe coalition have changed. A new director has been named by the Board of Directors and activities are now organized around five working committees: Pesticide Safety, Ag Ergonomics, Vehicle Safety, Safety Related Innovations, and Safety Policy.

Farm Labor Organization Occupational Safety Education Program

Principal Investigator: Donald Villarejo, Ph.D., Executive Director, California Institute for Rural Studies, Davis, California, and Research Associate, Department of Sociology, UC Davis.

Description: The goal of this project is to create a model program to directly educate new immigrant farm employees in California about their rights and responsibilities, including occupational safety. Implementation of the project is accomplished at several levels: first, developing leadership skills among volunteer members of community-based organizations; second, conducting Spanish-language safety and worker rights training programs sponsored by these organizations; third, developing and distributing *Un Guia* (a model Spanish-language pocket guidebook) to individual workers. Recent immigrant agricultural employees in California are relatively uninformed about occupational safety and are often unaware of administrative remedies available to them to correct unsafe practices. By directly training individuals through their own organizations and in settings which they feel self-confident, participants learn to articulate positive safety suggestions as well as monitor the workplace for unsafe practices and, if necessary, bring them to the attention of appropriate enforcement agencies.

Accomplishments: Distributed over 7000 copies of *Un Guia* to more than 75 organizations and a portion of the publication was published in a major San Joaquin Valley newspaper.

Continuing Medical Education

Principal Investigator: Bruce Leistikow, M.D., Assistant Professor, Department of Community and International Health, School of Medicine, UC Davis.

Description: This project aims to develop, test, disseminate, and improve self-study continuing education materials for primary health care providers. Agricultural skin disease and respiratory disease case study booklets have been developed. They've been distributed to academic professionals for their evaluation, and are now being assessed in primary care focus groups. Final revisions will then be made prior to printing and dissemination in booklet and electronic formats. Health and agricultural professionals benefiting from these materials include: migrant clinic clinicians, family and general practitioners, public health practitioners, and health and safety professionals.

Accomplishments: Skin disease and respiratory disease in agriculture booklets have been tested. They are under review for accreditation. Migrant clinicians requested that patient education materials accompany the case studies. Farmworker/patient education materials in spanish and English have been developed on the topic of using disposable dust/mist masks on the farm, and acquired on the topic of smoking in Hispanic farmworkers.

Major Accomplishments 1996-2001

Extending Pesticide-Related Health and Safety Programs to Underserved Agricultural Populations in the Western United States

Principal Investigator: Patrick J. O'Connor-Marer, Ph.D.

Train-the-Trainer Workshops. In order to reach large numbers of agricultural workers with safety information we have developed, tested, and refined a model that focuses on preparing individuals to train pesticide handlers and agricultural fieldworkers. Since the inception of this project a total of 177 train-the-trainer workshops have been conducted, with 4,462 community members participating. Slightly more than one-third of the workshops have been conducted in Spanish. Based on feedback provided by the participants, the information we furnished and the skills we demonstrated will be extended to over 820,000 agricultural workers in California.

Extending Agricultural Safety Information. The hands-on training model that we developed and tested between 1992 and 1995 has been adopted in several communities. The Sonoma County Department of Agriculture, in cooperation with the UC Cooperative Extension office, conducted a large hands-on workshop during March of 1999 in Santa Rosa. Over 400 agricultural workers were sent to this training by their employers. Three hundred of these participants received pesticide safety training given in Spanish and the remaining received their training in English. Our staff developed and provided the training materials and presented a full day of training for the instructors involved in this workshop. We have also assisted the Washington State Department of Agriculture in conducting similar types of workshops in Wenatchee, Washington. Community members in Napa County, California, conducted a workshop held in March, 2000, that provided training to 420 agricultural workers.
Outreach to Rural Health Care Providers. We developed a prototype train-the-trainer workshop for health care providers and tested it in Monterey County in November of 1998. The

information presented was based on the results of a needs analysis we conducted in several major California rural health clinics in 1997. This workshop provided key clinic personnel and others with information, resources, and training skills to help them train others in the recognition, diagnosis, and management of pesticide-related illnesses and injuries. The workshop also provided participants with information about the legal requirements for reporting suspected and actual pesticide-related injuries. Based on the information gained from the prototype workshop, we conducted two additional sessions during 2000. These were held in San Luis Obispo and Merced counties. We developed an extensive workbook and resource manual for use in these workshops.

English-as-a-Second-Language (ESL) Feasibility Study. During 2000, we conducted two courses that employ English-as-a-Second-Language (ESL) and English-for-Specific-Purposes (ESP) concepts to teach limited-English-speaking pesticide handlers the skills they need to read pesticide labels. This was a feasibility study to determine if the ESL/ESP concepts would be effective in extending pesticide label comprehension skills. These courses were taught in Spanish and Hmong. Carrying out this feasibility study involved understanding the concepts of ESL/ESP so the investigators could better understand the techniques and how to apply them to teaching pesticide label comprehension. We developed a knowledge measurement tool to assist in assessing the effectiveness of the courses in increasing course participants' ability to read pesticide labels. This measurement tool consisted of 75 questions relating to a specific pesticide label. These questions ranged from very simple and basic to complex, increasing in complexity with their higher position on the list. These questions were translated into Hmong and Spanish and were given orally to course participants. During the first class session participants answered as many questions from the list as possible. Following the final lesson, participants were asked to answer the same list of questions. Scores from the pre- and post-assessment were compared to the highest score attained by a participant in the group. The group average on the initial test was 10.9% correct answers (high = 83.1%, low = 8.1%). On the final test, the group average was 47.9% correct answers (high = 100%, low = 11.1%). The individuals taking the test increased their number of correct answers by an average of 81.7% (high = 96.8%, low = 35.7%).

Future Plans: This project involves outreach and educational activities focusing on underserved agricultural population working in the Western U.S. As part of the project, investigators will research and test established and new methods of extending agricultural health and safety information to individuals in these communities. This project's unique approach involves three areas of significance: (1) developing and testing effective pesticide-related health and safety training methods and materials that can be extended to underserved populations through members of their communities—these methods and materials will be designed to address the cultural, language, and educational variabilities of underserved populations in agricultural communities; (2) devising innovative and practical techniques to assist agricultural employers of underserved populations in providing effective pesticide safety training and hazard awareness programs; and (3) extending agricultural pesticide-related health and safety information, resources, and training to health care providers, social service organizations, and other leaders within underserved agricultural communities.

The purpose of these activities is to reduce pesticide-related illnesses and injuries within the underserved populations and to develop educational and outreach models that will form the framework for ongoing, community-based programs for transferring important agricultural health

and safety information and hazard awareness training to immigrant and Native American farming families and communities in California, Arizona, Hawaii, and other Western states.

Collaborations: UC Statewide IPM Project, University of California, Davis
Outreach and educational activities will be conducted throughout agricultural areas of California and in specific parts of Arizona, Nevada, and Hawaii.

Best Management Practices for Pesticide Use and Food Safety among California's Small Farmers with Particular Reference to Limited English Speaking and Cultural Minority Farmers

Principal Investigator: Desmond Jolly, Ph.D.

Description: This project was devoted significantly to the development, pilot testing, and use of a pesticide practices survey in San Joaquin, Fresno and Monterey/Santa Cruz Counties. The survey focused on identifying the cropping patterns of the growers, the kinds of problems encountered with weeds, diseases and insects, and the methods employed to bring these problems under control. Needs assessment surveys were then extended to Tulare and Fresno Counties. Pesticide Safety for Small Farms: A Grower's Guide to Pesticide Safety is available in English, Hmong, Cambodian and Lao. Translations were completed of the pesticide safety video, which was reshot and translated into Spanish. The video is used in outreach efforts. Audiotapes have been developed in English, Hmong and Spanish.
Workshops were conducted in San Joaquin County in English/Spanish; Mien; and Hmong. Fresno County also delivered the workshops. Pre- and post-test results were analyzed; post-test scores show definite improvement over pre-test scores, indicating that the training workshops had a positive result. The project sponsored four individuals to receive training in a "train the trainer" program. Those trained individuals now are equipped to extend information to their clientele groups.

Educational Materials

- The Small Farm Center fulfilled requests to share the "Pesticide Safety for Small Farms" educational material with collaborators around the world. An English version of the video, "Pesticide Safety for Small Farms," was requested and sent to Barry Brennan, Extension pesticide coordinator, College of Tropical Agriculture and Human Resources, University of Hawaii.
- A Lao-language version of the video "Pesticide Safety for Small Farms" was completed in March 2000 at the request of collaborators Benny Fouche and Richard Molinar to meet the needs of Lao clientele in San Joaquin and Fresno counties.
- The Small Farm Center also sent four Hmong language "Pesticide Safety for Small Farms" video tapes and audio cassettes to Peter Kunstadter, Fresno Center for New Americans, who took the educational materials to northern Thailand in February 2000. There he shared the educational materials with research assistants and Hmong farmers involved in a survey of pesticide use patterns among Hmong farmers in northern Thailand.
- A Spanish-language version of the publication, "Pesticide Safety for Small Farms," is currently being translated by Maria de la Fuente, farm advisor, UC Cooperative Extension, Santa Clara County.

- A compact disc (CD) containing 30-second and two-minute pesticide safety messages is being distributed to Spanish-language radio stations in 60 cities throughout the country.
- Audio cassettes based on the "Pesticide Safety for Small Farms" video are now available from ANR Communication Services' ANR Catalog in English, Hmong, Spanish, and Lao languages.
- The Small Farm Program's Small Farm News newsletter published the article "Safety is Job One When Using Agricultural Chemicals" in the newsletter's Volume 1, 2000 issue. Small Farm News also published an article titled, "Best Practices for Promoting Food Safety in Organic Production: Water Quality" in its Volume II, 2000 issue.
- "Pesticides for Specialty Crops" is available online from the Small Farm Center web site at: http://www.sfc.ucdavis.edu/research/research.html and from the UC ANR Catalog at http://anrcatalog.ucdavis.edu/searchfree.ihtml
- The Small Farm Center has drafted eight "Food Safety Begins on the Farm" fact sheets, and has added a food safety section to its web site at: http://www.sfc.ucdavis.edu/docs/foodsafety.html
- The Food Safety Begins on the Farm Series include: Agricultural Water; Field Equipment Sanitation; Physical Location; Personnel; Sanitary Facilities; Packingshed Facility; Packingshed Equipment; Postharvest Water; Protecting Water Sources and Delivery; Documentation; and Sanitizers and Cleansers.

Richard Molinar, farm advisor, Fresno County, presented a workshop in Spanish to 18 Hispanic women from the Mayfair Neighborhood School in Fresno, California. The participants were predominantly farmworkers' wives concerned about pesticide residue on clothing worn when applying chemicals in the field.

Richard Molinar also reports that he and Rose Krebill-Prather are finalizing survey results to determine the educational impact of the workshop series he and Michael Yang, laboratory assistant, UCCE Fresno County, presented in August and September 1998. A final report will include survey results on data regarding ethnicity and type of language spoken to gain a larger picture of training effectiveness.

Michael Yang, laboratory assistant, UCCE Fresno County, presented three pesticide safety workshops during the first quarter to the following groups: the Fresno Hmong American Women's Association Garden Project; the Fresno Grace Lutheran Church Garden Project; and the Fresno Economic Opportunity Commission Garden Project. In November and December 2000, he presented four pesticide safety workshops: to the Fresno Hmong American Women's Association Garden Project; the Fresno Lao Community in cooperation with the National Resource Conservation Service; and two presentations at the Fresno County Agricultural Commissioner's office. Yang also presents a bi-weekly pesticide safety presentation on Fresno Hmong radio that is sponsored by the Small Farm Center and Farm Service Agency.

Benny Fouche, farm advisor, San Joaquin County, presented a pesticide safety talk at the March 2000 strawberry grower meeting in Sacramento, CA. No studies published. However, a great amount of methodological development for estimating the costs of agricultural injuries for 1992 has been accomplished.

Extending Pesticide-Related Health and Safety Programs to Underserved Agricultural Populations in the Western United States

Principal Investigator: Patrick J. O'Connor-Marer, Ph.D

Description: This project involves outreach and educational activities focusing on underserved agricultural population working in the Western U.S. As part of the project, investigators will research and test established and new methods of extending agricultural health and safety information to individuals in these communities. This project's unique approach involves three areas of significance: (1) developing and testing effective pesticide-related health and safety training methods and materials that can be extended to underserved populations through members of their communities—these methods and materials will be designed to address the cultural, language, and educational variabilities of underserved populations in agricultural communities; (2) devising innovative and practical techniques to assist agricultural employers of underserved populations in providing effective pesticide safety training and hazard awareness programs; and (3) extending agricultural pesticide-related health and safety information, resources, and training to health care providers, social service organizations, and other leaders within underserved agricultural communities.

The purpose of these activities is to reduce pesticide-related illnesses and injuries within the underserved populations and to develop educational and outreach models that will form the framework for ongoing, community-based programs for transferring important agricultural health and safety information and hazard awareness training to immigrant and Native American farming families and communities in California, Arizona, Hawaii, and other Western states. UC Statewide IPM Project, University of California, Davis Outreach and educational activities will be conducted throughout agricultural areas of California and in specific parts of Arizona, Nevada, and Hawaii.

External Education and Communication

Principal Investigator: Patrick J. O'Connor-Marer, Ph.D

Description: This project provides information and education to Center investigators and to individuals and organizations outside the Center throughout the Western region, the entire United States, and worldwide. Communication and information is accomplished through a newsletter and the Center's website and listserver. Research and educational information is also disseminated through monthly Center-sponsored seminars held on the UC Davis campus. The Center sponsors Regional multi-day conferences dealing with issues of agricultural health and safety. These conferences attract individuals from throughout the US and provide a forum for exchanging information and establishing collaboration on important issues. Beginning in 2002, conferences will be jointly sponsored by the UC Center and the Pacific Northwest Center for Agricultural Safety and Health and the conference location will rotate between the two major agricultural areas served by these Centers.

Best Management Practices for Pesticide Use and Food Safety among California's Small Farmers with Particular Reference to Limited English Speaking and Cultural Minority Farmers

Principal Investigator: Desmond Jolly, Ph.D.

Description: The project aims to maximize the impact of educational interventions with respect to the adoption of 'best practices' in pesticide use as well as in the management of microbiological hazards in agricultural production, post-harvest and marketing. By implication, if these intervention methods are effective, we will reduce the incidence of injuries and illnesses associated with these risk factors.

Various communication tools and media will be utilized in channeling the information to growers. A longitudinal study utilizing random surveys each year for the next five years will track changes in levels of awareness, knowledge, motivation and adoption of acceptable 'best practices.' Surveys and focus groups will also be used to evaluate the role and importance of alternate channels of communication. We will test whether communication channels and tools vary in terms of their effectiveness across different socioeconomic and demographic groups. This will inform our knowledge base as to how to more effectively transmit information to affect the behavior of a multicultural farm population. The work will be coordinated through the UC Small Farm Center on the Davis Campus at the University of California, Davis, California. Outreach efforts will be targeted in Central Valley and Central Coast counties in California. Workshops will be associated with large statewide and regional conferences. The Central Valley and the Central Coast, the prime agricultural producing areas in the state, and home for large settlements of cultural minority farmers – S.E. Asians, Latinos and African-Americans – are the primary target. Other outreach will be focused through newsletters, fact sheets, CD's and videos.

Safety Education and Agricultural Injury Among California Rural High School Students

Principal Investigator: Stephen A. McCurdy, MD

Description: This project originally was designed as a follow-up of the "Incident Injury & Disease among a Cohort of 1,947 California Farmers and Farm Operators" who participated in the telephone survey from 1993. In the past project period, we have also developed a proposal to assess the impact of safety curriculum among rural California high school students participating in a state-approved agricultural sciences program.

1. **Farmer cohort study of injury**: Investigators have completed data collection and analysis. Selected results from the study are included in the R-1 section of this proposal. These were presented at the NIOSH Agricultural Health and Safety Centers meeting in Cooperstown, NY April 27-30, 2000, and two manuscripts are in preparation.
2. **Impact of School Agricultural Safety Curriculum on Injury Risk**: We have obtained approval for the study, including a draft questionnaire, from the UC Davis Human Subjects Review Committee. Fifteen rural California high schools with agricultural sciences programs teaching the state-approved agriculture curriculum have been identified and agreed to participate. In addition, the study has hired a Postgraduate Researcher, Lisa Scott, to coordinate the development and conduct of the study. We have conducted focus groups at three target high schools and are using the information from the groups to develop our survey instrument.

Future Plans: In spite of its status as one of the nation's most hazardous industries, agriculture is unique in utilizing significantly more child labor than other, less hazardous, industries. Approximately 1.3 million persons younger than 20 years of age live on U.S. farms according to the 1991 Census, and more than 120,000 children aged 14-17 perform agricultural work. There are approximately 100 fatal and 32,000 nonfatal injuries (15,000 of which were work-related) annually among children on U.S. farms. Efforts to reduce the toll of agricultural injury have included engineering improvements, education, and enforcement of existing laws. Although significant resources are devoted to education, few data exist to document its impact. We propose a longitudinal observational study of California Central Valley high school students enrolled in a state-approved agricultural curriculum to evaluate the impact of agricultural safety curriculum on reducing injury risk and instilling safety attitudes and behaviors. Approximately 600 students will be followed through their high school years; approximately half will receive the safety component (taught in Agricultural Mechanics classes) of the state-approved agriculture curriculum. The remaining students, although enrolled in the state-approved agricultural program, will not receive the safety component of the curriculum. Subjects will be surveyed regarding demographic characteristics, health and health behaviors, agricultural safety-related attitudes and practices, and injury experience in the preceding year. The survey will be repeated in subsequent years for four cycles of data collection. The study will evaluate whether students receiving the safety component manifest a reduced injury rate and higher levels of safety-related attitudes and reported practices compared to their peers who have not received the safety component of the curriculum.

Major Accomplishments 2001-2006

Pilot Study — Best Management Practices for Pesticide Use and Food Safety Among California's Small Farmers with Particular Reference to Limited English Speaking and Cultural Minority Farmer

Principal Investigator: Desmond Jolly, Ph.D.

Objectives: This study developed, tested, and evaluated effective ways to bridge language, cultural, and educational barriers that impede the delivery of safety training and hazard awareness information to agricultural workers and their employers. We focused on pesticide safety and pesticide hazard awareness because pesticides are of major concern to agricultural workers and we have considerable expertise in pesticide safety education.

Pesticide Safety Curriculum Developed for High School Work-Study Program Students. Investigators developed and tested a pesticide safety short course for 20 work-study program students participating in the "Construction and Landscape Academy" at a high school in Merced, California. The first lesson contained activities that focused on ways that students can protect the environment when working with pesticides and other chemicals. Students also participated in hands-on activities that led to better understanding and comprehension of pesticide label instructions especially as they pertain to protective equipment, restricted-entry intervals, and responding to pesticide exposure emergencies. Finally, students became familiar with resources that are available to assist them in identifying and controlling pests in and around the home, landscape, and farm. The activities in the lesson plan were designed to fit the

occupational and educational needs of students who are or will be employed in agriculture production or landscape maintenance.

Pesticide Safety for Small Farms Video, Ilocano language version. After identifying the need for more pesticide safety resources in Ilocano, investigators worked with University of Hawaii at Manoa staff to locate funding, translation, narration, and editing services to develop an Ilocano version of the video, Pesticide Safety for Small Farms. This video, which was originally created as a resource for Hmong, Cambodian, and Laotian small farm operators in California, is currently being used to extend pesticide safety information to Ilocano-speaking Filipino farmers in Hawaii.

Refresher Courses on Training Techniques and Pesticide Safety Resources. Staff of the Santa Clara County Agricultural Commissioner's office requested a 4-hour short refresher course for people who were already qualified to be pesticide safety trainers. Tim Stock and Jennifer Weber designed and presented information on a variety of training techniques and pesticide safety resources that can be used to develop effective safety programs for pesticide handlers and agricultural fieldworkers. Hands-on activities were included in the course to allow participants to practice using the methods and tools presented during the course.

Train-the-Trainer Workshops. Through over 290 day-long workshops, program staff reached over 4800 people responsible for providing safety training to pesticide handlers and agricultural workers. The trainers who participated in innovative train-the-trainer workshops are responsible for training nearly 900,000 agricultural workers and about 70,000 pesticide handlers. Since 1990, staff also assisted several county organizations in setting up and conducting day-long hands-on training workshops covering all aspects of pesticide handling safety. Staff provided training to the volunteer instructors and loaned materials and props for the workshops. Each workshop accommodates nearly 400 pesticide handlers and training is conducted in English and Spanish. Since the inception of this program, 17 of these workshops have been held and over 5,950 individuals have received training. Well over 300 community members have participated as volunteer trainers. Stanislaus and Napa counties continue to conduct these workshops each year.

Outreach to Tribal Communities. Program staff worked with the Inter Tribal Council of Arizona, Inc. (ITCA) to offer two series of train-the-trainer workshops that focused on improving the health of tribal community members in CA and AZ. Participants included members from tribal communities in AZ, CA, NM, IA, NV, and NB. Attendees also represented a variety of agencies, facilities, and services working directly with tribes on pesticide, health, and environmental issues. Among the participants were physicians, nurses, outreach workers, industrial hygienists, educators, and first responders (firefighters, paramedics, and police officers).

Outreach to Rural Health Clinics. In November 2002, Program staff worked with Family HealthCare Network (FHCN), a private, nonprofit community-based organization that has eight clinical sites in CA. Center investigators and FHCN developed and presented a workshop on pesticide exposure that served as a staff development course for FHCN clinicians and support staff. FHCN's clientele is multicultural, with 65% of the patients identifying themselves as Hispanic and 10% identifying themselves as Southeast Asian.

Collaborations:: UC Statewide Integrated Pest Management Project: We have integrated the Pesticide Safety Education Project with a newly funded Small Farm Food Safety Project. The Food Safety Project will target farmers who sell directly to consumers through channels such as farmers' markets, Community Supported Agriculture (CSA), farm stands, and u-pick programs.

Future Plans for 2006-2011

Needs Assessment and Outreach to Minority Agricultural Communities in CA and HI

Project Leader: Steve McCurdy, MD, MPH

Description: Agriculture has historically served as a bridge to integration into American society for many immigrant groups. The success of these communities is intimately affected by health and safety issues. The larger society also has a clear interest in the welfare of its agricultural immigrants, in that health and safety problems may not remain limited to the workers. For example, inadequate training of agricultural workers may lead to improper use of farm chemicals. This may affect not only the worker, but also the general public as consumers. Similarly high injury rates can add to the cost of production and be reflected in market price. In spite of the importance to the larger society that immigrant farmers succeed and produce in a safe environment, little information is available in regard to their agricultural health and safety knowledge, practices, needs, and concerns. There are few outreach and educational programs in existence promoting healthy and safe agricultural practices in these ethnic populations. The goals of this project are three-fold. First, we will conduct focus groups to assess the knowledge, practices, and needs regarding occupational health for three underserved communities of NIOSH's Western region: Hmong and Mixtec in California's Central Valley and Filipinos in Hawaii. These communities were selected because they are large and important in their respective states and because they will provide a breadth of experience that will assist in learning how to adapt the findings for other ethnic minority agricultural communities. Second, we will develop or adapt relevant educational materials and programs for improving occupational health in these communities, informed by the focus groups and ongoing dialogue with the community. Third, we will evaluate these materials and programs in the controlled fashion familiar to experimental science. Material shown to be effective will then be disseminated for use (including adaptation, as necessary) in other communities. This project is important to public health because it will identify areas in which health and safety knowledge is lacking in the target communities and develop educational materials and programs to address these. The materials and programs will help protect the health of the identified communities and other minority agricultural communities for which they may be adapted. Improved safety will be of benefit to the worker and family, the agricultural community, and society at large.

The High Plains Intermountain Center for Agricultural Health and Safety

CENTER OVERVIEW

HICAHS investigators have been very active for 15 years in building partnerships and developing projects to address the unique issues of the high plains and mountains of PHS Region VIII. We have also played a leading role in several national initiatives involving all of the NIOSH Agricultural Centers. A list of professional publications by Center personnel is attached as an appendix to this Center overview.

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Historical Introduction – the first 10 years

The High Plains Intermountain Center for Agricultural Health and Safety (HI-CAHS) has an outstanding record of 15 years of service to PHS Region VIII (Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming). The goals of HICAHS are to reduce agricultural injury and illness through focused research, education, and intervention. HICAHS has been nationally and internationally recognized for research on organic dust aerosols and respiratory disease, pesticides, and tractor Roll Over Protective Structures (ROPS) engineering. Education and Outreach, built on strong partnership with Cooperative Extension have served as national models. HICAHS has also supported numerous graduate students in a variety of disciplines, trained thousands of agricultural workers and health professionals, sponsored important regional, national, and international meetings and further disseminated findings through hundreds of scientific presentations and peer reviewed publications

Housed in a land-grant university, HICAHS is part of an environment explicitly dedicated to translate research knowledge into community action. HICAHS builds on Colorado State University's long tradition of engagement in agricultural health and safety. In 1967, Dr. John Collier established the Institute of Rural Environmental Health (IREH) with funding from the W.K. Kellogg Foundation. In 1968 Dr. John Bagby (retired Deputy Director of CDC) was hired to direct IREH, and Dr. Eldon Savage joining in 1970, conducted epidemiological studies on pesticides and their health effects that still stand as a cornerstone for much that we know today about low level exposure.

Dr. Roy Buchan was hired in 1971 to provide industrial hygiene expertise in agriculture, and began a five-year project to provide industrial hygiene/safety interventions on farms and ranches. IREH grew rapidly with success and eventually became the Department of Environmental Health. The High Plains Intermountain Center for Agricultural Health and Safety (HICAHS), created in 1991, grew into a prominent resource for the region and nation under the directorship of Dr. Buchan. A key to Center success was a very active and involved External Advisory Committee representing all aspects of agricultural production in Public Health Region VIII. Highlights of accomplishments over the early history of HICAHS are described briefly below:

Research and Intervention

HICAHS researchers have made important contributions to understanding and preventing organic dust-induced respiratory disease, fatalities from tractor rollovers, and pesticide exposures particularly among migrant populations. Collaboration with community partners has been critical in planning and conducting this research, and in dissemination of results.

A series of research projects has focused on organic dust exposures in a number of agricultural settings. Initial work characterized worker exposures to wheat and corn dusts, and measured respiratory health effects (Beard, App Occ Env Hyg 1996; Viet App Occ Env Hyg 2002). In complementary in vitro studies Cosma and Martinez (J Tox

Env Health 1996) found endotoxin to be responsible for more than 70% of the pro-inflammatory response in lung cells. In cooperation with the Colorado Corn Growers Association, Todd and Buchan (App Occ Env Hyg 2002) measured excessively high exposures to aerosols ideally suited to penetrating deep into the lungs. HICAHS also developed excellent laboratory facilities for aerosol studies and investigators have evaluated the performance of a variety of air sampling devices. The emphasis on organic dust exposures has continued with a new project evaluating a novel Recombinant Factor C endotoxin assay using organic dusts from livestock environments and testing new methods for measuring inhalable particulates, including endotoxins, and glucans/ ergosterols (Reynolds- PI).

HICAHS facilities for designing and testing engineering control strategies for tractors and other agricultural equipment are unique among all the NIOSH Agricultural Health and Safety Centers. Roll Over Protective Structures (ROPS) have been designed for Ford, Farmall, John Deere, and Allis Chalmers tractors and tested according to SAE J2194 (ASAE S519) including static, field upset, and axle strength tests (Ayers, J Agromedicine 1996; Liu JASH 1998; Liu, J Agromedicine 1999). As a result of this work, commercial ROPS are now available for Ford and Farmall tractors. Recent efforts have focused on development, and testing of a tractor stability monitoring system. Center of gravity and critical lateral and longitudinal stability angles have been determined for 15 agricultural tractors and this work was extended to include lawnmowers, off-road utility vehicles and ATV's (Liu JASH 1998; Ayers J Agromedicine 1998). Integration of global positioning system (GPS) and geographic information systems (GIS) with video mapping and tractor stability monitors will lead to important prevention tools

Major research (and outreach) efforts have also addressed the underserved population of migrant and seasonal workers who are so important to agriculture in this region. Partnerships were forged with migrant health clinics and other advocates to determine the prevalence and patterns of environmental and occupational health risks faced by these workers and their families (Vela-Acosta and Bigelow, Am J Ind Med 2002). Evaluating a risk reduction program, Vela-Acosta found that beliefs and perceptions were important predictors of the success of training interventions.

Education and Outreach

The HICAHS Outreach program, based on a strong partnership with Cooperative Extension has been very successful and touted as a model for other centers. HICAHS partnered with USDA/Cooperative Extension to fund a joint staff position serving as a resource to develop training materials and respond to technical requests from extension agents throughout the region. Weekly Safety Messages reached more than 25,000 readers in the US, Canada, Australia, and Europe when the “Fence Post” picked up these articles. Working with insurance carriers and producer groups, HICAHS developed targeted health and safety programs for dairy, corn, wheat, potato and other agricultural industry sectors. A CD-based educational curriculum for Vo-Ag teachers was developed in collaboration with the College of Agricultural Sciences. HICAHS also partnered with both an AHAPS project and 4-H to develop and conduct Safety Day camps for younger children throughout the region, and provided support for educational

efforts such as training Farm-Medic emergency responders in South Dakota. In 1996 HICAHS provided pesticide training for 482 migrant workers, and conducted health and safety audits at sixteen migrant housing camps, providing recommendations for hazard reduction to camp owners/managers.

Evaluation

Evaluation has been an integral component of HICAHS since its inception. The first accomplishment was development of a program monitoring system to track Center activities and products. The system utilized a form developed for Center personnel to document project activities and to help prepare year-end reports. Subsequent responsibilities of the evaluation unit included evaluation of projects within and outside of the Center, and development of a Center resource library. Projects evaluated included "Kid's Farm Safety Day Camps" and Center industrial hygiene services to agricultural clients. Educational presentations by HICAHS personnel were evaluated by representatives of stake-holder groups; Center publications were evaluated by subject matter experts. In addition, this unit was responsible for the second national Agricultural Health and Safety Centers meeting held in Ft. Collins, CO in 1995.

In 1996 the evaluation unit was renamed PARD (Program Assessment and Resource Development) to more fully reflect the duties of personnel involved. The database was upgraded to ACCESS, and Center personnel could now enter data directly by computer. The unit also developed a database of resources the Center had accumulated, including products from NIOSH, other NIOSH Agricultural Centers, publications and products of HICAHS and commodity group publications within PHS Region VIII. A number of evaluations were accomplished in the second funding cycle including process evaluation of NCCAIP, and assistance with field-testing back injury information developed for Hispanic migrant workers by the Southwest Center. PARD personnel also translated into Spanish the "ABC Curriculum" for children, a train-the-trainer curriculum that was developed by the Farm Bureau.

Agricultural Center Initiative Evaluation

In 1997, V. Buchan proposed to NIOSH that HICAHS host a workshop to discuss the potential for evaluation of the NIOSH Agricultural Center Initiative on a national level. This workshop was funded, and with leadership provided by HICAHS, a Multisite Program Monitoring model was developed based upon the collaborative work of a representative from each of the NIOSH Agricultural Centers. Over the next two years, via a series of workshops (one or two per year), the Multisite group identified and defined key evaluative variables that each of the Centers would collect. HICAHS developed the database for this project and each Center received a copy as well as training for Center personnel in both data collection and data entry. The Multisite group pre-tested the all-Center evaluation process in 1999 and implemented revisions based on the results. The Centers then collected data in fiscal year 2000, which was forwarded to HICAHS to be integrated into an Initiative database. Two reports have been issued by HICAHS based upon cumulative data representing the work of all Centers in the Initiative: one for FY 2000 and one for FY 2001.

Recent HICAHS operations - 2001-2006

Administrative Core

Dr. Stephen Reynolds, former Director of the Great Plains Center for Agricultural Health (GPCAH), joined HICAHS as Deputy Director in October 2001, becoming Director in May 2002. Dr. John Rosecrance, also formerly of the GPCAH, joined the faculty at CSU bringing important expertise in ergonomics. A new Internal Advisory Committee was established, bringing together an outstanding team with complementary strengths and expertise. The current Administrative team for 2003 –2006 includes: Dr. Reynolds – Center Director, Dr. Victoria Buchan, Center Deputy Director, Dr. John Rosecrance - Prevention/Intervention Core Director, Dr. John Tessari – Research Core Director, Dr. Dennis Lamm – Education/Translation Core Director, and Darla Borges, Outreach Coordinator. Dr. Dennis Lamm is also a direct link with Cooperative Extension and Dr. Jeff Goodwin serves as 4-H liaison.

The Administrative Core has continued to work hard to forge new partnerships and pursue new opportunities. HICAHS has initiated collaboration on projects with investigators from the CSU Veterinary School, the multi-agency Center for Rural Assistance, the Center for Animal Agriculture and Community Enhancement, and the Colorado Injury Prevention Center to leverage resources and enhance our ability to address needs of producers and agricultural workers in the region. A Memorandum of Understanding with the GPCAH (2002) provides a framework for current and future collaborations. As a key part of Strategic Planning we continue to enhance our External Regional Advisory Committee representing: agricultural producers, farm bureau, health/veterinary care providers, church, agricultural business, migrant advocates, Cooperative Extension, and a NIOSH ERC. In addition to building an infrastructure for collaborations, these advisors have provided critical consultation on the needs of constituents and potential mechanisms for meeting those needs. They have been important partners in developing and implementing successful Center projects.

Meetings and Conferences

The administrative core has also played a lead role in bringing together agricultural health and safety scientists and professionals in a series of important regional, national, and international meetings. HICAHS has conducted 8 regional conferences, assisted with planning the NIOSH Ag Centers meeting in Cooperstown, NY (2000), and co-sponsored a meeting of 3 Centers in Iowa in 2002. Dr. Reynolds has been responsible for organizing a series of international videoconferences using internet2 under the auspices of the American Industrial Hygiene Association, and led a special symposium on “Endotoxin and the Lung” at the 5th International Symposium: Future of Rural Peoples in Saskatoon, Saskatchewan in October 2003. HICAHS has also been very active in regional and national policy issues: Dr. Reynolds (as ACGIH Bioaersols Committee member) organized a meeting to develop national consensus on mold remediation in November 2003; Dr. Paul Ayers led planning of the Centers-wide Tractor-related Death and Injury meeting in February 2003, and HICAHS faculty are

heavily invested in this ongoing process (see below). HICAHS organized and hosted the first joint meeting of the National Institute for Farm Safety, North American Agromedicine Consortium, and NIOSH Agricultural Health and Safety Centers: "The National Symposium on Agricultural Health and Safety". This national conference was held in Keystone Colorado in June 2004, providing an outstanding opportunity to coordinate activities and maximize resources for agricultural health and safety throughout the nation; more details are offered below.

Providing Leadership Across Agriculture Centers:

The National Agricultural Tractor Initiative – P.I. S. Reynolds

Dr. Reynolds led the development of a grant proposal to NIOSH involving collaboration of all of the NIOSH Agricultural Centers to fund a National Agricultural Tractor Safety Initiative. This project was awarded by NIOSH in September, 2005 and includes six components to develop the necessary information and stakeholder support procedures (social marketing) to enable the next step, a national public health campaign. Tractors are the leading cause of occupational fatalities in agriculture and the means to prevent such deaths are available through the use of Rollover Protective Structures (ROPS). The components include: Leadership Group: Costs of Tractor Operator Injuries from Overturns and Highway Collisions; Impact of changes in ROPS Standards, Regulations, and Technology on Future Tractor ROPS availability; Documentation of Acceptability and Procedures for Financial Incentives for ROPS Retrofitting: Designing Community-based Social Marketing Programs for Tractor Safety; Website and Partners All projects have IRB approval and are underway; regular conference calls have been scheduled with all key personnel and a National Agricultural Tractor Initiative website is up and running.

The National Symposium on Agricultural Health and Safety

HICAHS (V. Buchan & S. Reynolds) led the organization and planning for the first National Symposium on Agricultural Health and Safety held in Keystone, Colorado June 20-24, 2004. This was the first conference that involved three national organizations each of which address agricultural health and safety; The NIOSH Agricultural Centers, the National Institute for Farm Safety, and the North American Agromedicine Consortium. Each had representatives on the planning committee. There were 6 plenary sessions, with Dr. John Howard as a keynote speaker. Seventy-four breakout sessions allowed attendees to select topics of specific interest, and the venue was used to introduce the National Agricultural Tractor Safety Initiative and seek stakeholder input.

The National Agricultural Health and Safety Center Evaluation Project

In 2004, HICAHS (V. Buchan & H. Holmquist-Johnson) applied for and received funding (late 2004) to provide training and leadership for an evaluation project for the Agricultural Center Initiative. Each Agricultural Center was asked to provide a representative to the project and in 2005 two workshops were held in Fort Collins, CO. to work on both renewing the program monitoring approach to documenting the work of

the Initiative and to develop cross Center projects that could pilot a joint approach to outcome assessment. An ACCESS database was developed and program monitoring data was collected by Centers for a five month pilot period (5/05-9/05) to test both data collection procedures at each Center, and the database variable definitions. A report on this pilot and the planned outcome assessment projects has just been completed. Centers are now collecting data for the 2005-06 fiscal years.

Research expertise in three key areas:

Development of Novel Biomarkers:

Under the leadership of J. Tessari, Ph.D. novel analytical methods in blood, brain and urine for atrazine and its three chlorinated metabolites have been developed. All methods involve either liquid/liquid extraction or mixed mode cation exchange solid phase cleanup. Based upon current limits of detection for atrazine and its chlorinated metabolites in each matrix, we anticipate considerable improvements in limits of quantification after integration of a stable isotope of atrazine as internal standard. This project has important applications for the largely Hispanic farmworker population.

Organic Dust Respiratory Disease:

Endotoxin exposure and genetic factors in organic dust lung disease is the focus of a multiple year research project under the leadership of S. Reynolds, Ph.D. Collaborators include Paul Siegal (NIOSH), David Schwartz and Lauranell Burch (NIEHS). The project has evaluated a novel Recombinant Factor C endotoxin assay, and new methods for measuring inhalable particulates including endotoxins, and glucans/ergosterols that can be used to help establish occupational exposure guidelines for complex organic dusts in swine, poultry, dairy, equine and cattle feedlot environments. While data collection is still underway, participants have exhibited significant decrements in baseline and cross-workshift pulmonary function, and in some cases very high exposures. Research protocols and questionnaires developed for this project (English and Spanish) have been shared with two other Centers and HICAHS conducted endotoxin analysis of samples from pilot studies in California. Again, the population affected in this region is predominantly Hispanic.

ROPS Design and Testing for Agricultural Vehicles:

Under the leadership of P. Ayers, Ph.D. and J. Liu, Ph.D. HICAHS has provided leadership in the development and testing of multiple models of ROPS for retrofitting a variety of tractors. The research team has continued their engineering research addressing front drive mowers and the need for a mower ROPS using the original ASAE S547 continuous roll model. The results have been presented to manufacturers including: Deere & Co., CNH, AGCO, Toro, Kuboto, AEM, FEMCO, Woods Equipment, Grasshopper, Excel Industries, Weasler Engineering, Scag Power equipment, Exmark, Custom Products of Litchfield, Full Vision, Inc., Moridge, MTD and Hustler. Drs. Ayers and Liu work closely with equipment manufacturers to bring these interventions to market.

Pilot Research Projects:

. Although resources have sometimes been limited, the Administrative Core has sought to continually foster new research, and recruit new researchers through targeted feasibility funds. Examples of recent projects funded include:

- Site Specific Management of Tractor Safety and Engineering Control Strategies Based on Tractor Stability. J. Liu, P.I.
- Feasibility Study of the Determination of large Aerosol Particle Size by elutriation; M. Tillery, P.I.
- Agricultural Injuries and Illness among Colorado Agricultural Workers (in collaboration with Workers' Compensation Insurer – Pinnacol); J. Rosecrance, P.I.
- Menstrual Cycles & Reproductive Patterns in Women exposed to Atrazine; Lori Cragen, P.I.
- Exposure Injury Analysis: The effects of Atrazine on Luteinizing Hormone; W. Hanneman, P.I.
- Validation of a Predictive Model for West Nile Virus Using Weather and Climate data; Keri Nakatsu, P.I.
- High-Speed Tractor Safety and Impact on Applicable ROPS; J. Liu, P.I.
- Evaluation of a Bacteriophage Cocktail to reduce Escherichia coli 0157:H7 shedding in cattle; L. Goodrich, P.I.

Education/Prevention Products for Children and Youth:

Two projects with the common goals of developing and testing computer based Agricultural Health and Safety curricula for youth in different age groups have been successfully undertaken by HICAHS.

<u>High School Vocational Agricultural Health and Safety CD:</u> R. Seiz, Ph.D. has had funding for the last five years to develop and rigorously evaluate a CD developed for high school vocational agricultural education classes in both Colorado and Wyoming. The CD, containing nine modules, was developed in collaboration with the College of Agriculture at CSU and the ag teachers association. Longitudinal research using treatment and control groups in the two states indicate both an increase in knowledge and a decrease in injuries in the experimental group versus the control. The project is near completion, with final data analysis underway. The modules will be individually accessible on the HICAHS website as well as on the original CD format.

Interactive Health and Safety CD: 4-H The second project (V. Buchan, funded 2003-2006) has developed and formatively evaluated an interactive CD developed for 4-H youth in grades 3-6. Using a "concept team" of parents, children and Cooperative Extension personnel, five topics were chosen to develop into educational modules. The modules include: tractor safety, chemical safety, livestock handling, ATVs and grain handling. The CD includes 3-4 video clips per module, embedded quizzes with immediate reinforcement by pop-up characters, voiced characters that lead the younger child through the CD and a certificate of completion. The 4-H CD is currently undergoing process evaluation in regional states including Montana, South Dakota and Southern Colorado. Early process evaluation results indicate significant knowledge gain by the children in the treatment groups when compared with control groups in the same state.

Regional Outreach Project

A unique and very important component of HICAHS is our "Regional Outreach" project. The model developed by the Center has built upon the opportunities provided by being located in a Land Grant Institution. Cooperative Extension under USDA has an extensive and well organized statewide network organization already in place. Utilizing these existing outreach systems HICAHS has developed partnerships with the Cooperative Extension organization in each of the six states in Federal Public Health Region VIII (Utah, Montana, North Dakota, South Dakota, Wyoming and Colorado). The partnership has provided benefits for all parties. HICAHS has provided seed money funding for the extension specialists in each state to develop and conduct health and safety projects according to their local needs. In return, the agents provide a key route of dissemination for HICAHS educational materials, as well as logical testing grounds for new products. With reductions in USDA funding for Extension, we have focused efforts on building partnerships to optimize resources. In the past three years we have doubled our partners.

Professional Education

More than **64** undergraduate and graduate students have been involved in HICAHS research, gaining hands-on professional training related to agriculture in industrial/occupational hygiene, education, epidemiology, toxicology, ergonomics, human behavior, program evaluation, and agricultural engineering. More than **217** peer reviewed journal articles, and **101** Media articles have been published. HICAHS staff and investigators have, over the years, given hundreds of presentations to community and producer organizations, special populations including children, women and migrant and farm labor; as well as platform presentations at professional meetings.

Other recent highlights:

Additional Research Projects

- Improving Injury Information for Migrant Farmworkers; L. Stallones, P.I.

Prevention/Intervention Projects

- Redesign Radio Control System and LVDT set for testing tractors; J. Liu, P.I.
- Reduction of Exposures from Dairies and Cattle Feedlots; S. Reynolds, P.I.

Education/Outreach

- HICAHS website (redesign); J. Liu, H. Holmquist-Johnson http://www.hicahs.colostate.edu
- **"**Children's Corner" HICAHS Website (in development, funded 2006); V. Buchan
- Website for Mower ROPS design information; J.Liu http://www.hicahs.colostate.edu/rops_design.asp
- . In response to fatalities involving injectable veterinary drugs, an article was written for Colorado Dairy News with a regional circulation of 1,000 and then picked up by the Bovine Veterinary Magazine with a national circulation. The articles provided specific guidelines to modify practice and prevent injection of veterinary drugs. The intent of the Bovine Veterinary Magazine issue was to provide veterinarians with information for training their clients.

Total amount funded by NIOSH 1996-2006 = $6,577,865.00

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Barriers to success

The following factors have provided some barriers to HICAHS productivity:

- Vast geographic distances in PHS Region VIII
- Time needed to build relationships with partners and constituents.
- Lack of resources and interest in funding surveillance.
- Negative effect of economic downturn (since 2001) on agricultural production and on ability to secure funds for research, education, intervention, or outreach.
- Current political climate and uncertainty regarding immigration issues.
- Poor national/political understanding of the scope and cost of occupational disease and public health.

Successes

We count among our successes the following:

- Professional publications (see Appendix A)
- Agricultural health and safety professionals educated
- Agricultural health and safety curricula for multiple target groups (see products in 2 program areas: Education and Regionalization Project)
- Research methods and tools (see database program areas: Asthma and Chronic Obstructive Pulmonary Disease and Evaluation)
- Leadership on two all Center Projects: National Tractor Initiative and Agricultural Center Evaluation Project
- First National Conference for the three major Agricultural Health and Safety Organizations: NIFS, North American Agromedicine Consortium and the NIOSH Agricultural Centers Initiative.
- Creation of an Outreach Model to both develop pilot research projects and disseminate Center generated products and information (See Program area – Regionalization Project.)

In addition to those outcomes highlighted above, there are many more intermediate outcomes listed in the Program databases under the variable “Products.”

Table 1 below illustrates translation of HICAHS projects into the workplace using the NIOSH "Research to Practice" designation for the last three years of funding. The variable categories were defined by the Agricultural Center Evaluation Team in conjunction with Delon Hull of NIOSH.

Table1. Project r2p Categories for FY 2004, 2005, 2006

r2p CATEGORY	PROJECT TITLE
Research to Surveillance and Intervention	Agricultural Injuries and Illness among Colorado Agricultural Workers (pilot study)
	Reduction of Exposures from Dairies and Cattle Feedlots
	Improving Injury Information for Migrant Farmworkers
Research to Research	Stability and Engineering Control Strategies
	ROPS Design and Testing for Agricultural Vehicles
	Evaluation of a Bacteriophage Cocktail to Reduce *Escherichia coli* 0157:H7 Shedding in Beef Cattle (pilot study)
	Menstrual Cycles and Reproductive Patterns in Women Exposed to Atrazine (pilot study)
	Exposure Injury Analysis: The effects of Atrazine on Luteinizing Hormone (pilot study)
	Validation of a Predictive Model for West Nile Virus Using Weather and Climate Data (pilot study)
	Endotoxin & Genetics in Organic Dust Lung Disease Facilities
	Development of Novel Biomarkers for Pesticides in EPA Region VII
	Ergonomics for Farm Workers
	Feasibility Study of the Determination of large Aerosol Particle Size by elutriation (pilot study)
Research to Field Use	Ergonomics for Farm Workers(pilot study) ROPS Design and Testing for Agricultural Vehicles
Research to Academia	Theses/Dissertations
	Professional Education
	Previous Publications
	Regional Cooperative Extension Project
Research to Intervention and Education	Ag Center Tractor Initiative
Research to Policy	Ag Center Tractor Initiative
Research to Evaluation	Interactive Agricultural Health & Safety CD: 4-H Youth
	Agriculture Health and Safety Curriculum Evaluation Project
Research to Technical Assistance	Redesign Radio Control System and LVDT Set for Precise Tractor(pilot study) High-Speed Tractor Safety and Impact On Applicable ROPS(pilot study) Reduction of Exposures from Dairies and Cattle Feedlots

The High Plains Intermountain Center for Agricultural Health and Safety

Outreach Campaign Program Area

Accomplishments from 1991 to 1996

HICAHS has served the agricultural population of Public Health Service (PHS) Region VIII (Colorado, Utah, Wyoming, Montana, North Dakota, and South Dakota) for nearly 15 years. The goals of HICAHS are to reduce agricultural injury and illness through focused research, education, and intervention. The translation of knowledge discovered from projects leading to these goals has been possible through an evolving and opportunistic nationally recognized outreach campaign.

Since 1991, HICAHS was involved a series of outreach activities to promote heath and safety to assist agricultural associations, producers, farmers, farm families, and migrant farm workers. The initial HICAHS outreach activities were focused on the delivery of existing and new knowledge from HICAHS personnel to the end-users. Examples of early outreach activities included presentations on a variety of topics from equipment safety to emergency pre-planning and included audiences such as Young Farmer Associations, Kids Farm Safety Day Camps, and agricultural associations. HICAHS personnel developed teaching / training modules, brochures, newsletters and scaled models that were presented to many agricultural groups.

A major outreach effort in the first 5-years was the Hazard Evaluation Project. On-site hazard evaluations were designed to assist agricultural business owners and operators in the identification of workplace hazards, the development of solutions for the elimination of hazards, and periodic follow-up visits to evaluate the effectiveness of the solutions. Approximately 25 to 50 Hazard Evaluation site visits were conducted each year between 1991 and 1996 and improved the working conditions of more than 1000 workers.

The third major outreach effort in the early HICAHS years was focused on the health and safety of migrant and seasonal farm workers in Colorado. With the assistance from rural migrant health clinics, a medical referral system was organized to ensure that migrants and seasonal workers who had suffered an agricultural related injury or illness received proper medical care. Student interns from HICAHS conducted migrant camp visits with medical personnel to identify health and safety hazards and to develop and distribute educational materials related to the identified hazards. A concerted effort by several HICAHS personnel was devoted to pesticide training for migrant and seasonal farm workers. By the end of the first five years the pesticide training was provided to nearly 500 migrant workers.

Accomplishments from 1997 to 2002

As HICAHS matured as a Regional Center, outreach activities grew from being primarily Colorado based to one with greater regional emphasis. Agricultural safety information sheets called Agri-Action were developed as a vehicle to reach more audiences in rural locations. The Agri-Action information sheets were disseminated through the internet, at farm shows, during agricultural association meetings, and to migrant farm health clinics. Sample topics addressed in these information sheets included *Air-Purifying Respirators*, *Electrocution Dangers Associated with Aluminum Irrigation Piping, Heat Related Illnesses,* and *Farm Tractor Safety, Children on the Farm, Grain Storage Bins,* etc. Hazard evaluations on farms and at agricultural facilities continued to be a major activity during this period. Approximately 20 to 30 workplaces were visited each year to help owners and operators identify and eliminate hazards associated with their operations. Outreach efforts also continued with migrant and seasonal farm workers. The focus with farm workers was on bilingual training to help them obtain Environmental Protection Agency certification under the Worker Protection Standard. Additional training in English and Spanish was provided on general farm safety and chemical hazards.

Beginning in 1999, HICAHS personnel implemented the "Regionalization Project." The goal of the project was to extend center activities to all states in PHS Region VIII. To facilitate this effort Cooperative Extension Farm Safety Specialists were identified in each state and contacted. The two most significant region-wide issues identified by the farm safety specialists were children's farm safety and farm accident rescue training. To help address these safety issues, farm safety specialists in each state were awarded up to $7,000 from HICAHS to develop programs and projects to improve safety in these areas.

Funds for outreach were eliminated from the HICAHS budget between 2000 and 2002 severely limiting outreach activities in Colorado and Public Health Service Region VIII. During that time period, HICAHS personnel referred requests for outreach activities to other sources such as Cooperative Extension.

Accomplishments from 2003 to 2006

The goal of most recent outreach activities has been to determine the feasibility of utilizing the Agricultural Extension Model and the existing structure of Cooperative Extension Services to develop and disseminate community-specific agricultural health and safety information throughout PHS Region VIII.

In the initial phase of the "Regionalization" project, Farm Safety Cooperative Extension Specialists and Agents in each State of PHS Region VIII were provided funds (average of $4,000 per year) to collaboratively develop intervention programs appropriate for the agricultural health and safety needs in their communities. Each regional expert developed a proposal(s) indicating the significance, objectives, target audience, and budget needs for the proposed project. The network of regional Cooperative Extension

Specialists in each state provided a key route of dissemination of educational materials, such as articles and fact sheets developed from the community projects, as well as from HICAHS research projects.

During the last three years, HICAHS personnel determined that the use of the Agricultural Extension Model was a feasible method for establishing regional collaboration, developing region-specific educational materials, and in providing HICAHS' researchers access to end-users such as farmers, ranchers and farm workers. However, in this process, the investigators learned that Cooperative Extension projects funded under HICAHS are more successful when they are closely coordinated from regional bases such as the state universities rather than by individual Extension Agents. We now rely on the Extension Specialists and Directors to help set regional priorities and work closely with the Agents as they conduct projects in their own locale. We learned from these experiences that the dissemination of agricultural health and safety material was limited to those involved with Extension Programs. There was little information dissemination beyond the reach of Cooperative Extension Programs. In response, HICAHS personnel expanded their partnership base in an effort to provide wider dissemination of existing and new agricultural related health and safety information. They established many new partnerships with agricultural associations, agricultural equipment and service companies, insurance carriers, dairy owners, community health clinics that treat migrant farm workers, and organizations such as Farm Safety 4 Just Kids and the AgrAbility Program or Easter Seals. Work with these organizations and companies has enabled them to develop relationships with a wide range of agricultural stakeholders also concerned with improving occupational health and safety.

Over the last several years HICAHS recognized that several levels of information dissemination are necessary to reach the many agricultural stakeholders (agricultural associations, other researchers, equipment manufacturers, insurance companies, ranchers, migrant and seasonal workers, disabled farmers, health care providers) concerned with health and safety. Lastly, HICAHS has modified their approach within the Agricultural Extension Model. Instead of the traditional *technology transfer,* or top down approach from the university researcher to the farmer, they now emphasize a participatory approach. The participatory approach with the Agricultural Extension Model allows for greater input on research needs from end-users, provides more effective dissemination methods, and affords greater attention to the regional needs of our agricultural partners that have direct access to end-users (farmers, ranchers, farm families, and migrant and seasonal farm workers). This participatory approach has enhanced the current Regionalization project and will be carried forward in future education / translation projects.

The High Plains Intermountain Center for Agricultural Health and Safety

Education Program Area

Introduction

The production and provision of agricultural-related educational programming has been a consistent and central component of HICAHS since its inception in the fall of 1991. During the past 15 years HICAHS personnel have sponsored and conducted well over 50 high quality educational projects. With a targeted six state regional responsibility (Public Health Service Region VIII) the Center began with conducting needs assessments of both regional producers (farmers and ranchers) and agricultural service organizations to identify the topics that would be most useful and also the modalities that our target audiences desired. Performing periodic needs assessments has continued to the present day. Consequently, the educational projects developed by HICAHS have dealt with diverse topics (e.g., health, safety, production, best practices, etc.), were delivered in a variety of formats and locations, and served multiple stakeholder groups.

It is important to indicate that evaluation of HICAHS education efforts has been consistently undertaken and results have been used to improve our education efforts over the years. Very early in the development of the Center some key partners were identified that have contributed significantly to the Centers' educational efforts: among those partners have been an AHAPS project, 4-H, Cooperative Extension in each regional state, OSHA 7(c)1 consultation project, SALUD Migrant Clinic System, Utah ERC, and multiple Colleges and professional disciplines both at Colorado State University and other regional institutions of higher education. Over the years additional groups have been added to our partners greatly assisting in the development, testing, and dissemination of our educational projects.

The following overview will highlight a number of educational efforts and products that were undertaken in the Centers' early years prior to the NAS review period. As the Center matured several programmatic emphases began to emerge, based upon both expressed need and available expertise. These emphases were based upon two regional target groups; children and adolescents, and seasonal, migrant and settled farm workers for whom Spanish is their primary language. We felt these groups were not being as well served as we would like, which in turn provided the impetus for more recent educational projects.

1991-1992

In the first year of funding, the Center began with several regional needs assessments in order to understand what efforts would be most useful for both the Agricultural production community in Public Health Service Region VIII, e.g.

farmers and ranchers, but also with those stakeholder groups that served the producers such as: cooperative Extension, Farm Bureau, Farmers Union, various agricultural commodity organizations, FFA. The results of these two needs assessments were then reviewed by the Center Executive Committee and proposals were developed to address the identified needs taking into consideration the expertise available.

In the first year of operation educational efforts focused on developing expertise in "Train the trainer" methods for Cooperative Extension Personnel and for first responders with Emergency Planning Train the trainer workshops for many regional producer groups. Working in conjunction with an OSHA 7(c)1 program also housed at CSU, train the trainer workshops were developed for hazard evaluations unique to agricultural settings such as Farmer CO-OPs, bean processing facilities, Feedlots, Nurseries and Sawmills. The Center also sought to respond quickly to requests from agricultural organizations such as National Wheat Growers, FFA, Vocational Agricultural Education Instructors and Colorado Corn Growers on numerous topics.

1992-1993

In these very early years, a firm partnership was developed with an already funded AHAPs project that sought to address health and safety issues through Cooperative Extension. This opportunity provided by being housed in a Land Grant University has proven to be a very important partnership for HICAHS personnel and has provided an already existing route of dissemination of information and materials and eventually a model of outreach (presented as a Program area for HICAHS) was established working directly with Cooperative Extension in all six states in the Federal Public Health Region that HICAHS took responsibility for.

A second early area of emphasis also began with the AHAPs project and has remained a consistent focus for HICAHS personnel – Health and Safety for children living and working in agricultural production. Between 1992 and 1995, Safety Day Camps for children were developed in Cooperation with the AHAPs, Cooperative Extension and HICAHS. These day camps presented interactive learning opportunities developed for children ages 5-12 that addressed topics pertinent to their living environment. Children have remained a consistent emphasis, as the Center has evolved; as both theory and literature indicate early intervention is more likely to change behavior. It became clear that we needed to develop more specific curriculum for different developmental age groups among children and youth, an identified need that led to current educational proposals and funded projects that will be discussed in detail and are part of the database submitted.

1993-1994

In 1993 - 1994 we began providing occupational health and safety education to a very significant population in the region, migrant workers. Working closely with the SALUD Migrant Health Clinic System, health and safety education sessions were presented at 14 migrant worker camps around Colorado. This experience eventually led to a dissertation project researching the effectiveness of such training.

Forty-nine health and safety audits in agricultural businesses were performed by the OSHA 7(c)1 consultation project, which worked in concert with HICAHS. These consultations always included a component of education around the specific hazards identified. During this fiscal year a train the trainer module was developed on Anhydrous Ammonia, and a HICAHS educational booth was developed by HICAHS addressing common regional health and safety issues to be presented at state, county and local fairs and meetings. HICAHS staff continued to provide health and safety educational components for the Safety Day Camps for kids sponsored by the AHAPs and regional commodity organizations.

1994-1995

In 1994 - 1995 HICAHS again worked with Cooperative Extension and the AHAPs to present health and safety information at Safety Day Camps for Kids around Colorado. Twenty on site hazard audits were completed in both agricultural businesses and on individual farms. HICAHS staff completed 38 trainings or educational activities. These included 8 Worker Protection Standard trainings and four in Wyoming for a combined total of over 600 individuals. Grain elevator health and safety training was provided in Oklahoma and Kansas, and general health and safety education was presented in Utah. Again, in conjunction with the SALUD Migrant Health Clinics health and safety education was presented in 16 migrant worker camps. Five monographs were developed by Education staff addressing the *Evaluation of Instruction, Legal Implications of testing learners, and how to construct criterion-referenced tests that are both valid and reliable.*

1995-1996

In 1995 - 1996, industrial hygiene staff reworked the EPA Worker Protection Standards for Agricultural pesticides and delivered a six-hour interactive video satellite course to over 350 workers in Colorado and Wyoming. Sixty-nine training or education sessions were delivered impacting more than 2600 individuals including children, agricultural workers, business owners, health care providers, and government employees. In addition twenty-one more on-site health and safety audits with educational components were completed. Worker Protection Standard education was also developed for migrant worker camps; and 60 visits to eleven migrant camps helped to resolve occupational or

environmental issues. Two new monographs were developed by Education personnel in HICAHS: *Experiential Learning: Theoretical Underpinnings,* and *Program Development Techniques for Agricultural Health and Safety Specialists: Working with Subject Matter Experts.*

1996 - 1997

Certification under the EPA WPS continued to be a desirable goal in the migrant farm worker population. During 1997 approximately 800 individuals received training provided by HICAHS staff: information was provided in both written and verbal format, as well as in either Spanish or English.

HICAHS staff also worked closely with the Colorado Head Start Program and the Migrant Education program, to provide basic safety and health training to over 500 children of migrant and seasonal farm workers across Colorado.

HICAHS received "Best of Show" and "Most Information" awards for our Center poster at the NIOSH Agricultural Health and Safety Conference in Morgantown, July, 1997. The Education staff have continually developed posters to assist in the communication and distribution of information to our many stakeholders.

A new product line was started in 1997, special information sheets were developed that can be downloaded from the Website and are also available in hardcopy. The first is *Air-Purifying Respirators* (IS-97-01); the second is *Farm Farality Reminder of Electrocution Danger Associated with Aluminum Irrigation Piping* (IS-97-02).

A final outstanding opportunity was provided to HICAHS staff to work with The Colorado Corn Growers Association to participate in the development of a Safety Training Video related to an equipment entrapment enactment related to a corn harvester. This has provided a unique opportunity to work with a commodity group to enhance safety procedures by also recognizing the costs associated with "accidents".

The following projects were conducted within the indicated timeframes. Various outputs were created depending on the type of project.

1997-1998

Collaborative development and dissemination of Narrative Learning Exercise:
- Carson's Difficult Decision. (Based upon Kayle's Difficult Decision from SE Center, H. Cole, P.I.).
  - Adapting and Field Testing Narrative Simulation – Planning and development.
  - Adapting and field Testing Narrative Simulation - dissemination

Facilitate Spanish Translation of North Dakota's ABC Curriculum

Design and deliver Customized Training – Kids Farm Safety Day Camps

Design and deliver Customized Training – Booth, display, poster development

Design, develop or update Agri-Action Information Sheets

Planning and facilitating First Regional Agricultural Health and Safety Conference

1998 - 1999

Design and deliver Customized Training – Worker Protection Standards

Design and deliver Customized Training – General Agricultural Health and Safety

Design, develop or update Agri-Action Information Sheets

Customized education – Kids Farm Safety

Customized education – Is it worth the Risk?

Customized education – Safety begins with the right attitude

Migrant Farm Worker Safety Training

1999– 2000

Design, develop and disseminate Health and Safety Information Sheets

Migrant Farm Worker Safety and Health x 2

Health and Safety Training – based upon client requests x 10

Needs assessment – Colorado Vocational Agricultural Education Instructors

Design interactive display booth

2000 – 2001

Develop Agricultural Health and Safety Curriculum for High School Youth: 9 module CD

Development, Implementation and Assessment of a Pesticide Use and Safety Training program for Thai Farmers – Phitsanolok Province, Thailand Education Research Project.

Use of Famphur by Livestock handlers: Knowledge about and Perceptions of Risk
Education research project.

2001 – 2002

Note: in this year Educational Outreach moved under Regionalization Project.

Evaluation of Agricultural Health and Safety Curriculum for High School Youth; Project year I

2002 – 2003

National Symposium for Agricultural Health and Safety – NIOSH Agricultural Centers, National Agro-Medicine Consortium, National Institute for Farm Safety. Chaired planning committee of the three sponsoring organizations. Conference Program planning

Evaluation of Agricultural Health and Safety Curriculum for High School Youth; Project year II

2003 – 2004

Chair and Host: National Symposium for Agricultural Health and Safety – Ag Centers, National Agro-Medicine Consortium, National Institute for Farm Safety. Keystone, Colorado, June, 2004.

Evaluation of Agricultural Health and Safety Curriculum for High School Youth; Project year III

Interactive Agricultural Health and Safety CD for 4-H Youth: Design and Develop, Project year I

2004-2005

Evaluation of Agricultural Health and Safety Curriculum for High School Youth; Project year IV

Interactive Agricultural Health and Safety CD for 4-H Youth: Design, Develop, and Evaluate Project year II

Note: Education of professionals in a variety of health and safety related disciplines has been an ongoing objective since HICAHS began. The count of professional degrees is reported in the Center overview; some of the products of these students are reported in the ACCESS database.

The High Plains Intermountain Center for Agricultural Health and Safety

ROPS Design for Pre-ROPS Tractors 1991 – 1997

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Scope of the Report

This report summarizes the accomplishment and progress for Pre-ROPS tractors/older tractors and tractor safety engineering control strategy, conducted by Dr. Paul Ayers and Dr, Juhua Liu in HICAHS during 1994-2005.

Tractor overturns are a major cause of agricultural-worker deaths each year. These deaths and serious injuries may have been prevented if the tractors had been equipped with ROPS, and the operator was wearing a seat belt. Many tractors manufactured prior to 1970 did not have ROPS as an option and thus the axle mounts were not designed to structurally support a ROPS during an overturn. If ROPS were available for these pre-ROPS tractors, then rollover protection will be more readily available and lives could be saved. The specific aims of the projects were to:

1. Identify major axles categories of pre-ROPS tractors in order to determine axle designs appropriate for ROPS design and testing.
2. Design, construct and test ROPS for each of the major axle categories identified. This includes conducting static and field upset ROPS testing in accordance with SAE J2194, and ASAE S519.
3. Determining torsional axle housing strengths for pre-ROPS tractors (initially vibrational loading tests).
4. The development of guidelines for the design and installation of ROPS for pre-ROPS tractors, focusing on axle housing support.

Tractor Stability and Safety (1996-1998)

The factors involved in tractor stability include speed, slope, center of gravity, wheel base, tread width, and turning radius. Dynamic stability measurements include ground speed, yaw rate (turning radius), and pitch and roll (reference, rate and acceleration). These factors and the physical characteristics of the tractor (center of gravity, wheel base, and tread width) can be used to determine the degree of stability of the tractor. These factors have been used to develop a stability index to determine the degree of stability of tractor operations. The stability index determination incorporates the dynamic measurements, physical tractor characteristics and stability models to produce an index from 0 to 100. A stability index of 100 indicates high stability (tractor on level terrain with no velocity). A stability index of 0 indicates a tractor operating under conditions where an upset is likely.

The objective of this research project is to evaluate the relative stability of tractors during typical agricultural operations. A quantitative value, referred to as a stability index, will be determined from the tractor's dimensions and operating conditions. The stability indices developed are: 1) static longitudinal stability index, 2) static lateral stability index, and 3) lateral steady-state turning stability index.

Engineering Control Strategies Based On Tractor Stability (1996-2002)

Tractor overturns need to be reduced and operators need to be alerted and/or protected when they are operating in a condition potentially hazardous for a field upset. In addition, deployment of safety control features, including ROPS, restraint system, stabilizing maneuvers and/or warnings need to be made based on reliable measurements and models of tractor stability. The factors involved in tractor stability include speed, slope, center of gravity, wheelbase, tread width, and turning radius. These factors have been used to develop a stability model to determine the degree of stability of tractor operations. A quantitative value referred to as a stability index has been developed from the tractor physical and operating conditions. The stability index determination incorporates the dynamic measurements, physical tractor characteristics and stability models to produce an index from 0 to 100. A stability index of 100 indicates high stability (tractor on level terrain with no velocity). A stability index of 0 indicates a tractor operating under conditions where an upset is likely.

The overall objective of this project is to develop and evaluate a tractor stability monitoring system designed for monitoring relative tractor stability and engineering control deployment strategies. A radio-controlled Ford 8N tractor has been equipped with the stability monitoring system and field data acquisition has been conducted. The stability monitoring system includes sensors to monitor pitch and roll angle, rate, and acceleration; yaw rate and ground speed.

Verification of the stability index model for the deployment of engineering control strategies is underway. Field testing has been conducted on slopes ranging from 15 to 60 degrees at the Agricultural Engineering Research Center. Model parameters have been chosen based on rigid body and dynamic analysis. Videotechnology has been incorporated to assist in the model verification. Field results indicate the ability of the model to predict a tractor field upset (stability index < 0) when the tractor was operated in 6th gear (see figure). The model correctly indicated non-upset situations when operating in 3rd and 5th gears.

The application of the stability monitoring system for the deployment of engineering control strategies will be explored in various field upset conditions, including longitudinal and lateral overturns.

ROPS Design and Testing for Agricultural Vehicles (2003-2006)

The overall objective of this project is to investigate, develop, evaluate and disseminate information regarding rollover protective structure (ROPS) designs for agricultural vehicles in the United States to provide and ensure operator protection on vehicles not currently available. The specific objectives include:

1) Evaluation of the continuous roll prediction accuracy of the model described in the newly approved (December 2002) ASAE Standard S547 “Tip-Over Protective Structure (TOPS) Protective Structure for Front Wheel Drive Turf and Landscape Equipment”. The evaluation includes:

- Field upset test verification (roll behavior and angular velocities) using Deere F925 commercial front mower
- Determination of measured and calculated critical ROPS height (CRH) for the Deere F925 commercial front mower
- Model sensitivity analysis and parameter estimation on model factors including moment of inertia, mower deck size, ROPS and test slope deflection, center of gravity location, and coefficient of elasticity of slope,

2) Determination of the required critical ROPS height (CRH) for the 17 previously examined agricultural vehicles (lawn tractors, lawnmowers, off-road utility vehicles and ATV’s), utilizing the continuous roll prediction model described in ASAE S547. A comparison of the calculated (CRH) to the actual ROPS height for the available ROPS will be conducted,

3) Dissemination of information addressing ROPS design and testing will be presented to the Agricultural Vehicle Industry (including tractor, lawnmower, off-road utility vehicle and ATV). Dissemination will occur in the form of technical presentations and literature distribution at national meetings, individual site visits (vehicle and ROPS manufactures), specialty meeting (i.e., ASAE PM 52 and the OPEI EXPO). The topic areas will include general ROPS design and testing, ASAE S547 test slope construction, ASAE S547 model validation and utilization. A website presenting 1) the test slope construction details for the S547 lateral field test and 2) the OECD Code 6 continuous roll prediction model accuracy evaluation and limitations will be developed,

4) Conducting lateral field upset tests in accordance with ASAE S547 of prototype or commercially available ROPS and non-ROPS frames designed for non-traditional agricultural vehicles including lawnmowers, off-road utility vehicles and ATV’s to evaluate operator protection characteristics.

End outcomes

We have designed and tested ROPS for Ford 800, John Deere A, Farmall M, AC D17, and AC WD-45. ROPS design and test have been collaborated with Saf-T-Cab and FEMCO as well as relevant tractor manufactures.

Myers and Snyder survey in 1995 indicated that of 70 most popular tractor models in the United State (Myers and Snyder, 1995), 50.4% were pre-ROPS tractors. Thereofre, after completion of AC D17 and AC WD-45 design project, over 90% of the Pre-ROPS tractors (in the top 70) would have a ROPS design. In addition, with the request of OSHA office at Colorado State University, a ROPS has been designed for IH2400 industrial tractor. The accomplishment and progress are summarized in Table 1.

Table 1 ROPS Design for Pre-ROPS Tractors

ROPS Design for Pre-ROPS Tractors					
Tractor Models / **Research Work**	Ford	Farmall	Deere	AC	IH2400
Design ROPS	X	X	X	X	X
Static Tests	X	X	X	X	
Radio-Controlled Tractor	X	X	X	X	
Field Upset Test	X	X	X	X	
Axle Strength	X	X	X	X	
ROPS Drawings	X	X	X	X	X
Test Commercial	X	X			
Sold Commercial	X	X			
X – Accomplished, C - Currently Underway					

Through the projects, we have established ROPS Test Lab (including data acquisition system) and field upset test site, which meet the SAE J2194 (ASAE S519) requirements. There have been approximately 26 undergraduate graduate students and 5 graduate students related to the projects.

Center of gravity and critical later and longitudinal stability angles have been determined for 15 agricultural tractors and this work was extended to include lawnmowers, off-road utility vehicles and ATV's.

The High Plains Intermountain Center for Agricultural Health and Safety

Organic Dust and Respiratory Disease

HICAHS has been a national and international leader in research concerning respiratory disease and exposure to agricultural dusts. This work has included the training of a significant number of MS and PhD students, and resulted in advances in methodology and knowledge that have been shared with researchers, medical practitioners, cooperative extension agents, and agricultural producers. Since 1991 a sustained series of research projects has focused on evaluating and controlling exposures to organic dusts in a number of agricultural settings. Initial work characterized worker exposures to wheat and corn dusts, and measured respiratory health effects. The important role of endotoxin was explored with in-vitro studies designed to complement the exposure assessment studies. HICAHS also developed excellent laboratory facilities for aerosol studies and investigators have evaluated the performance of a variety of air sampling devices. The emphasis on organic dust exposures has continued with a new project evaluating a novel Recombinant Factor C endotoxin assay using organic dusts from livestock environments and testing new methods for measuring inhalable particulates, including endotoxins, and glucans/ergosterols. Current work involves evaluation of an intervention to reduce exposures, and application of new exposure assessment methods to an epidemiological study of gene-environment interactions in respiratory disease.

Accomplishments from 1991 to 2003

Initial work focused on understanding the extent of health problems and the needs of the agricultural population in Federal Region VIII. A telephone survey of 314 farmers and ranchers in 4 Colorado counties collected information to assist in delivering such health and safety information, including respiratory problems. Early research efforts focused on characterizing exposures and respiratory outcomes in a variety of agricultural settings. *A Characterization of the Potentially Pulmonary Toxic Components of Winter Wheat Grain Dust On Farms and Elevators During Harvest* entailed industrial hygiene surveys at 8 farms and 7 elevators in Northeast Colorado during the 1992 wheat harvest, 4 farms and 3 elevators during winter grain shipments, and 4 farms and 3 elevators during the 1993 grain harvest. *Exposure to Pulmonary Reactive Components of Winter Wheat Grain Dust* examined in greater detail the concentrations of grain dust to which wheat farmers are exposed during various work tasks. *Molecular Biomarkers of Grain Dust Exposures* focused on laboratory studies to develop biological markers of exposure responses to agricultural grain dusts for use in the prevention of respiratory diseases in farm workers.

Two additional studies focused on unique respiratory disease issues in this region. A*ltitude and Carbon Monoxide Exposure* examined the effects of

occupational exposure to CO on blood concentrations in individuals living and working at different altitudes. *Tuberculosis Among Migrant Workers* looked at the prevalence of tuberculosis among 213 migrant farm workers in northeastern Colorado during the summer of 1994.The earlier efforts concerning exposure and biomarkers were further developed and results were published in peer reviewed journals. (Beard M, Buchan R, Reeves F, Salasek M [1996]. *Pulmonary reactive components of winter wheat grain dust at Colorado farms and elevators.* Applied Occupational Environmental Hygiene 12(11):1409-1416). (Buchan R, Veit S, Stallones, L [2001]. *Acute respiratory effects and endotoxin exposure during wheat harvest in northeastern Colorado.* Applied Occupational and Environmental Hygiene 16(6)685-697). An important new finding by Dr. Greg Cosma and Tony Martinez demonstrated that bacterial endotoxins were responsible for over 70 percent of lung cell pro-inflammatory responses, as determined by measuring cytokine levels in alveolar macrophages treated in vitro with wheat dust particles. The other 30 percent of response was unaccounted for, but they recommended that measuring endotoxin exposure might be a better index for respiratory risk assessment than measuring total dust concentrations alone. (Cosma G, Martinez A, Ufferfilge D, Beard M, Olenchock S [1996]. *Pro-inflammatory responses of respiratory cells to grain dust extracts.* Journal of Toxicology and Environmental Health - *submitted pending review – need final reference on this*).

Responding to concerns of farmers in the San Luis Valley, HICAHS conducted two research projects to assess exposures to total dust, respirable dust and respirable silica at potato harvest. Year one was conducted by Lori Berberet and year two was performed by Michelle Adams (both MS students). Both investigators concluded that although occupational exposure guidelines were generally not exceeded, working conditions were extremely dusty and often uncomfortable for many potato harvesting employees, and that NIOSH approved dust masks should be made available to all workers. (Berberet L, Buchan R, Beard M [2001]. *Respirable dust and crystalline silica (quartz) exposure resulting from potato harvesting operations.* Journal of Agricultural Safety and Health 5(1)97-107; Adams M [1999]. *Characterization of dust exposures during potato harvest*. HICAHS Colorado State University, Fort Collins, CO).

At the request of the Colorado Corn Growers Association, research into corn dust exposures in storage facilities was conducted by Brit Todd. 58 percent of total dust samples and 33 percent of the respirable dust samples collected exceeded the OSHA PEL. The most significant finding was high levels of endotoxins. Given the particle size (optimal for deposition in the tubular airways) and the pro-inflammatory nature of endotoxins an additional study looking at the endotoxin levels as measured by Thoracic Particulate Mass (TPM) sampling indicated a definite possibility of an environmental hazard conducive to the promotion of chronic obstructive airways disease among workers in corn handling facilities. (Todd B, Buchan R [2002]. *Total dust, respirable dust, and microflora toxin*

concentrations in Colorado corn storage facilities. Applied Occupational and Environmental Hygiene17(6)411-415).

Marv Tillery lead additional work to develop an improved device for size selective sampling of organic aerosols. This contributed to the MS thesis of Jason Buchanan.

Accomplishments from 2003 to 2006

It became clear from the earlier work that advances were needed in accurately sampling the aerosol that actually impacts the human respiratory system and in measuring endotoxin. HICAHS researchers have been leaders in developing new tools for exposure assessment of agricultural dusts and in applying these tools to better understand and control respiratory disease. Three major projects are nearing completion. Protocols and results from HICAHS studies are being used by other researchers and practitioners.

Focusing on exposure assessment methods development Dr. Reynolds is leading a study of New Methods for Evaluation of Organic Dust Aerosols involving a collaboration of HICAHS at Colorado and the GPCAH at Iowa. This work is funded separately from the HICAHS Center, but is integral to the Center. The primary goals of this study include:

1. Evaluate and compare the precision and relative predicted dust concentration for the following gravimetric methods for measuring organic dusts in swine, poultry (chicken and turkey), dairy, equine, and sheep environments: Inhalable (IOM) sampler, Inhalable (IOM) sampler with size-selective MultiFoam disc, button aerosol sampler, total dust (37 mm cassette), respirable dust (cyclone) using a laboratory wind tunnel and field studies.

2. Evaluate and compare the precision and relative predicted dust concentration of these devices and collection media for measurement of endoxotins and glucans/ergosterols in these same environments using a new Recombinant Factor C fluorometric endotoxin assay, the chromogenic LAL assay and chemical methods.

3.Determine the performance of the new Recombinant Factor C fluorometric endotoxin assay, and compare the relationships between chemical analyses and biological assays for endotoxins and glucans in these dust samples, and identify specific chemical fractions that best correlate with assay measures. Characterize the distributions of endotoxins and ergosterols by specific chemical components and size fraction in these various organic dust environments.

4. Evaluate the precision and relative predicted dust concentration for direct reading aerosol instruments including the DataRam, HAM, and their relationship to the gravimetric methods in these organic dust environments. Derive correction

factors if needed for adjustment of data produced by these devices. Characterize aerosol size distributions using Grimm direct-reading particle counter.

5. Evaluate the usability and utility of these direct reading aerosols devices for practical applications in these agricultural environments.

Studies involve both a field component and laboratory studies in a wind tunnel at CSU and in a still air chamber at Iowa. A total of 30 sampling sessions were conducted for each dust type, comprised of 10 field sessions and 20 laboratory sessions. Each laboratory session included 10 runs at 1.0 and 0.2 meters per second (m/s) wind velocities. While Pearson's correlation coefficients (r), for field runs resulted in paired PDR to gravimetric sampler r values as high as 0.979 with p-values < 0.01, fewer significant correlations were seen with the HAM. Likewise comparisons of the wind tunnel trials resulted in a correlation at the 1.0m/s velocity between the 37mm Total Dust cassette and both PDR's with r values from 0.622 to 0.772 and p-values <0.01. In addition to aerosol source, results so far suggest that wind speed and particle size may have an effect on both gravimetric and photometer sampler performance. GC/MS efforts have focused on improving the method for markers of endotoxins – 3-hydroxy fatty acids (3-OHFAs) in lipid A of lipopolysaccharide. The major changes in the modified method are elimination of the liquid-liquid extraction step, use of polymeric media in the place of silica for sample clean up, and use of 3-OHFAs to construct the calibration curves instead of 3-OH methyl esters. This approach allows detecting small changes which is critical for agricultural dusts containing very low concentration of 3-OHFAs. Results from the modified method and the rFC assay show that livestock dusts have a better correlation (0.9450 feedlot; 0.4185 dairy) than grain dusts (0.1723). Feedlot dusts contain more variable 3-OHFAs than grain dusts. In general, good correlations exist between the biological assay and our modified GC/MS method. The modified GC/MS method is especially useful for identification of specific 3-OHFA's for endotoxins from various agricultural environments. Data from these agricultural dusts suggest that wind speed may not be the sole determining factor affecting sampler performance. In addition it appears that performance of direct reading devices is also affected by windspeed, and particle size distribution. Differences found in endotoxin content by aerosol size may have implications for respiratory disease. GC/MS analysis has demonstrated distinct differences in the predominant 3-OHFA content of endotoxins in dusts from different agricultural environments.

This work will contribute to the PhD dissertations of two students, Jason Nakatsu and Rena Saito. Two manuscripts have been submitted to date and are undergoing revision:

Reynolds SJ, Mehaffy J, Ragan JV, Tessari J, Keefe T, Milton D, Alwis U, Larsson L, Chen L. *Evaluation and Optimization of a new rFC Endotoxin Assay using Agricultural Dusts.*
O'Shaughnessy, Lo, Golla, Nakatsu,Tillery, Reynolds*. Comparison of Aerosol Samplers Relative to the Inhalable and Respirable Collection Criteria.*

A protocol for extraction and analysis of samples for the new rFC endotoxin assay was completed and is available by contacting Stephen.Reynolds@Colostate.edu. We have assisted the University of Saskatchewan and the University of California Davis with conduct of endotoxin assays. A modified GC/MS method for endotoxins – 3-hydroxy fatty acids (3-OHFAs) has been developed and a publication is being prepared. The modified method reduces sample handling, use of organic chemicals, and the analyst's exposure.

Tools from this study are being applied to two other HICAHS efforts. In *Reduction of Exposures from Dairies and Cattle Feedlots* Drs. Reynolds, Stanton, Keefe are collaborating with local dairies to evaluate a novel intervention, using algae to create aerobic conditions in manure to reduce exposure to gases and aerosols. Twenty one workers at the intervention and control dairies are participating in repeated sampling. Personal sampling has focused on characterizing occupational exposures for various tasks including milking, feeding, maintenance, working sick cows, and driving tractors. Total particulate and endotoxin levels were 0.54 and 1.56 mg/m^3, and 352.0 and 577.6 EU/m^3 for maintenance and milkers, respectively. Inhalable particulate and endotoxin levels were 1.96, 0.77, 0.68, and 1.5 mg/m^3, and 494.4, 360.1, 206.6, and 728.1 EU/m^3 for working calves, working sick cows, feed mixing tractor, and feed loading tractor, respectively. Surprisingly, exposures to endotoxins are highest in the milking parlor, which was thought to be the cleanest area. This work is the basis of a PhD dissertation for Brad Lester (anticipated graduation 2007). This work also contributed to the MS thesis for Marcus Cusannelli (2006).

Drs. Reynolds, Koehncke, Tessari, Keefe, Siegel, Bush, Schwartz, and Von Essen are collaborating on an epidemiological study of *Endotoxin and Genetics in Organic Dust Lung Disease*. The specific aims include
1) characterizing worker exposure to endotoxin-containing corn dust aerosols;
2) evaluating respiratory outcomes including symptoms, cross shift changes in pulmonary function, (PFT) and cellular/immune markers (cytokines);
3) surveying genetic markers related to lung disease and endotoxin etiology (TLR4 gene mutations, and polymorphisms of IL1-RN, and TNF-alpha).
Dr.Siegel is conducting cytokine analysis on nasal lavage samples, and Drs. Burch and Schwartz are conducting genetic analyses.

Of the first 81 participants, 52% were Hispanic, and 99% males. Inhalable dust levels ranged from 0.36 to 76 mg/m3. Endotoxins ranged from 30 to 50,100

EU/m^3. Exposures and respiratory outcomes differed by type of operation. At grain elevators (n=22) inhalable dust and endotoxin exposures averaged (geometric mean) 5.5 mg/m^3 and 900 EU/m^3 respectively. Exposures averaged 2.5 mg/m^3 and 2,200 EU/m^3 at cattle feedlots (n=34), and 2.1 mg/m^3 and 800 EU/m^3 at dairies (n=17), and 2.8 mg/m^3 and 900 EU/m^3 at farms (n=7),. The rank order of endotoxin content per gram of dust was dairies > feedlots > farm > grain elevators. In addition, the make-up of the endotoxins varied by operation; 3-hydroxy fatty acid content of endotoxins was dominated by C13, C14 for grain elevators, C9, C13,C14,C18 for feedlots, and C14,C15, C17 C18 for dairies. The mean cross-shift change in FEV1 was – 8.1% for farmers, - 4.2% for dairy workers, -3.0% for grain workers, and -1.8% for feedlot workers. The cross-shift change in FVC was greatest for farmers (-9.1%), followed by dairy workers (-2.8%), grain workers (-1.6 %) and feedlot workers (-0.6%). The most common symptoms reported included eye irritation, nose irritation, increased mucous production, and cough. IL-8 in nasal lavage samples ranged from 24to738 pg/ml. TNF alpha and IL-4 were non-detectable in most samples. Myleoperoxidase ranged from 4 to 88 pg/ml. Most participants were homozygous for TLR4 299 and 399. In preliminary analyses, TLR 4 mutations and endotoxin were correlated with shortness of breath (R^2 = 0.29 multiple regression). Exposure, cross-shift changes in pulmonary function, and symptoms differed by type of operation. Exposures to dust and endotoxin were extremely high in some cases – identifying opportunities for intervention. Protocols developed for this project were shared with two other NIOSH Agricultural Centers, and Dr. Reynolds will be conducting “Webinar” for the ACGIH on Endotoxins this summer which will reach an international audience. These projects will be completed by Fall 2006.

HICAHS research on organic dust exposures and respiratory disease has encompassed a progression from initial studies exploring the scope of the problem, to advances in tools for characterizing exposures, which are now being used for more sophisticated studies that will lead to better understanding of disease etiology and strategies for reducing exposure and disease. The methods and protocols developed by HICAHS researchers are being used by other researchers in the US and internationally. Results of this work have also be disseminated through HICAHS outreach activities, and shared with health professionals and agricultural producers.

The High Plains Intermountain Center for Agricultural Health and Safety

Exposure Assessment Methods – Novel Biomarkers for Pesticides

Accomplishments from 1991 to 1997

In 1987, the National Research Council (NRC) of the U.S. National Academy of Science (NAS) issued a report examining the current state of the science for the use of biomarkers in environmental health research and risk assessment. This model has since been expanded and modified in numerous articles and reprints. The classical epidemiological “black box” model links exposure with disease and the NRC biomarker paradigm expands the black box to reveal discrete measurable stages in the exposure/disease continuum. For all manifestations of chemical-induced toxicity, a series of cascading events must occur between ambient exposure and the observation of clinical disease. Prior to the last two decades, toxicological methods were not sufficiently sensitive to identify and characterize these intermediate events; they were instead considered part of the “black box” linking exposure and disease. Consequently, they could not be directly exploited for predicting or associated with exposure or for identification of potential toxicity.

At any given time or condition, all proteins expressed by the genome of cells, tissues, or organisms are collectively termed the “proteome”. Proteomics is therefore defined as “any large scale protein based systematic analysis of the entire proteome or a defined sub-proteome from a cell, tissue, or entire organism”. This broad analysis can be very complicated as the proteome is constantly changing, unlike the genome, and is subject to changes due to developmental stage, disease state, or environmental conditions. Different cell types or the same cells may express different proteomes at different times. No cell in any organism will contain all the proteins encoded by its genes together at one time, so the proteome represents a subset of all possible gene products. In proteomics studies, analytical methods are used to identify proteins in a sample, develop protein expression profiles, map protein networks, and identify protein modifications.

Biomarkers are useful tools for understanding the nature and extent of human exposure and risk from environmental toxicants. They can serve as quantitative measures of chemical exposures and biologically effective doses, as well as early warning signals of biological effect. They can help increase the understanding of the processes by which a chemical is transported and transformed within an organism to produce a dose to a target tissue and the interactions at the cellular and molecular levels leading to a toxic endpoint. Although the field of biomarkers is still relatively new, many different analytical techniques have been developed to quantify such events as exposure to a certain chemical or early biological events resulting from exposures. Problems

exist with many current biomarkers in that they have not been validated for use in large population studies and their significance for predicting the risk of clinical disease is unknown, In other words, although a biomarker may indicate exposure to a certain environmental chemical, it may not be well understood how that marker relates to other events in the toxicological paradigm. Ideally, a series of biomarkers can be used to help strengthen the knowledge base about the entire disease continuum, from exposure to effect, or disease outcome.

Taken together, these intermediate events constitute the mechanism of toxic action for a given agricultural chemical under specific exposure conditions. The objectives of our biomarker research are to develop rapid and sensitive biomarkers of chemical exposure and to expand the present knowledge of the “black box” events that link exposure to agricultural chemicals and disease using state- of-the- art proteomic, analytical, and molecular techniques.

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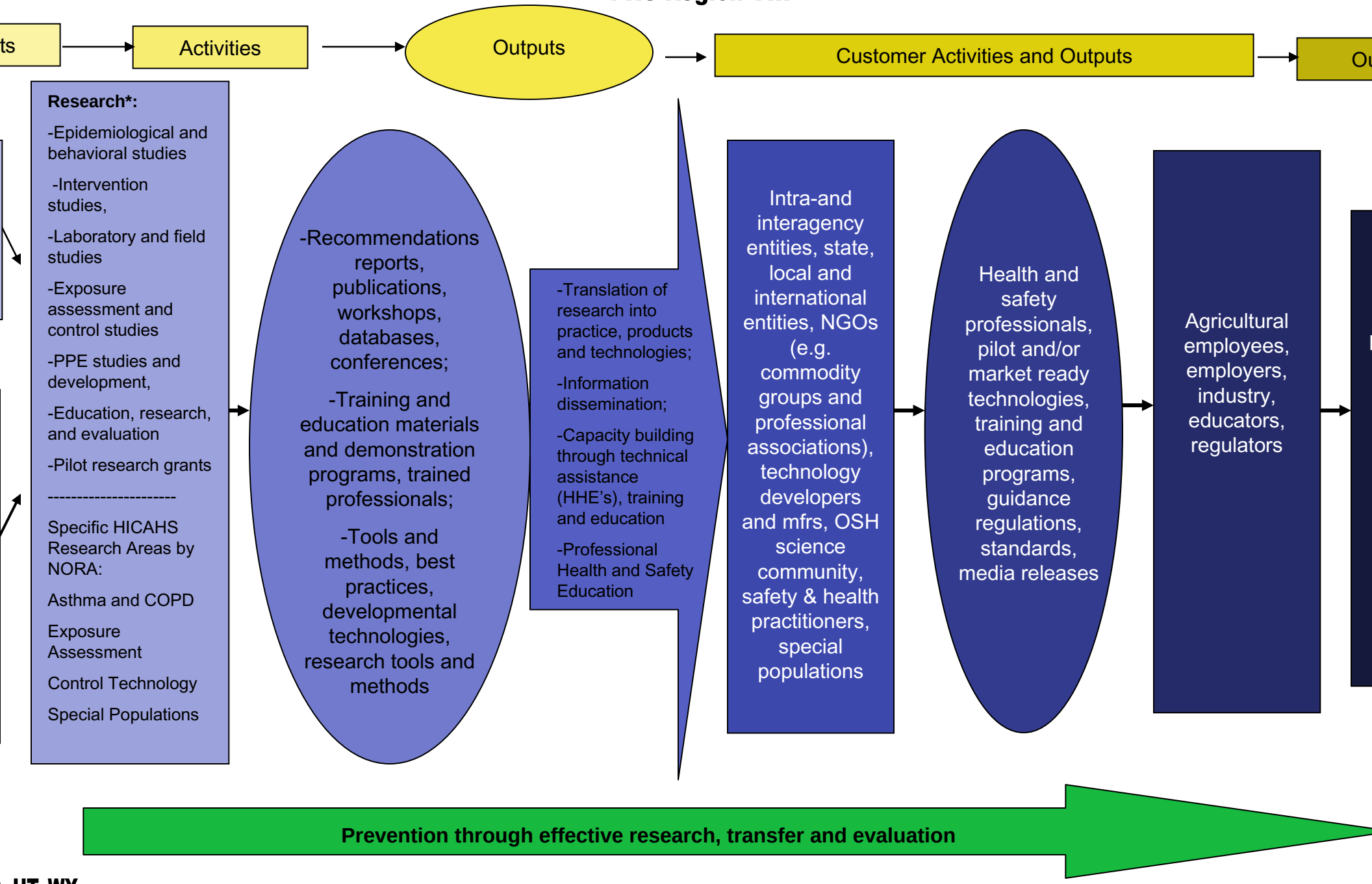

Prevention through effective research, transfer and evaluation

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Great Plains Center for Agricultural Health

Introduction

The Great Plains Center for Agricultural Health at The University of Iowa has served as the NIOSH Agricultural Health and Safety Center for Federal Region VII and the corn belt, America's most productive agricultural region, since 1990. Iowa, with a population of 2.9 million (Goudy and Burke, 1991), and agricultural and agriculturally driven industrial diversity and a wide variety of agricultural and other rural environmental exposures, provides an ideal location for such a center. The rural population of Iowa is genuinely concerned about agricultural health and safety and the Iowa Congressional Delegation and the Iowa General Assembly have been consistent and strong supporters of agricultural health and safety programs. This is in large part a reflection of the demographics of Iowa, which is the second most rural state in the US with 56% of Iowans living outside Metropolitan Statistical Areas (compared to 27% nationally), and 39.4% of Iowans meeting the US Census Bureau definition of rural (living outside communities with populations less than 2,000) compared to 14% nationally (Goudy and Burke, 1991). As a result, Iowa provides a large, stable and suitable rural population for assessment of agricultural health and safety exposures, for assessment of health outcomes, and for evaluation of the efficacy of prevention programs targeting farmers and farm families. While the other states in Federal Region VII (Missouri, Kansas, and Nebraska) have higher proportions of their populations concentrated in urban areas, they share similar agricultural production and thus similar occupational and environmental exposures. As a result, an agricultural health and safety center located in Iowa is well suited to address agricultural health and safety needs of the entire region.

An important common denominator of rural living is poverty. A disproportionate share of poor people live in rural areas and account for a third of America's poor (Rowland and Lyons, 1989). Of the 45 million non-elderly rural residents, at least 8.3 million live in poverty with a family income of less than $11,600 for a family of four. One out of every five rural residents is poor, and poverty serves as a risk factor with a major influence in overall rural mortality rates (Schneider and Greenberg, 1992). Another result of poverty is that rural residents are less able to afford health insurance coverage. Over 8 million rural Americans lack health insurance, 26.5% of the rural uninsured are children, and 18% of all farm families are uninsured. Medicaid coverage is known to be less prevalent in rural states (Rowland and Lyons, 1989), and there are a disproportionately high number of Medicare dependent rural residents (Straub and Walzer, 1992). Important geographic barriers to health care also exist. More than half of the rural poor do not have a car and nearly 60% of the elderly rural poor do not drive. Rural residents are more often employed in agriculture, which is recognized as having high rates of work-related disease and injury, yet frequently does not provide health care insurance coverage (Merchant et al, 1988). In addition, rural residents are increasingly bearing the burden of a deteriorating rural health care system with increasing shortages of physicians and other health care professionals and with rural hospitals that continue to decline in both numbers and services (Gordon et al, 1992). As a result, rural residents in the Midwest and America face multiple barriers that

adversely affect their health--more poverty, geographic barriers to health care, less health insurance, and poorer access to health care. All of these factors contribute to increased agricultural disease and injury morbidity and mortality, much of which arises from preventable occupational and agricultural exposures. Because of these multiple rural health concerns, GPCAH Director James Merchant organized and chaired the first national conference on health care reform for rural America in December of 1993 (Merchant and Ungar, 1994).

Within the last decade, the people of Iowa and in other agricultural regions have become much better informed regarding the widespread use of agricultural chemicals and their potential adverse health effects. These widespread rural exposures have lead to a demand for both public information and further research. A second major development in the last decade has been national recognition of the importance of agriculturally related injuries and diseases culminating in the Surgeon General's Conference on Agricultural Safety and Health held in Des Moines, Iowa in May of 1991 (Merchant, 1992). These agriculturally-related public health issues, which have been documented extensively through the research of GPCAH investigators, have been brought to the attention of the U.S. Congress, several federal agencies, state legislatures, agribusiness, farm families, and the academic public health community in the midwest and nationally (Merchant et al, 1988). The national leadership of GPCAH faculty members, GPCAH Director James Merchant, Associate Director Kelley Donham, and the former Education and Training Core Director Burton Kross, in publishing Agriculture at Risk -- A Report to the Nation, which was instrumental in the very significant increases in national funding to address adverse occupational and environmental health effects faced by farm families and other rural dwellers (over $40 million in FY 95 from the CDC, NIH, USDA, EPA, and the Kellogg Foundation). GPCAH investigators have continued to provide both national agricultural health and safety policy and research leadership in addressing agricultural health and safety issues. The discussion below summarizes current adverse health effects faced by farm families in Iowa and Region VII and comments on specific contributions of the currently funded GPCAH--together providing a rationale for continued support for a NIOSH Agricultural Health and Safety Center at The University of Iowa for Federal Region VII.

The widespread use of agricultural chemicals is a primary concern to all involved with agriculture. On a national scale, the total amount of pesticides applied for agricultural purposes has increased significantly over the last three decades (EPA, 1987). In 1985, about 861 million pounds of pesticide active ingredients were used in agricultural production in the U.S.--60% were herbicides, 25% insecticides, and the remainder fungicides and other pesticides (Wintersteen, 1987). Total pesticide usage has declined over the last decade with total usage now about 760 million pounds of pesticides, of which 63% is herbicides (Wintersteen, 1987). Iowa leads the nation in total herbicide use, with 95% of corn acres and 97% of the soybean acres receiving at least one herbicide application. A second important class of agricultural chemicals is nitrogen fertilizer. The rate of nitrogen application in Iowa has increased very rapidly over the past three decades. In 1960 about 100,000 tons of nitrogen fertilizer were applied in Iowa, but after 1980 well over a million tons of nitrogen fertilizer have been used annually on essentially the same number of crop acres. However, recent studies indicate a decrease in nitrogen fertilizer application over the past five years as Iowa

farmers begin to adopt best agricultural management practices for continuous corn production (Iowa DNR, 1991). Studies by University of Iowa investigators suggest a direct correlation between increased use of nitrogen fertilizer and higher concentrations of nitrate in surface and groundwater used as sources of potable water (Hallberg, 1987). Additional studies by GPCAH investigator Burton Kross and colleagues have also observed the continuing importance of nitrate/nitrite toxicity among farm and other rural children (Kross et al, 1992; Ayebo et al, 1996).

The impact of this chemically-based agricultural production on the health of farm families and other rural dwellers has become a public health issue of some magnitude (Isacson et al, 1985). Early epidemiological studies by GPCAH investigator Leon Burmeister demonstrated an association between certain agricultural chemicals and some types of cancer (Burmeister et al, 1983). Farmers and farm family members have contact with a variety of potentially hazardous substances including pesticides, solvents, fuels and oils, diesel exhaust, organic dusts and zoonotic viruses and other microbes and their associated toxins. In addition to carcinogenicity, several pesticides and the organic solvents which serve as carriers for their application, are potentially important renal, reproductive, neurologic, and respiratory toxins (Gordon and Shy, 1981; Schwartz and Logerfo, 1988).

Early studies by GPCAH investigators and others in the United States and abroad have reported excess risks for cancer of the lip, stomach, brain, prostate, connective tissues, and the lymphatic and hematopoietic system among male farmers (Brown et al, 1990; Blair et al, 1985; Blair et al 1986; Burmeister, 1990; Blair et al, 1993). These associations have not been found in all studies, but there is a clear trend for these cancers to be increased among farmers (Blair and Zahm, 1991). Some studies have linked increased rates of certain cancers among farm women--ovarian cancer with triazine herbicides (Donna et al, 1989), breast cancer with some insecticides (Falch et al, 1992; Wolfe et al, 1993), and various pesticides with multiple myeloma and non-Hodgkin's lymphoma (Zahm et al, 1992a; Zahm et al, 1992b). These excesses appear in the face of a farm population that is known to smoke less and to have consistently lower mortality rates for all causes combined, for heart disease and for many other cancers. As a result, the excess organ-specific cancer rates observed among farm populations are not likely to be occurring by chance. The strongest link between agricultural chemical exposure and cancer has been found for hematopoietic and lymphatic systems. Non-Hodgkin's lymphoma has been linked to phenoxyacetic acid herbides in several studies (Hoar et al, 1986; Wigle et al, 1990; Zahm et al, 1990), but this has not been a uniform finding in other studies. Non-Hodgkin's lymphoma has also been found to be elevated in one study of grain millers exposed to fumigants including phosphine and other insecticides (Alavanja et al, 1989), and in a second study of forest and soil conservationists (Alavanja et al, 1989). Insecticides and fungicides have been associated with increased farmers' cancer rates to non-Hodgkin's lymphoma (Zahm et al, 1990), leukemia (Flodin et al, 1988; Brown et al, 1990), and multiple myeloma (Boffetta et al, 1989; Cantor and Blair, 1984). A trend has been observed between leukemia and duration of exposure among agricultural extension agents (Alavanja et al, 1988). These studies are clearly important to our understanding of the etiology and prevention of these cancers among farmers and farm family members. These studies also have important implications for other occupational exposures

including their use in green houses, parks, and on golf courses – which has been recently documented by GPCAH investigator Burton Kross (Kross et al, 1996). Under the leadership of GPCAH investigator Charles Lynch, with sponsorship from NCI, NIEHS, NCEH/CDC, and EPA, University of Iowa investigators are now conducting the largest and most comprehensive investigation ever undertaken to assess the relationship between agricultural chemical exposures and cancer. This study, which includes farmers, farm wives and children, has now enrolled over 40,000 in the cohort with a target of enrolling at least 50,000 in Iowa for prospective follow-up over the next decade. This study will afford many opportunities to conduct case-control studies on other important health outcomes such as farm injuries, currently the subject of an R01 grant application to NIOSH from GPCAH investigator Nancy Sprince, neurologic disease, and respiratory disease, as well as many site-specific cancers and birth defects.

Acute and chronic adverse health effects from pesticide exposure on the nervous, renal, reproductive and respiratory systems have been observed among both farm men and women. Nephrotoxicity has been associated with both organophosphates and chlorinated hydrocarbons (Finn, 1983). Acute tubular necrosis, azotemia, and chronic interstitial nephritis has been found following acute poisoning from arsenic-containing insecticides (Fowler and Weissberg, 1974), and a number of adverse renal effects have been found following exposures to hexachlorobenzene, 2,4,5-T and TCDD (Hook and Serbia, 1982). A number of studies have demonstrated increased risk for acute and chronic renal disease following exposure to organic solvents (Finn, 1983; Churchill et al, 1983; Sandler and Smith, 1991), but there is little data to evaluate the risk of solvents as carriers of pesticides. Cohort studies of pesticide manufacturers and applicators have not adequately addressed the risk of death from renal disease, but the cohorts have been small and renal disease is often underreported on death certificates. Renal disease arising from exposure to agricultural chemicals is clearly an underinvestigated area. The Agricultural Health Study, through case control studies for renal cancer mortality, and the GPCAH Keokuk County Rural Health Study, for assessment of biomarkers of renal function, will both provide very good opportunities to more fully assess the risk to renal disease arising from agricultural chemical exposures.

Acute neurotoxicity of pesticides, especially from exposures to organophosphates, is well established (Ecobichon et al, 1990). In addition to acute health effects, it has now become clear that persistent neurotoxicity effects may be a sequelae of acute pesticide poisoning (Rosenstock et al, 1991). While epidemiologic findings are currently unclear, pesticides have also been proposed as etiologic agents for chronic neurodegenerative diseases including Alzheimer's disease, Parkinson's disease, and amyotrophic lateral sclerosis (ALA) (Tanner and Langston, 1990; Deapen and Henderson, 1986, Gunnarsson et al, 1992). Chronic exposures to pesticides have been linked to a number of clinical outcomes including reduced nerve conduction velocity, decreased sensory acuity, poorer neurobehavioral performance using standard test batteries, and non-specific symptoms including insomnia, mood alterations, and cognitive impairment. As was demonstrated by Rosenstock et al (1991), these adverse health effects can often be more easily observed in developing countries where more toxic pesticides are used, where exposures are often higher, and where environmental

controls are less often available or used. Recent studies of Costa Rican banana plantation workers by GPCAH investigator Laurence Fuortes and Alfredo Vergara support Rosenstock's findings (Vergara, 1993). Large cohort studies of chronically exposed agricultural workers like the Agricultural Health Study, with linkage to neurodegenerative disease registries, remain an unexplored yet very important research question for GPCAH investigators. Adverse neurobehavioral health effects are currently under investigation as part of the Keokuk County Rural Health Study and have been proposed for study as a part of the Agricultural Health Study.

Adverse reproductive and developmental outcomes have also been linked to agricultural chemical exposures. These have included menstrual cycle impairment from estrogenic properties of organochlorine and organopohosphate pesticides (Mattison, et al, 1990), increased rates of spontaneous abortion among pesticide exposed women (Rupa et al, 1991; Restrep et al, 1990), and a clear association with increased risk for still births (McDonald, et al, 1988). Data regarding low birthweight and prematurity is unclear. There is some animal data suggesting that some pesticides may retard fetal development (Mattison et al, 1990; Barlow and Sullivan, 1982), but good epidemiological data is not yet available. An ecological study by University of Iowa investigators observed low birthweights among women living in proximity and drinking water from Lake Rathbun, a reservoir known to be contaminated with agricultural chemicals, in southern Iowa (Munger et al, 1992). Other evidence of potential adverse developmental effects of pesticides come from studies of lactating women. An inverse relationship between duration of lactation and concentration of DEE, a stable degradation product of DDT, has been observed among North Carolina women (Rogan et al, 1987). A recent study by GPCAH investigator Laurence Fuortes on the impact of agricultural exposures on Iowa women presenting at the University of Iowa infertility clinic found occupational exposure in agricultural industries increased the risk of infertility seven fold (Fuortes et al, 1996). The Keokuk County Rural Health Study is currently studying the fertility and reproductive outcomes among farm men and women. Much of Keokuk County is served by water taken from Lake Rathbun and the rest from deep wells. This will allow the question of birthweight and exposure to agricultural chemicals from water supplies to be further evaluated. The Agricultural Health Study will utilize the Iowa Birth Defect Registry to evaluate birth defects and other developmental abnormalities as major health outcomes of this large cohort study.

Respiratory exposures to farmers and farm family members have been a major focus of GPCAH investigator initiated research. Significant exposures to organic dusts are the common denominator of respiratory exposure to agricultural workers. Studies of farm families in Iowa have documented that 80% of farm women, as well as a large proportion of children, are engaged in agricultural operations and therefore experience agricultural exposures (Merchant, 1994). In addition to organic dusts from a variety of vegetable products, farmers are commonly exposed to multiple insecticides, herbicides and fungicides which are frequently respiratory irritants and are occasionally known to cause pulmonary fibrosis (paraquat and silica) (Merchant, 1986). Other important respiratory exposures include animal danders and proteins, irritant gases, antibiotics commonly used in feeds, mites and other insects, and an array of microbial toxins including gram negative endotoxins and a number of mycotoxins (Reynolds and Merchant, 1994). Studies of swine, poultry, dairy, and grain farmers and handlers by

GPCAH investigators have documented increased rates of chronic bronchitis, asthma, and functional declines in expiratory flow rates over a work shift compared to non-farm blue collar workers (Donham et al, 1990a; Donham et al, 1990b; Schwartz et al, 1992; Marx et al, 1993; Reynolds et al, 1993). GPCAH investigator David Schwartz and colleagues have documented dose-response relationships between grain dust and endotoxin exposure, and cross-shift declines in FEV1 have been observed, as has longitudinal loss in lung function in association with cross-shift declines in lung function among swine confinement workers (Schwartz et al, 1992). Evaluation of the first 400 households from the Keokuk County Rural Health Study has already documented significantly more work-related respiratory symptoms and interaction between pack years and farm residence associated with poorer lung function among farm men and women (Merchant et al, 1996). Evaluation of specific risk factors within this 1000 family cohort will be the target of cross-sectional and prospective evaluation of lung function over the next five years. Case control studies regarding asthma and airway hyperresponsiveness will be important priorities. The Agricultural Health Study also provides a unique opportunity to evaluate exposure to agricultural chemicals and pulmonary mortality.

Rural Americans are known to have a significantly higher combined unintentional injury mortality rate (60/100,000) than Americans living in the largest cities (37/100,000) (Baker et al, 1992). Much of this increase in rural injury incidence is related to motor vehicle crashes, and is inversely related to population density and per capita income (Baker et al, 1987; Maio et al, 1992). A number of factors are likely to be responsible for these findings. These include higher travel speeds in rural areas, poorer roads, less seat-belt use, more use of high-risk utility vehicles, travel in open pick-up trucks and recreational/farm vehicles, and poorer access to trauma care (Baker, 1992; Maio et al, 1992; NAS, 1985). Farmers and farm family members, especially children and the elderly, are at significant risk to farm-related injuries (Merchant et al, 1988; Merchant, 1991). The National Safety Council (NSC) has consistently found farm resident deaths to be elevated. NSC has adopted the Bureau of Labor Statistics' Census of Fatal Occupational Injuries (CFOI) fatality figures beginning with the 1992 data year. Most recently (1994) the death rate in agriculture was 26/100,000 compared to 4/100,000 in all industries (National Safety Council, 1995). The high rate in agriculture is related to both increased injury risk from farming and rural living. Death certificate-based surveillance, that likely underreport farm fatalities (NIOSH, 1993; Kraus et al, 1990), the NIOSH National Traumatic Occupational Fatality Register (NTOF), found agriculture consistently among the four most dangerous industries, along with mining, construction, and transportation. Morbidity studies have shown that exposure to farm machinery and animal handling constitute the two major risks to farm family members, that farm injuries are often multiple and severe and result in substantial disability (Merchant, 1991; Fuortes et al, 1990). Other important causes of increased injury mortality among farm families relate to residential fires, suicide and unintentional firearm deaths (Runyan et al, 1992; Gunderson, et al, 1993). All of these agricultural and other rural injuries and risk factors are being studied in detail in the Keokuk County Rural Health Study, and in several other studies by GPCAH investigators.

In summary, farmers and farm family members are more often poor, are at significantly increased risk to a number of agricultural and other rural environmental

hazards and exposures, have poorer access to health care providers, and generally have poorer health outcomes than Americans living in urban areas. These findings have been extensively documented and confirmed in a comprehensive report on rural health care in Iowa authored by GPCAH Director James Merchant and colleagues (1994). Farmers, farm family members, children, the elderly and the poor are at particular risk to agricultural and other rural diseases and injuries. While Iowa is but one rural state, it has the highest density of farm families of any state in the union, and provides through perhaps the nation's best health databases, an excellent opportunity to study relationships between agricultural exposures and health outcomes. GPCAH investigators have provided national leadership in the identification, assessment and remediation of multiple agricultural exposures through presentation and publication their research.

Great Plains Center for Agricultural Health

Training, Education, and Outreach Projects

A. Background and Need

The University of Iowa has developed a strong training, education, and outreach program in agricultural safety and health (ASH). The University of Iowa organized the first specialized institute for agricultural health and safety in the western hemisphere (the Institute of Agricultural Medicine) in 1955. Now renamed the Institute for Rural and Environmental Health, it has been a long-standing leader on the issues of agricultural health and safety in the state of Iowa, the region, the nation, and internationally. This Institute has had a major influence in policy regarding agricultural safety and health. In 1988, the faculty of the Institute designed and hosted a series of conferences and follow-up activities that shaped the public health policy in agricultural occupational health, resulting in agricultural health initiatives by NIOSH (about 24 million dollars annually) and the W.K. Kellogg Foundation (5 million). The 1988 conference "Agricultural, Occupational, and Environmental Health: Policy Strategies for the Future," directed by Dr. Kelley Donham produced a seminal report, *Agriculture at Risk: A Report to the Nation* (Merchant et al., 1989). This report was based on a consensus process of 170 national and international leaders in agricultural health and safety. Among several specific policy recommendations, was a strong recommendation for training programs for health professionals in agricultural health and safety.

A needs survey in 1982 (Donham and Mutel, 1982) revealed the complete lack of specific training programs in agricultural occupational health and safety in the US, outside of that initiated at The University of Iowa in 1974 (the first such program in the US). This result was disconcerting, given the large size of the agricultural work force and the high rates of health and safety problems in this industry. The 1990 census revealed over 3 million persons with income from over 2 million farms where 6 million family members reside and an additional 2.7 million (documented) hired workers are employed. This represents at least nine million exposed persons, plus many more unreported or undocumented workers. Death rates from agricultural injuries are recorded at 29 per 100,000, more than eight times the overall national average of 3.5 per 100,000 (National Safety Council, 2006). These data include only injuries. There is relatively little information on other health concerns. However, surveys of individual agricultural industries, such as swine and poultry production, reveal nearly 30 percent of the workers experience chronic respiratory disorders (Donham et al., 1995, 1990; Reynolds, 1996). The *Agriculture at Risk* report further reveals that the agricultural population experiences increased skin diseases, excesses of certain cancers, noise-induced hearing loss, chronic musculoskeletal disease, pesticide and other toxic exposures, and 24 different environmental infectious (zoonotic) disease hazards. Recently, mental health issues also have been recognized as a concern (Thu et al. 1997).

In 1997, OSHA levied its highest fine ever for occupational health and safety violations. A five million dollar fine was issued to a large industrial-style poultry production company for gross violations in hazardous exposures. Although settled out of court for something less than the fine, the case was precedent setting. The number of large-scale agricultural operations of 100 or more employees is growing fast, and there are simply not enough agricultural health specialists to meet this growing need, let alone the large unmet need for the health and safety of smaller family operations. The need for agricultural health and safety training and education is clearly expressed in the following documents:

- "Agricultural Medicine: The Missing Component of the Rural Health Movement" In the mid-1970s, there was a growing initiative to place health care professionals in rural areas. However, there was little effort to train them about specific rural health problems, such as agricultural occupational health. A national survey of medical colleges confirmed this suspicion: there were no programs in the U.S. for training health professionals in agricultural medicine (Donham and Mutel, 1982).
- Agriculture at Risk Conference. This conference established a policy for actions to correct the "epidemic" of deaths, injuries, and illnesses in agriculture. Of the 90 specific recommendations, participants ranked the training of health professionals in agricultural medicine as one of the most important. Additionally, a need was cited for industrial hygienists trained in agricultural medicine. There is a great need for providing training in agricultural safety and health to those practitioners who provide health services to the agricultural community.
- Agricultural Occupational Health Nursing. The success of Scandinavian occupational health services for farmers, and the obvious need for such services for U.S. farmers was the inspiration for a new pilot program in Iowa, which began in 1987 (Gay and Donham, 1990). This program has grown from a two-clinic pilot to more than 22 clinics across the state which have organized as the Iowa AgriSafe Network. This service system, unique to the U.S., offers a full complement of preventive services to the agricultural community, including clinical preventive screenings (e.g. pulmonary function and hearing testing, skin cancer screening, occupational exposure assessment, and remediation consultation.

GPCAH carried out an outreach feasibility study in 1996 (Rautiainen et al., 1996). Respondents (n=219, 39% response rate) represented extension (21%), health care providers (32), FFA (20%), 4H (10%), and other interest groups (16%). The majority (82%) responded that farmers need more information on health and safety; 51% would increase their activity in health and safety promotion with the support of a new resource center and outreach network. Information on a wide variety of topics is needed. Fact sheets (64%), videos (57%), and displays (43%) were most popular materials. 1-day training (48%), evening courses (31%) distance education (31%), mailed materials (30%) and the Internet (22%) were suitable forms of education. The results indicate that the Center's leadership in coordinating outreach activities is needed. The results have been used for planning the Centers outreach activities.

B. Goals

The GPCAH training, education and outreach program goals have included graduate training in agricultural safety and health, enrichment training for health and safety professionals who serve the agricultural community, continuing education through training courses, information sharing through conferences, development of educational resources, and outreach to the agricultural community in collaboration with other organizations. Following are the specific aims of the Center's training, education, and outreach programs during the three funding cycles.

1990-1996 goals for training, education, and outreach:

1) Expand the capacity for graduate student education
2) Refine and expand the post-graduate training program
3) Conduct train-the-trainer programs
4) Develop Educational Modules
5) Farm Safety 4 Just Kids Chapter Development

1996-2001 goals

Training:

1) Provide graduate student education in agricultural and rural health and safety.
2) Provide training in agricultural and rural health and safety research.
3) Train researchers in agricultural health and safety at the post-doctoral level.

Education and outreach:

1) Provide continuing education in agricultural health and safety to primary care physicians, practitioners, veterinary students, and other interest groups in Federal Region VII.
2) Provide outreach services to professionals who are in frequent contacts with the farming population and have an interest in promotion of health and safety.
3) Provide technical assistance and consultation to GPCAH investigators in dissemination of information and delivery of services produced through other core activities.
4) Implement an agricultural occupational health nurse education/certification program;
5) Implement a short course training for primary care physicians, veterinarians, and students;
6) Develop educational materials, including a textbook for health professionals in agricultural medicine;
7) Support Farm Safety 4 Just Kids chapter development, leadership conferences, and safety competition;
8) Clearinghouse - Developing, implementing, and evaluating and information dissemination model for the Great Plains Center for Agricultural Health.

2001-2006 goals

Training:

1) Increase the quantity and competency of healthcare and occupational health practitioners in the knowledge and practice of agricultural health and safety;
2) Increase the quantity an competency of researchers in agricultural health and safety;
3) Produce new leaders in the field of agricultural health and safety.

Education and Outreach:

1) Communicate to the region and the nation, current information and trends in ASH, and the activities, progress, and outcomes of GPCAH research,
2) Enhance the opportunity for undergraduate collegians to choose ASH as a field of study,
3) Extend to the region and nation three proven programs developed in Iowa: 1) the AgriSafe Network, 2) Certified Safe Farm, and 3) the Agricultural Occupational Health Certification Program;
4) Facilitate competency of teachers and organizations in the region and nation to deliver ASH education to health and safety professionals.

C. Inputs

The budgets for the training, education and outreach projects are presented in the attached database.

Supplemental funding was secured for the Agricultural Occupational Health Nurse Training and Certification Program from the National Office of Rural Health Policy (H.H.S.) The Outreach Grant was secured to expand training for nurses who will set up preventive agricultural occupational health clinics in their regions. This $360,000 grant is held in cooperation with the Coordinator of the Iowa AgriSafe Network, Carolyn Sheridan (Spencer Hospital in Spencer, IA).

The primary staff for the training, education, and outreach projects have included:

Kelley Donham, M.S., D.V.M.
Nancy L. Sprince, MD

Burton Kross, Ph.D.
Risto Rautiainen, PhD
Barbara Pies, MS
Lois Burkett
Risa Lumley
Kay Mohling
Julia Venzke, MLS
LaMar Grafft, MS
Farm Safety 4 Just Kids staff (described in the childhood injury prevention section)

The primary facilities used for the training, education, and outreach programs include The University of Iowa's Institute for Rural and Environmental Health, other University of Iowa teaching and training facilities, and Farm Safety 4 Just Kids head office in Earlham Iowa, and their national network of chapters (described in the childhood injury prevention section).

D. Activities

Training, 1990-1996.
The Training component of the Training and Education Core has been an active part of the Great Plains Center for Agricultural Health (GPCAH) since year 01 of Center funding. The Training and Education Core expanded the capacity for graduate student education.
The Center awarded stipends and tuition support for graduate students focusing on agricultural health and safety. The supported students had to fulfill curriculum requirements and carry out a research project in agricultural safety and health, in association with core faculty from the GPCAH. A needs assessment (focus groups and survey) was conducted in order to evaluate, review, and improve the graduate program. Recommendations were used to update and improve the curriculum and overall graduate program. Recruitment plans were developed to attract students with an interest in agricultural industrial hygiene, rural environmental health, and applied ergonomics. Graduate course 63:209, "Agricultural Medicine and Rural Health" was updated and condensed during year 1992.

Progress of the GPCAH training program has been evaluated favorably by both the Internal and External Advisory Committees. The program has had success in providing education in agricultural and rural environmental health and safety at the graduate level to a substantial number of students. As measured by relevant completed theses, presentations, and publications, this group of graduate students show promise for productivity in this field. In addition, numerous educational programs and lectures on topics in agricultural and rural environmental health and safety have been given by GPCAH faculty and graduate students.

Education and Outreach, 1990-1996. The Great Plains Center for Agricultural Health provides outreach services in the Federal Region VII (Iowa, Nebraska, Kansas, and Missouri). Dr. Donham, working with Iowa State University, has developed and taught education components for two major courses in the curriculum of the Veterinary College in Ames, Iowa. The first level of training is with second year veterinary students, as a part of their Preventive Medicine course. This three-hour lecture series is called Agricultural Occupational Medicine for Veterinarians. The entire class of 90 students receives this overview of agricultural occupational safety and health and the veterinarians' role and responsibility in prevention. The second component of veterinary training is for fourth year students specializing in livestock production practice. The occupational hazards of livestock production are emphasized. Lectures supplemented with a field laboratory (visits to actual livestock production farms) are used to teach these students

about basic industrial hygiene techniques and equipment to assess the environment and control hazardous occupational exposures. The results are discussed in class and a report is sent to the owner, as a group project.

The Center has developed two community-based intervention models: 1) TRAC-SAFE (Tractor Risk Abatement and Control), A Community-Based Program for Reducing Injuries and Deaths Due to Tractor Overturns, and 2) Facilitator's Guide for the Swine Confinement Respiratory Health Project. The facilitator's manual for TRAC-SAFE was first published in Iowa and the region; 575 copies were disseminated. TRAC-SAFE was published nationally by NIOSH (Lehtola and Rautiainen, 1995); 6,000 copies were printed for dissemination. TRAC-SAFE activates the community to encourage installation of rollover protective structures (ROPS) on tractors. The TRAC program encourages participating owner-operators to sign a pledge to inspect their tractors, install ROPS on at least one tractor, enforce no-rider policy, assure youth under 16 years of age have proper training for tractor operation, and participate in first on the scene training. This program, piloted in Northeast Iowa was very successful. The local John Deere dealer was one of the active partners. TRAC-SAFE enabled that dealer to install approximately ten times more ROPS than other dealers in Iowa.

A similar community-based program was produced for prevention of respiratory illness in swine producers (Olson et al, 1994). The Facilitator's Guide for the Swine Confinement Respiratory Health Project is a community intervention guide, designed to facilitate environmental assessment of swine facilities, achieve a control plan to reduce exposures to meet maximum recommended exposures, and monitor respiratory health. This program has been extensively evaluated and shown to be effective in increasing producers' knowledge and attitudes toward prevention, and has resulted in significant behavior change relative to hazard reduction.

The Center outreach activities have included co-hosting regional agricultural health and safety conferences in collaboration with the Marshfield Center. GPCAH hosted two conferences in Iowa City on June 28-30, 1992, and November 13-15, 1994. Both of these conferences reached over 100 health and safety professionals in the region. In 1996 (March 24-26, 1996) the regional conference was held concurrently with The Third NIOSH Agricultural Health and Safety Conference in Iowa City. This conference was well attended by 214 participants who made 70 oral presentations and 48 poster presentations. The Journal of Agromedicine published a special proceedings edition which included over 40 manuscripts. Dr. Donham and Mr. Rautiainen were co-editors. The NIOSH conference presented the latest research, surveillance, training and education projects carried out by the centers, OHNAC nurses, Farm Family Health Hazard Survey grantees, Fatality Assessment and Control Evaluation (FACE) programs, and W.K. Kellogg funded projects. The conference also included an International Panel, which had overview presentations form agricultural health and safety programs from Finland, Sweden, Norway, Denmark, Germany, The Netherlands, England, Canada, and Australia.

The Center co-hosted an International Workshop on Agricultural Health and Safety on March 27-29, 1996, in conjunction with the Third NIOSH Agricultural Health and Safety Conference. Representatives for the above mentioned countries, and Romania, as well as US representatives from NIOSH, the NIH Fogarty International Center, and most NIOSH agricultural centers had constructive discussions on three major topics: research collaboration, information exchange, and training collaboration. Several collaborative projects have been initiated based on the workshop discussions.

GPCAH outreach activities have included several child safety initiatives which are described in a section entitled: Childhood Agricultural Injury Prevention Projects.

Training, Education and Outreach, 1996-2001. The Training and Education and Outreach Cores provided support for graduate students, developed the Agricultural Occupational Health Professional Certificate Course, and provided medical education for family practice programs.

The GPCAH worked with FS4JK to help develop their network of chapters. A clearinghouse was established for agricultural health and safety education materials. The Center hosted several conferences and workshops in agricultural safety and health. A major objective of the Center during was to provide research training in agricultural health. Twelve graduate students received support to work with core directors on agricultural health and safety research projects. Following are examples of Training, Education, and Outreach programs conducted during this time period:

Development and Implementation of an Agricultural Occupational Health Nurse Training and Certification Program. An Agricultural Occupational Health Nurse Training and Certification Program course syllabus was developed and the 40-hour course is given annually in two sessions. We have had attendees from Iowa, Nebraska, Wisconsin, Illinois, Texas, and Virginia. The backgrounds of the persons taking the course include nurses, physicians, emergency medical technicians, physician assistants, nurse practitioners, and respiratory therapists. A total of 110 students have completed the training and all but one have taken the required examination. They had the option of receiving 40 hours of CEU's and/or two (2) graduate credit hours from The University of Iowa. A total of 109 students have become certified as agricultural occupational health professionals. These healthcare providers represent rural hospitals, rural health clinics, and rural county health departments. They are in the process of establishing agricultural health clinics, with a potential of 36 total clinics. The activities of these clinics have included health screenings at the annual meetings of the Farm Bureau, the Pork Producers, and the Cattle Producers. These clinics provided full clinic screenings of farmers with occupational health consultations, and community education programs. Supplemental funding was secured for this project from the National Office of Rural Health Policy (H.H.S.)

Development and Delivery of Short Courses for Practicing Physicians in Federal Region VII.
The establishment of an agreement with The University of Iowa Department of Family Medicine on resident and outreach training has progressed. Additionally, excellent progress has been made with the network of Family Practice Residency Programs in the state. There are nine such programs, all of which are positioned to host Visiting Professors in the area of Agricultural Medicine. This includes traveling to the various program sites periodically; presenting lecture/discussions to the resident physicians and community physicians, and discussing recent cases they have had regarding agricultural medicine.

Develop Comprehensive Educational Materials and a Textbook on Agricultural Medicine for Health Professionals. An outline of the book contents was prepared and provided to possible publishers. Agreement was made with Blackwell publishing. GPCAH outreach supplement helped Dr. Kelley Donham Dr. Anders Thelin to complete the textbook entitled, Agricultural Medicine: Occupational and Environmental Health for Rural Health Professionals. This 410-page text was released May 2006.

Clearinghouse - Developing, implementing, and evaluating an information dissemination model for the Great Plains Center for Agricultural Health. The primary funding source for the Clearinghouse project was the NIOSH Community Partners for Healthy Farming Intervention initiative. This three-year project funding ended at the end of the 98/99 fiscal year. The GPCAH has provided staff support for the Clearinghouse project and continues to carry out the Clearinghouse function as part of the Education and Outreach Core for the remaining GPCAH project-funding period. Overall the response from the community has been very positive showing the need for a link between university-based research programs and the educators in the community.

Contract with Farm Safety 4 Just Kids (described in: Childhood agricultural injury prevention programs)

Outreach projects, 2005. In 2005, GPCAH implemented several outreach projects with supplemental funding, described briefly below.

The GPCAH started capturing and reporting agricultural injury information from press clippings under a feasibility project during the fall of 2002. A summary (electronic) record is created for each incident. On average each year since then, over 110 fatalities and over 100 non-fatal injuries were identified. In 2005, 129 fatalities and 115 non-fatal injuries were recorded. During 2005, as for each of the previous two years, both the fatal and nonfatal incidents reported in press clippings were dominated by "tractors, ATVs, and other machinery", which typically represent 2/3 of all incidents reported in press clippings. Other injuries were associated with livestock handling and grain, silage, or manure storage and handling.

FS4JK highlighted ATV safety at the 2004 national FFA convention. More detail in: Childhood agricultural injury prevention projects.

The University of Missouri Extension service provided in-depth 3-day train-the-trainer workshops for seven regional extension specialists. These workshops focused on how to teach youth age 12 through 16 about safe ATV riding techniques and operating practices. Safe use of ATV's in agriculture was given special emphasis, including loading and unloading ATVs, towing ATV-powered implements, and using ATVs with attached equipment such as sprayers and blades. The workshops consisted of both classroom and hands-on instruction led by a certified ATV Safety Institute instructor using materials from the national 4-H Community ATV Safety Program, the ATV Safety Institute, and FS4JK. Over 1000 youth who visited the University of Missouri Extension area at the Western Farm Show learned more about ATV safety.

GPCAH outreach supplement funding supported participation for a farm first aid instructor in each of North Dakota State University Extension's programs on tractor safety. Overall, four schools were conducted with a total of 48 youth in attendance; 12.5% were female.

Outreach supplement funding has also made it possible for Dr. Kelley Donham and co-author Dr. Anders Thelin to complete their textbook entitled, Agricultural Medicine: Occupational and Environmental Health for Rural Health Professionals. This 410-page text was published by Blackwell and released May 2006.

Collaboration between the AgriSafe Network of clinics and the GPCAH is a model for translating research to practice. Three AN clinics leveraged outreach supplement funding in their communities to provide innovative programs for recruiting farmers and changing their behaviors. In Humbolt County the AN clinic provided pulmonary function testing and recommended personal protective equipment. Twenty-nine farmers completed pulmonary function testing (PFT) and seventy-six fully participated in the education series. Of those completing the PFT, four had poor results and were immediately referred. The Floyd Valley AN clinic provided PFT and Dermascan screening at their county fair: thirty-five farmers participated. Every farmer that received the Dermascan screening had signs of sun damage.

The University of Illinois and Carle Clinic have revised materials by the University of Illinois (Chicago) Great Lakes Center for Occupational and Environmental Health for the agricultural

confined space training short course to make it more attractive in our Region as a one-day session. The plan is to arrange and promote train-the-trainer workshops in each of the Region's states by March 2006. The revised workshop curriculum addresses the issues important to workers safely entering and working in confined spaces. The primary audience as identified through various organizations and associations is owners, supervisors, and workers of small businesses that service agricultural confined spaces such as silos, grain storage structures, and manure storage facilities. The current expectation is to train at least 25 trainers in each state of our Region.

E. Outputs

The training, education, and outreach efforts of the GPCAH have produced numerous publications, presentations and products, which are included in the Appendix.

Training, education, and outreach 1990-1996. The Center provided support for graduate students through stipends and tuition support. Highlights of achievements of this training program for this time period follow:

- 30 graduate students have received or are receiving tuition and/or stipend support
- 12 graduate students have received M.S. degrees
- 2 graduate student have received the Ph.D. degree
- 12 graduate students are working towards their M.S. degree
- 6 graduate students are working towards their Ph.D. degree
- 10 Master's and 2 Ph.D. theses have been completed on topics relevant to agricultural and rural environmental health
- Supported graduate students have a record of more than 50 publications or presentations
- Graduate course 63:209, "Agricultural Medicine and Rural Health" was updated and offered to veterinary students at Iowa State University

Examples of completed theses are the following: A Descriptive Epidemiological Study of Injuries in Farm Children of Iowa, Pesticide Exposure Assessment among Agricultural Workers, Farming as a Risk Factor for Female Fertility, Field Validation Studies for Assessment of Bioaerosols in Agricultural Buildings, Agricultural Injuries in Banana Plantations in Costa Rica, and Development of a Murine Model for Endotoxin and Corn Dust-induced Airway Inflammation. Theses in progress include an assessment of Respiratory Hazards in Poultry Production Workers and Agricultural Bioaerosol Assessment Methods.

The Center's outreach outputs during this time include:

- Agricultural rescue workshop in Mt. Pleasant, Iowa. Seventy emergency services personnel representing fourteen rescue units participated in this four day workshop.
- Dr. Kelley Donham, Dr. Burton Kross, and Gayle Olson conducted "train-the-trainer" activities. Numerous presentations were given to audiences such as environmental health professionals, farmers, agricultural educators, physicians, nurses, veterinarians, and environmental scientists through continuing education programs and presentations to professional conferences, seminars, and meetings.

Training, 1996-2001. The highlights of the 1996-2001 funding period include the following training, education, and outreach activities:

- Twelve students (8 M.S. and 4 PhD) received graduate research assistantships for agricultural health research training.
- A well-defined continuing education course was developed (the Agricultural Occupational Health Professional Certificate Course). This 40 hour course was initially

designed for nurses but now been broadened to include physicians and other health care practitioners, and an exam-based certificate process has been instituted.

- A continuing medical education program in agricultural medicine was developed for the nine family practice programs in the state. These programs are now offered a lecture series in Agricultural Medicine, so that all programs will have received a complete curriculum in agricultural medicine over the three years of each resident‘s training period.
- The GPCAH worked with FS4JK to help them develop their network of chapters, which grew to 139 chapters in 33 states and four Canadians provinces. We worked with FS4JK on several other programs, including the initiation of a safety contest with Successful Farming magazine (more detail in: Childhood agricultural injury prevention projects).
- A clearinghouse was established for agricultural health and safety training materials, and a 300-page catalogue (as well as electronic version) of well over 5,000 entries. This was well received, and over 1000 copies were disseminated.
- In 1996, GPCAH investigators started the Certified Safe Farm program, which was delivered by the AgriSafe Network in Iowa and the University of Nebraska Medical Center in Nebraska. This program stimulated the demand for training of nurses in the region and beyond. Up to 2001, we trained 110 agricultural occupational health nurses in Iowa and 12 nurses in Nebraska, Virginia, Wisconsin, Illinois and Texas.
- A national task force was established by Dr. Donham to develop a national standard for this program: to define subject matter, methods of delivery, and methods of training (Donham and Venzke, 1997).
- Regional Workshop in Agricultural Health Training, Resource Development, and Agricultural Occupational Health Services Delivery was held on March 5, 1999 at The University of Iowa. Prominent health and safety professionals from Kansas, Nebraska, Iowa, Minnesota, and Wisconsin worked in an information and consensus process for an entire day. The outcome resulted in a detailed description of training needs, delivery of occupational services to farmers, and training materials needed.
- GPCAH held the Central States Agricultural Health Conference in Kansas City, September 21-23, 2000. The conference continued the dialogue regarding needs for training, training material and needs for delivery systems of agricultural health services. Essential consensus points that came out of this meeting included the need to work collaboratively on development of a core curriculum for health professionals in agricultural health. Furthermore, the group recognized the need for ASH training to new groups that may impact the agricultural community, noting especially parish nurses. Development of distance learning modalities for ASH training was also recognized as a need. Furthermore, there was a call from participants for our center to regularly hold regional conferences in ASH. Finally, there was a call to provide training for development and expansion of our specialized network of agricultural occupational health clinics (AgriSafe).
- GPCAH had a strong participation in the March 1-3, 2001, Baltimore, Maryland, conference entitled, “Using the Past and Present to Map Future Action.” An entire breakout session was held on training and agricultural occupational health services delivery. Papers by Wheat et al, 2001, and Erisman, 2001, supported strongly the recommended needs for training of health care providers in ASH and the need for specialty delivery of ASH services.

A major objective of the Center during 1996-2001 was to provide research training in agricultural health. Twelve graduate students received support to work with core directors on agricultural

health and safety research projects. Following is a list of the students and their research projects:

- Chris Conrad: “Field Evaluation of Respirator Protection for Ammonia in Agricultural Environments”
- Erik Svendsen: "Keokuk County Rural Health Study”
- Jill Gassman: "Causative Agents in Organic Dust-Induced Lung Inflammation”
- Risto Rautiainen: “Occupational Disease and Injuries in Farmers in Finland”.
- Jeremy Slagley: “Environmental Assessment of Air Contaminants Emanating from Large Scale Swine Production Facilities” and “Comparison of Aerosol Photometer Response When Exposed to Atmospheres Containing Aerosolized Inorganic (silica) and Organic (grain dust) particles”.
- LaMar Graft: “Emergency Medical Response to Flowing Grain Injuries in Agriculture”.
- Joung Ae Lee: “Evaluation of Health and Environmental Exposures Among Residents of Three Hog Producing Regions, Varying in Density and Methods of Production”.
- Martin Jones: “Exposure Assessment in the Farm Family Health Hazard Surveillance Study”
- Stacey Hearne: “Generation of Grain Dust Aerosol in Support of Inhalation Toxicology Research Related to the Occupational Hazards Associated with Grain Elevators”.
- Zane Nelson: “The Time Varying Nature of Airborne Contaminants and Environmental Conditions in a Swine Confinement”.
- Alba Quinones: “Migrant Farmers in Iowa and Their Exposure to Occupational and Environmental Hazards-Assessing Health Needs and Policy”.
- Katarina Kulhankova: “Endotoxin Evaluation In House Dust as Part of The National Lead, Allergen and Endotoxin Survey in Housing”.

<u>Education and Outreach 1996-2001</u>

GPCAH education and outreach core has provided occupational health certificate courses annually. Following is a list of the courses during 1996-2001, including numbers of students who completed the courses.

- 1998, Session 1 April 28-29; Session 2 June 17-18. 28 students.
- 1999, Session 1 May 18-20; Session 2 June 29-July 1. 19 students.
- 2000, Session 1 May 17-19; Session 2 June 21-23. 28 students.
- 2001, Session 1 February 21-23, 2001; Session 2 April 18-20, 2001. 25 students.

GPCAH has provided short courses on agricultural medicine. Following is an example of courses presented during 1998 - 2001:

- Iowa Lutheran Hospital, Des Moines, Iowa, 11/5/98
- Covenant Memorial Hospital, Waterloo, Iowa, 11/11/98
- Sioux City Hospital, Sioux City, Iowa, 11/20/98
- Sioux City Family Practice, Sioux City, IA, 2/6/99
- Waterloo Family Practice Program, Waterloo, IA, 3/5/99
- Des Moines, Iowa Lutheran Hospital, 3/11/99
- Sioux City Family Practice, Sioux City, IA, 4/13/99
- Davenport Family Practice Program, Davenport, IA, 5/7/99
- Des Moines, Iowa Lutheran Hospital, 9/23/99
- Broadlawns Hospital, Des Moines, IA, 12/15/00
- Iowa Lutheran Hospital, Des Moines, IA, 1/8/01

The Clearinghouse project published a resource catalog: Educational Resources in Agricultural Health and Safety (Pies et al, 2000). This catalog contains a listing of 4,316 agricultural health and safety materials and contact information for 230 publishers of these materials. The catalog was mailed to 3,491 local representatives of health care, public health, agricultural extension, FFA and agribusiness, as well as publishers and national experts. A quantitative analysis of the materials was conducted (Rautiainen et al., 1996). A series of farm chemical safety materials for farm women and children was published as part of the project. The series won the National Safety Council Youth Activities Division award in 1998. The materials consist of Pat the Environmental Rat Visits the Farm - A Coloring and Activity Book on Pesticide Safety, tablemat, and an instructor manual. The materials are available from the Clearinghouse, Farm Safety 4 Just Kids and the National Education Center for Agricultural Safety.

The Clearinghouse project identified community leaders and educators in the region. Address information for 5,831 contact persons, 3,076 of them in the Federal Region VII, were been entered into a database. A cover letter, program brochure, resource catalog and a return card were mailed to the regional contact persons, publishers, and national experts in September of 1999. These materials introduced the Clearinghouse services including web addresses and the toll free line 1-877-611-4971. More than 350 return cards (10%) were received. The card included questions for evaluation. Over 99% of the respondents expressed that the resource catalog has been useful for them. Over 97% of the respondents expressed that they want to remain on the community partner mailing list.

F. Outcomes

The “Agriculture at Risk” conference in Iowa in 1988 had a major impact on the development of agricultural health and safety policies and programs in the US. The University of Iowa investigators were instrumental in organizing this conference, which initiated the NIOSH agricultural safety and health program and moved the field forward. GPCAH was funded in 1990 as one of the two original Agricultural Centers. Many of the Agriculture at Risk leaders (Drs. Donham, Merchant, Kross, Ms. Marilyn Adams) have served in key roles in the GPCAH till present. They have also made an important impact in the development of training, education, and outreach activities of the GPCAH.

The GPCAH has become a well recognized resource in agricultural health and safety education in the Federal Region VII, and the nation. The Center’s training program has prepared many of today’s agricultural health and safety leaders with knowledge and skills to make an impact through their organizations, reducing the burden of agricultural injury and illness in the agricultural community.

Nationally, the agricultural fatality statistics have not developed as favorably as hoped. However, in Iowa the agricultural fatality and non-fatal injury statistics, collected by the Iowa Department of Public Health in 1990-1999, showed a decreasing trend. The GPCAH, FS4JK, Iowa’s Center for Agricultural Safety and Health, National Education Center for Agricultural Safety, Iowa State University, Iowa Farm Safety Council, and many other organizations have jointly provided education and outreach to farmers. It is likely that farmers in this state have received more safety information than farmers in many other states. It is not clearly demonstrated whether educational programs in general reduce farm injuries. No attempts have been made to evaluate the effectiveness of the GPCAH outreach, or the other organizations. However, the fact that the increasing level of farm safety education and the decreasing trend in farm injuries occurred simultaneously is encouraging. It appears to support the hypothesis that increased education leads to decreased injury rates, although this hypothesis is not verified.

Following is a summary of specific outcomes of the GPCAH training, education, and outreach programs:

1. Establishment of Agricultural Health and Safety as a recognized academic area of study. Prior to the beginning of this education and outreach program, there were no recognized programs of study in this area. The first such program was developed at the University of Iowa, and now there is opportunity for an MS or PhD in this field, as well as a certificate. This program will provide researchers and leaders to carry on activities in the future in agricultural safety and health.

2. Facilitation of agricultural health and safety training at other NIOSH Agricultural Health Centers. The GPCAH education and outreach program worked with health and safety professionals at the University of Illinois and the University of Kentucky. Professionals from both programs came to the University of Iowa for training, and took our certificate course in agricultural occupational safety and Health. We then continued consultation with these programs, helping them to attain approval at these institutions. This is a very classic train the trainer program.

3. Development of a consensus curriculum/subject matter for the academic study area of agricultural health and safety. A series of conferences was held with academicians in the field of agricultural health to develop the components of a standard curriculum for agricultural safety and health. This consensus curriculum is now available to help other programs around the country to establish training in this area.

4. Production of the first text book in agricultural medicine. Using the consensus curriculum as a guideline, a new textbook has been produced and published (May 2006) which provides a tool for health and safety professionals in industrialized countries around the world to develop courses and training programs in agricultural health and safety.

5. Development of the first specialized agricultural occupational health and safety service program in North America. The GPCAH education and outreach program has helped develop the AgriSafe Network which provides specific occupational health services for farmers. Designed and founded at the University of Iowa, the Agrisafe Network is a not-for-profit organization with some 25 community based clinics in Iowa and Illinois with new clinics scheduled to open in Wisconsin, South Dakota, Missouri, and Kansas.

6. Founded and developed the Farm Safety Day Camp Program. Although there may have been similar demonstration projects put on in the past, an organized program which we named "Farm Safety Day Camp" was developed as a program of the AgriSafe Network. The first manual was developed by nurse coordinator Jane Gay and nurse clinic director Pam Dellagadelle. With funding from Wellmark Foundation, the second version of the Farm Safety Day Camp manual was developed by AgriSafe Network, led by Carolyn Sheridan. She then worked with Progressive Farmer Magazine to develop the not-for-profit Progressive Agriculture Foundation which coordinates Progressive Agriculture Safety Days. This program is one of the most widely delivered farm safety programs in the world.

7. Facilitation of the development of Farm Safety for Just Kids. The GPCAH education and outreach program worked with Marilyn Adams in the very early days of her organization, FS4JK. NIOSH funding and collaboration with GPCAH were instrumental in establishing

the FS4JK network of chapters and the development, implementation, and evaluation of FS4JK programming.

8. Facilitation of AgriWellness. The education and outreach program worked with Dr. Michael Rosman to develop the concept of an organization that would attend to the mental and behavioral health of the farming community. This program is now a not-for-profit organization that conducts education and outreach services to the farming community primarily in the upper Midwest region of the US.

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Great Plains Center for Agricultural Health

Intervention Projects

A. Background and Need

Injuries and Illnesses. In 2005, agriculture had the highest occupational fatality rate in the US (29/100,000 workers per year); a rate that has remained relatively unchanged during the past decade (National Safety Council, 2006). Non-fatal injury rates are not well documented but have been variously reported as 0.5/100 to 42/100 per year depending on the source (McCurdy and Carroll, 2000; Hard et al., 2002; Rautiainen et al., 2004). Farmers experience 15% of work-related deaths, yet comprise less than 2% of the United States workforce. Worker's compensation premiums are 1.3-4.1% of the payroll for most industries, but are 2.8-16.9% for agricultural workers (Oregon Department of Consumer Business and Services, 2001). Agricultural injury costs have been estimated at $4.57 billion per year, which is $2,400 per farm, or 2.8% of the value of farm sales and 15.0% of the net cash returns in the US in 1992 (Leigh et al., 2001; USDA, 1992). Work-related illnesses are also common in agriculture, including respiratory disease, musculoskeletal problems, noise-induced hearing loss, certain cancers, skin conditions, and zoonoses (Rautiainen and Reynolds, 2002).

Interventions. The "three E's"—enforcement, engineering, and education—have been traditional prevention approaches, however, they all have limitations in agriculture. Enforcement has not been effective, mainly because of the OSHA exemptions for operations with fewer than 11 employees. Engineering has improved new machinery and equipment, but old machines lack modern safety engineering features, such as Rollover Protective Structures (ROPS). Education is a commonly used approach, however, it has been criticized for lack of success in modifying knowledge, attitudes, and behaviors (Murphy, 1992). A systematic literature review of 25 farm safety interventions (supported by GPCAH) found little evidence that farm safety programs have been effective. While some programs were able to report at least temporary changes in knowledge, attitudes, and behaviors, none showed sustained decrease in injuries or illnesses. Multifaceted programs appeared most successful (DeRoo and Rautiainen, 2000). Recent programs involving financial incentives appear promising. A workers' compensation premium incentive in Finland lowered claims by 10% (Rautiainen et al., 2005). A New York project involving a farm safety audit, training, and workers' compensation rebates lowered claims by 27% (Abend, 1998). A Swedish program providing funding for safety improvements showed a 22% decrease in the injury rate (Lundqvist, 1996). Although not conclusive, these examples are encouraging and provide strong justification for further research in developing and evaluating incentive-based prevention models.

Systematic reviews. GPCAH has supported systematic reviews of intervention effectiveness research in agricultural health and safety. These reviews provide important information for the development of new interventions. Dr. Rautiainen co-authored a systematic review of farm safety interventions, published in 2000 (DeRoo and Rautiainen, 2000). This work is currently being updated and expanded. Dr. Rautiainen is lead author of a Cochrane Collaboration Review entitled: Interventions for Preventing Injuries in the Agriculture Industry. Drs. Stephen Reynolds and William Groves (2000) authored a systematic review of the effectiveness of Roll-over Protective Structures. The evidence presented in this review has been helpful in subsequent efforts, including the current NIOSH Tractor Safety Initiative.

Program evaluation research. GPCHA has supported research evaluating interventions conducted by other organizations. Evaluation of new and ongoing interventions provides opportunities to learn from programs in a cost-effective manner. Dr. Rautiainen evaluated a Finnish Farmers Workers' Compensation Incentive program, using insurance claims records (Rautiainen et al., 2005). This research has been expanded to the evaluation of the Finnish occupational health service model among farmers, which is perhaps the largest (n~34,000 members) voluntary multi-faceted program aiming to reduce injuries and illnesses in agriculture. The results of this intervention effectiveness study will have great interest to the agricultural health and safety field in the US and elsewhere. GPCAH investigators have collaborated with Farm Safety 4 Just Kids, evaluating their programs such as promotion of safe play areas on farms, intergenerational education programs, and ATV safety programs. GPCAH investigators have also assisted the Agrisafe Network and other organizations to evaluate their programming.

Development of the Certified Safe Farm Model

GPCAH intervention research builds on extensive program development experience. Over the past 20 years, The University of Iowa's Institute for Rural Environmental Health has developed several prevention programs that have lead to the Certified Safe Farm intervention model:

- 1983 - The Swine Confinement Workers Respiratory Disease Prevention Program (Donham et al., 1990 ; Gjerde et al., 1990)
- 1987 - The AgriSafe Network (Gay et al., 1990)
- 1990 - Iowa's Center for Agricultural Safety and Health (I-CASH, 2002)
- 1991 - Farm Safety Day Camp (Donham et al., 1998)
- 1993 - The Farm Safety Walk About (Hawk, 1991; 1994; 1995)
- 1995 - Tractor Risk Abatement and Control (TRAC) Program (Lehtola et al., 1995)

Through this program development experience, we have found that no one theory or method is likely to create an effective, sustainable, and transferable program. Therefore, our CSF model incorporated several theories and principles of intervention and health promotion from past research and experience. Features of the CSF program have been described by Von Essen et al. (1997), Thu et al. (1998), Hodne et al. (1999), Jaspersen (1999), and Schneiders (2003).

Certified Safe Farm Program Concept. In 1987, early in the history of the AgriSafe Network, we developed the integrated triad of CSF services. The nurse who conducts the clinical screenings has a good understanding of farming and has been certified by examination in our agricultural occupational health nurse certification course (Donham and Venzke, 1997). Because of the nurse's training and background, she is able to *personalize* educational materials, and provide culturally relevant *social and technical support*. The screenings are performed periodically, so there is *repetition* in the educational interventions. The on-farm safety review is conducted by a person from the farm community who has gone through a consultant training and certification program. The consultant *personalizes* the farm review process, based on the individual's own farm operation. *Practical* suggestions for remediating farm hazards are given to the farmer, and *technical support* is provided to assist in certification. The CSF farmer must take personal responsibility, ie. *ownership*, for becoming certified. Basic education is conducted one-on-one by the nurse who also conducts the clinical screenings. Individual test results are discussed and specific recommendations are made, based on clinical and farm review findings. This is a very direct way to *personalize* the information and create *ownership* of the individuals' health. Farm safety consultants have an opportunity to discuss safety features related to machines, buildings, and environments as they visit the farm and conduct the on farm safety review. In addition to

these intensive one-on-one education opportunities, community education *involving the entire family* is conducted, and information is provided through regular mailings.

Consideration of special populations and different types of farming. The CSF model was first developed and implemented in an area where row crop and hog production are the primary commodities. In the upper Midwest and other areas of the US, dairy farming is the primary type of agricultural production. We tested the feasibility of expanding the CSF model to address the needs of various agricultural commodities in the region and the nation, using dairy farming as an example. Senior farmers have high risk of injury on the farm. The average age of farmers is increasing due to various factors. Unlike many other occupations, farmers do not have a set age for retirement, and they continue to provide an important contribution well beyond the traditional retirement age of 65. Iowa State University Extension reported that 30% of the 1993-97 agriculture-related deaths involved a farmer 65 years of age or older (ISU, 2000). In a study of agricultural injuries in Finland, age was strongly associated with injury severity, due to greater proportion of serious injuries (incl. bone fractures) in older farmers and lengthier disability times for similar conditions when compared to younger farmers (Rautiainen, 2002). Many factors are known to be associated with increased risk among older farmers including medications (Xiang, et al, 1999); hearing loss (Sprince et al. 2003); vision problems (ISU, 2000); depression (ISU, 2000; Zwerling et al.1995).

B. Goals

The long-term goal of GPCAH intervention research is to reduce the rate and the cost (physical, financial, emotional, and social) of injuries and illnesses to farmers and farm workers in the United States. This section discusses the specific goals of those CSF research projects that were funded by NIOSH as part of the GPCAH.

Senior Farmer Certified Safe Farm Project (2005-2007). The goal of this project is to translate the Certified Safe Farm (CSF) model to address farm hazards of senior farmers, age 60 and older. The original CSF research study focused primarily on providing health and safety services to the principal farm operator, which in many cases excludes the older farmer who also works on the farm. Through this program, about 140 previously unserved Iowa farmers, aged 60 and older receive CSF services. In addition, Iowa Easter Seals Rural Solutions, which is affiliated with Iowa AgrAbility, provides collaboration in the development of the review tool, and visits the farms of those with age-related disabilities to provide recommendations for occupational rehabilitation and assistive technology. This helps the farmers continue their work on the farm, while reducing their risk of injury. Iowa Easter Seals and Area Agencies on Aging provide services which complement the CSF program and strengthen the ability to provide the program to older farmers.

The main research questions addressed in this project include:

- What are the primary occupational health and safety hazards for older Iowa farmers?
- How can the CSF program be translated to more thoroughly address the agricultural health and safety needs of older farmers?
- Can a CSF program tailored to older farmers successfully engage them in the process of improving health and safety on the farm?

The Certified Safe Dairy Farm project (2001-2006). This project aims to modify CSF services to meet the needs of the dairy farmers. This experience is useful in adapting the program for different commodities in the various geographic areas of the US. This project sets an example for further expansion to other commodities. The Specific aims of the CSF dairy project are to:

1. Evaluate the CSF on-farm safety review checklist and develop modules to address the specific hazards of dairy farming.
2. Evaluate the occupational history and clinic forms and develop questions that address exposures and health effects in dairy farming.
3. Select and/or develop educational materials for dairy farms.
4. Pilot test the CSF dairy health screening, education and on-farm safety review procedures on at least three farms and make modifications as needed.
5. Recruit at least 25 dairy farmers into the study.
6. Provide health screenings and on-farm safety reviews for participating farms.
7. Collect data on exposures and health outcomes using the existing CSF phone interview and other methods, and
8. Develop guidelines for further program expansion into other commodities and types of farming.

C. Inputs

The budgets for the inretervention projects are presented in the attached database. The Certified Safe Farm intervention effectiveness research has been primarily funded by the NIOSH Community Partners for Healthy Farming (intervention) initiative. The Certified Safe Dairy farm project and the Senior Farmer CSF project were funded as part of GPCAH. The total project funding since CSF began in 1996 is nearly $2 million, a level of funding that demonstrates the interest and faith of its public and private sector supporters. The main supporters have been NIOSH, Iowa Pork Producers Council, National Pork Producers Council, Pioneer Hi-Bred International, Inc., Wellmark Foundation, and The Iowa Farm Bureau Federation. Further in-kind support includes donated time by the AgriSafe nurses and other project supporters, and county Farm Bureaus in Iowa.

The primary staff for the intervention projects have included:

The University of Iowa:
- Kelley Donham, MS, DVM
- Risto Rautiainen, PhD
- Kendall Thu, PhD
- Murray Madsen, MBA
- Sara Schneiders, MS
- Natalie Roy, MPH
- LaMar Grafft, MS

Agrisafe Network clinic staff at several clinic sites in Iowa
- Natalie Roy
- Carolyn Sheridan
- Kristie Fisher

National Education Center for Agricultural Safety (NECAS)
- Sam Steel, EdD, Co-Principal Investigator
- Dan Neenan, Safety Auditor
- Charlotte Halverson, Health Assessor

The primary facilities used for conducting the intervention projects involve The University of Iowa's Institute for Rural and Environmental Health, Agrisafe clinic sites in several locations in Iowa, and the National Education Center for Agricultural Safety (NECAS) in Peosta, IA.

Stakeholders in the intervention research projects include AgriSafe clinic nurses, I-CASH staff, Easter Seals Iowa staff, Area Agencies on Aging, Iowa Farm Bureau Federation, and Wellmark Blue Cross and Blue Shield.

D. Activities

The CSF model was formalized in a 1996 research proposal to NIOSH Community Partners for Healthy Farming (intervention) initiative. The proposal was funded and it included development and pilot testing of research tools and methods. Additional funding was provided by the Iowa Pork Producers' Association, the National Pork Producers' Council, and Pioneer Hi-Bred International Inc. This funding enabled expanding the initial pilot study groups (25 in Iowa, 17 in Nebraska) in 1998 to include 149 control farmers and 154 intervention farmers in northwest Iowa in a nine-county area around the AgriSafe Clinic at Spencer Hospital. In 1999, NIOSH awarded funding for the second phase of the study extending the program an additional four years. In 2000, we re-enrolled 91% of the intervention farmers and 78% of the control farmers (demonstrating that once enrolled, farmers choose to remain in the program). The third phase of the study was started in 2003 with additional funding from NIOSH and Wellmark. This study expanded the program to six additional counties in Iowa. Two additional projects were funded as part of the GPCAH, first developing a CSF model specifically for dairy farms, and the second adapting the CSF program to senior farmers.

The first funding cycle of the study included focus groups to gain farmer input into the program design. The farmers were very supportive of the program concept and offered useful ideas for program planning. The clinical procedures, health data collection tools, and on-farm safety audit checklist were developed, and pilot farms were recruited; 25 in Iowa and 17 in Nebraska. With additional private sector funding, the enrollment of subjects was expanded. Personnel were trained to perform health screenings, education and farm reviews. Exposures and health outcomes were followed using annual occupational history forms and health screenings, and quarterly phone calls. The Nebraska Certified Safe Farm portion was conducted in the West Point area. This effort was a collaboration between St. Francis Memorial Hospital in West Point, Cumming County Cooperative Extension and the University of Nebraska Medical Center.

During the second funding cycle (1999-2003) the CSF project maintained over 125 intervention farms and 125 control farms in the study. Agrisafe Clinic at the Spencer Hospital provided local leadership and offered the clinical services and education. Three trained local farmers conducted the on-farm safety reviews. The targeted nine-county area had 7617 farms (USDA, 1997). An introductory mailing was sent to 5287 active farms identified from the United States Post Office mailing list and other sources. Those who returned the postage-paid card were interviewed by telephone in the following months until a total of 300 farmers were recruited. A small number of respondents were excluded due to minimal agricultural production or not meeting the USDA farm criteria (at least $1000 sales of agricultural products per year). The 300 farms were pair matched on: 1) crop, corn, and soybean acres; 2) number of cattle and hogs; and 3) previous injury experience. The pairs were randomly assigned into the intervention and control groups. The intervention and control cohorts had similar demographic and farm production characteristics but differed from Iowa farms in terms of the mean farm size (intervention 643 acres, control 612 acres, Iowa 339 acres); proportion raising hogs (intervention and control 41%, Iowa 33%); mean hog herd size (intervention 2309, control 3287, Iowa 445 hogs), and proportion raising cattle (intervention 33%, control 35%, Iowa 45%). Additional recruiting in year 2000 added 19 intervention farms and 39 control farms to replace drop-outs and maintain at least 125 farms in each cohort.

The third phase of the study (2003-2007) involves a multi-site CSF program in collaboration with Iowa Farm Bureau Federation and Wellmark Blue Cross Blue Shield of Iowa. The effectiveness of the CSF program will be evaluated by comparing health insurance claims in the participating CSF farm population and a control farm population. The main research questions addressed in this project include: 1) Are there pre-existing differences in demographic, farm, and claims characteristics between CSF farms and control farms (a possible self-selection effect)? 2) Will the number and cost of health insurance claims be reduced among CSF farms after enrollment into the CSF program relative to control farms? and 3) Are health insurance claims associated with demographic, farm production, insurance, health status, and farm hazard characteristics? This study has enrolled about 300 Iowa farmers into the CSF program who are members of the Iowa Farm Bureau Federation and have Wellmark health insurance coverage through Iowa Farm Bureau Federation. We provide CSF services to each of the enrolled farmers twice during the four-year project. We provide safety and health education to CSF farm families on a continual basis. We conduct retrospective and prospective analyses of health insurance claims data for the 300 CSF farmers and at least 2000 control farmers who are also Iowa Farm Bureau-Wellmark insurees. We analyze the association of health outcomes and demographic, farm production, health status, insurance, and farm hazard characteristics. Finally, we utilize project findings to build an ongoing CSF program in collaboration with insurance and agribusiness partners.

Senior Farmer CSF Study. The AgriSafe clinic sites in the CSF senior farmer study were selected using a competitive process. They had to demonstrate collaboration with Area Agency on Aging, community involvement, effective recruitment strategies, and adherence to the timeline and protocol standards. Agricultural Occupational Health Screenings and Education are designed to address health risks from agricultural exposures, and are conducted by a trained and certified nurse at an AgriSafe Network clinic. During the health screening at the AgriSafe clinic, farmers are assessed to determine whether they should be referred to the Easter Seals Rural Solutions program for services. Following the exam, the health care provider reviews the results with the farmer. Guidelines based on test results indicate appropriate action. A summary sheet is prepared and shared with the farmer and includes specific recommendations and goals. Recommendations may include use of personal protective equipment, or referral to a weight loss program or a health specialist. As part of this outreach, we contact the farmers at least once yearly to check on the progress toward their occupational and wellness goals. On-Farm Safety Reviews are performed by a farm safety consultant twice during the project period. The CSF farm reviewer uses the redesigned CSF farm safety review checklist that includes prevention of injuries common among older farmers. These modifications may include engineering controls for slips and falls and animal-related injuries. This comprehensive survey also addresses safety issues related to structures, machinery, equipment, chemical handling and livestock. After the review, the farmer receives a summary statement with recommended improvements.

The Certified Safe Dairy Farm Project is conducted in collaboration with The University of Iowa and the National Education Center for Agricultural Safety (NECAS). The project updated CSF forms and procedures to fit the needs of dairy farmers. Twenty-five farms were recruited. They have received farm reviews, health screenings, and training. We used experience from developing the dairy checklist and we revised the entire CSF farm safety checklist which is now used in all CSF study locations. The checklist has an automated scoring system, based on Microsoft Excel program. During year 3, we used both the old and new checklist versions, and we will compare results in terms of safety scores and safety problems identified. The new CSF farm review document was printed in September 2005, and is now used for all CSF farm reviews in all study locations. This project raised local funding ($11,000) and the project staff

were able to provide respiratory and hearing protection to every farm, as well as 188 slow moving vehicle (SMV) emblems, and 18 ten-pound fire extinguishers. In addition, ten tractors from seven farms were retrofitted with Rollover Protective Structures (ROPS) and seatbelts. Collectively, the safety equipment reduced the on-farm review scores of the 24 farms by 1,470 points, and all farms were able to reach certification status. The CSF dairy project helped develop the CSF program for wider implementation in collaboration with Iowa Farm Bureau and Wellmark Blue Cross Blue Shield of Iowa. This project is now ongoing and will compare health insurance claims on CSF farms versus control farms. The CSF dairy project has been well received among participating farmers, and this has helped recruitment efforts for the new expanded CSF studies.

E. Outputs

In 1996, NIOSH funded (#UO6/CCU712913) the initial CSF project, which included development and pilot testing of research tools and methods. Additional funding from the private sector was secured, and in 1998, 149 control farmers and 154 intervention farmers were enrolled in the CSF study. In 1999, NIOSH awarded funding to extend the program an additional four years, and in 2000, we re-enrolled 91 percent of the intervention farmers and 78% of the control farmers (demonstrating that once enrolled, farmers choose to remain in the program). In 2001, we received funding from the Wellmark Foundation to provide CSF services to an additional 100 Iowa farmers residing in six additional counties. In 2003 we received funding for a new phase of the study which has recruited about 300 farms into a four year study. Additionally, the senior farmer study has recruited about 140 senior farmers. Geographically, the Certified Safe Farm program has covered over 20% of the state of Iowa. Table 1 provides a summary of the numbers of subjects in the study so far, which exceeds 700 farmers.

Table 1: Number of Farmers Enrolled in the CSF Study by Year and Location

	1998	2000	2001	2002	2005	Tot.
Control Farms (NE Iowa)	125	39				164
NE IA, 9-county area around Spencer	133	19				152
SW Nebraska	17					17
Hampton, Manchester, Ida Grove, Dubuque			100			100
CSF, Dairy farmers				25		25
CSF, Senior farmers, 8 locations in IA					139	139
CSF, Wellmark-FarmBureau-UI, 8 locations in IA					290	290
Total number of CSF intervention farms	150	19	100	25	429	723

Services Provided

Table 2 shows the number of CSF services provided during the 1999-2003 pilot project including occupational health screenings, referrals, and farm reviews. The numbers of farms that did and did not become certified are also presented in this table.

Table 2: Number of CSF Services Provided by Year

	Year 1 1998-99	Year 2 1999-00	Year 3 2000-01	Year 4 2001-02	Year 5 2002-03	6 New Sites 2001-2003
Occupational health screenings completed	135	133	135	127	122	125
Referrals made	52	49	60	59		56
Farm reviews conducted	134	133	133	129	119	103
Farms Certified	110 (82%)	125 (94%)	126 (95%)	119 (92%)	115 (97%)	34 (33%)
Farms not certified	24 (18%)	8 (6%)	7 (5%)	10 (8%)	4 (3%)	69 (67%)

Occupational health screenings. Since enrollment of CSF farmers began in 1998, 652 occupational health screenings have been conducted at the AgriSafe Clinic in Spencer, IA. In addition, a total of 125 occupational health screenings were conducted at six other AgriSafe locations in Iowa from June 2001 through March 2003.

Referrals. The importance of the occupational health screenings is demonstrated in the referrals to health care providers for treatment before serious complications arise. Without the occupational health screenings, many of the farmers would not have received vital health care services. For example, a 51-year old farmer in Delaware County had his first eye exam. In Butler, Grundy, and Franklin counties, one person was diagnosed with prostate cancer, and two diabetics were detected. In Dubuque County, one person had two basal cell carcinomas removed as a result of the screening visit. As a result of CSF addressing behavioral health, six people started a new medication, one increased the dose of a current medication, seven reported a change in lifestyle or diet. Furthermore, one participant had surgery, one got a hearing aid, one got corrective lenses, two saw a chiropractor, two had a colonoscopy, one had a skin problem checked, and one received a chest x-ray.

On-Farm Safety Review. During the five-year data collection period, farm safety review scores improved consistently on the CSF farms in northwest Iowa. A total of 1,292 on-farm safety improvements were reported, at an estimated total value of $69,000 ($130 per farm per year). A wide range of improvements were made including adding 9 tractor ROPS and skid loader cages, adding 59 Power Take-Off (PTO) master shields and 207 Slow Moving Vehicle (SMV) signs, improving lighting on 72 machines, placing 171 warning decals on machinery, shielding 77 moving parts, locking up 17 chemical storage areas, making 83 lockout/tagout improvements, and making general housekeeping upgrades in 62 farm buildings.

Training of service providers. We have held four farm safety reviewer training sessions in Sioux City and Iowa City, Iowa. A total of 31 extension workers, occupational health nurses, and farmers attended the trainings and 26 took the written and on-site examinations necessary to become CSF on-farm safety reviewers. A 40-hour training has been conducted annually, and over 200 health care providers so far have taken this training. The training is required for those providers who want to establish an AgriSafe Clinic and offer CSF services.

Focus groups. In August 2002, two focus groups of CSF intervention farmers were held in Spencer, Iowa. Farmers expressed strong concern about health insurance costs, e.g., “Health

insurance is out of control," and "I wait to go to the doctor. We have a $5,000 deductible, so I'll wait about a week and a half before I think of going." Farmers find themselves with very high insurance deductibles and little hope that the situation will improve. Other themes that surfaced during the focus group discussions include: 1) Farmers want the CSF program to continue long-term; 2) Farmers would be willing to "sacrifice" to a certain extent in order to receive the CSF screening, education, and farm review. Examples of this included not needing the $200 incentive for certification, helping with the recruitment of other potential CSF farmers, and paying for additional services at the screening, such as prostate specific antigen (PSA) testing; 3) Farmers did not recommend any major programmatic changes to CSF. They thought the services should be offered each year, and they were pleased with how the screenings and reviews were conducted. They did express a general desire for more information, such as learning about laws that might affect how they do their farm work, receiving regular updates on the results of the study, and having periodic educational meetings; and 4) Farmers found it very beneficial to receive multiple occupational health screenings, so they could track changes in test results. A 2002 satisfaction survey to the northwest Iowa CSF farmers (n=90) found that most farmers (70%) viewed the CSF program as very important or extremely important.

Peer Reviewed Publications from CSF studies include the following:

1. Hodne, C.J., K. Thu, K.J. Donham, D. Watson, N. Roy. 1999. Development of the Farm Safety and Health Beliefs Scale. *Journal of Agricultural Safety and Health* 5(4): 395-406.
2. Jaspersen, J., P. List, L.Howard, D. Morgan, S. Von Essen. 1999. The Certified Safe Farm Project in Nebraska: The First Year. *Journal of Agricultural Safety and Health* 5(3): 301-307.
3. Schneiders, S, K.J. Donham, P. Hilsenrath, N. Roy, K. Thu. 2001. Certified Safe Farm: Using Health Insurance Incentives to Promote Agricultural Safety and Health. *Journal of Agromedicine* 8(1): 25-36.
4. Thu, K, B. Pies, N. Roy, S. Von Essen, K. Donham. 1999. A Qualitative Assessment of Farmer Responses to the Certified Safe Farm Concept in Iowa and Nebraska. *Journal of Agricultural Safety and Health* 4(3): 161-171.
5. Von Essen, S., K. Thu, K. Donham. 1997. Insurance Incentives for Safe Farms. *Journal of Agromedicine* 4(1/2):125-28.
6. Rautiainen R, Lange JL, Hodne CJ, Schneiders SL, Donham KJ. Injuries in the Iowa Certified Safe Farm study. J Agric Saf Health. Jan. 2004;10(1):51-63
7. Donham KJ, Rautiainen RH, Lange JL, Schneiders S. Injury and illness costs in the Certified Safe Farm Study. Journal of Rural Health. 2006. Submitted.

F. Outcomes

The CSF program was formally initiated in 1996 through a proposal to NIOSH in response to the Community Partners for Healthy Farming (Intervention) initiative. CSF has since evolved into a well-recognized prevention model in agriculture. Although CSF is a unique program in the United States, it is not the first of its kind internationally. Similar programs in Finland and Norway have 34% (Eskola, 2001) and 5% (Landbrukshelsen, 2000) participation rates respectively, showing the growth potential of the CSF program. While the traditional enforcement, engineering, and education efforts are limited, the CSF program combines numerous prevention principles and offers a mechanism to make progress in agricultural health and safety in the United States in a way that has not been possible thus far.

Over 700 farmers have participated in the CSF studies so far and the experience shows that CSF is well accepted by farmers, feasible to deliver, and effective in reducing farm-related exposures and injury and illness costs. The program has been tested among senior farmers and

dairy farmers. The experience shows that the CSF program can address the needs of special population and different types of farming. Following are some indicators from the 1999-2003 study, showing the effectiveness of the CSF program.

Reduction of Hazards. During the data collection period, farm safety review scores improved consistently on the CSF farms in northwest Iowa. A total of 1,292 on-farm safety improvements were reported, at an estimated total value of $69,000 ($130 per farm per year). A wide range of improvements were made including adding 9 tractor ROPS and skid loader cages, adding 59 Power Take-Off (PTO) master shields and 207 Slow Moving Vehicle (SMV) signs, improving lighting on 72 machines, placing 171 warning decals on machinery, shielding 77 moving parts, locking up 17 chemical storage areas, making 83 lockout/tagout improvements, and making general housekeeping upgrades in 62 farm buildings.

Respiratory Disease. Because respiratory conditions are among the most important health problems in the farming community, CSF has focused its intervention in this area. The overall rate of respiratory disease symptoms was 17/100 exposed persons per year, which included bronchitis (11/100), asthma-like condition 11/100, mucous membrane irritation (13/100), and organic dust toxic syndrome (9/100). One of the primary interventions for respiratory conditions included education and proper selection and use of respiratory personal protective equipment (PPE). We observed a significant increase in the rate of PPE usage and a downward trend in the percentage of intervention farms that do not use PPE. We observed a downward trend in asthma symptoms among intervention farmers. This decrease in symptoms was corroborated by pulmonary function testing over time in that 29% of farmers (those with FEV1 deficits greater that 10%) improved over the four years follow up.

Injury and Illness Costs. During the follow-up period, the total costs (out-of-pocket + insurance costs) of occupational illness and injuries were 27% lower among intervention farmers than control farmers. Specifically, the insurance cost of medical care per farmer per year was 45% less in the intervention farmers than in the control farmers. The out-of-pocket costs for the farmer were similar; 6% difference between intervention and control farms. The difference in cost between the cohorts varied according to the type of occupational injury or illness. For occupational injuries, the insurers paid 37% more for the control farmers than the intervention farmers. Out-of-pocket expenses for control and intervention farmers were equivalent. One occupational injury leading to fatality occurred in the control group. However, this case was excluded from the analyses. The out-of-pocket costs were similar for the intervention and control farmers for all outcomes, except respiratory and hearing conditions. The intervention encouraged obtaining hearing aids when needed, and since insurance does not usually cover them, they are paid out-of-pocket. The costs covered by insurance were lower in the intervention group for injury, skin conditions, and musculoskeletal conditions, which was by far the largest cost outcome. The highest cost cases involved joint replacements. The intervention group had higher costs for respiratory conditions. The intervention involved lung function tests, which may have triggered further examination and treatment among intervention farmers. Among the intervention farms, the safest farms (ie, those with the highest safety scores) had lower total costs of occupational injuries and illness than less safe farms. Those farms with the lowest farm review scores had medical costs that were about twice as high as the safest farms. The linear association between medical costs and safety score can be seen for injury, respiratory disease, and musculoskeletal conditions, while other conditions do not show the same trend.

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Great Plains Center for Agricultural Health

Toxicology Core

Background:

The Toxicology Core of the GPCAH was formed in recognition of the importance of toxicant exposures to the health of farmers and farm workers, and as a result of research initiatives begun in the first six years of the Center. In the first five (1990-1995) year funding period, the toxicology research activities took place primarily within the projects: *Experimental Exposures to Grain Dust*, *Bioaerosol Exposures, Lung Disease Among Dairy Farmers*, *Field Evaluation of Endotoxin Air Sampling Assay Methods* and to a lesser degree under the rubric of the *Keokuk County Rural Health Study*. In the next six years (1995-2001), toxicology activities were focused in one research project, *Bioaerosols Research for Agricultural Environments* and one chemical injury investigation, *Ocular Trauma Arising from Tire Ballast Fluid*. GPCAH toxicology staff also contributed significant effort to the *Interlaboratory Comparison of Endotoxin Assays* and the study of *Assessment of Ammonia Vapor/Particles in Agricultural Aerosols* by setting up the vapor and aerosol generation systems in the Inhalation Toxicology/Aerosols Labs and by performing the bioaerosol and endotoxin analyses.

The rationale for inclusion of a Toxicology Core in the GPCAH is best demonstrated by a consideration of the occupational hazards in agriculture. Historically, agriculture has been recognized as an occupation with significant health and safety hazards. Lineus in the 1500's and Ramazzini in 1703 were among the earliest to describe the hazards of work in agriculture. Since that time workplace risks in general industry have diminished considerably while those in agriculture have seen less significant improvement. The principal health risks reported for U.S. agricultural workers arise from a wide range of hazards. Chemical hazards and non-infectious and infectious biological hazards have received considerable attention of late but noise, trauma, fires, electrocutions, thermal stress and drownings are very important causes of morbidity and mortality. Stress, chronic pain and fatigue can lead to physical or mental impairment which can cause inadvertent elevated exposures to chemical and biomechanical hazards. While many of these hazards have been well characterized and preventive measures are available, diseases arising from chemical and biological exposures are less well understood. Respiratory diseases in agriculture, in particular, have received relatively little attention.

The Toxicology Core of the GPCAH was formed to conduct and facilitate research to characterize exposure-response relationships for toxicants that affect farmers and rural populations and to explore the mechanisms by which these toxicants cause disease. The Toxicology Core also has as its mission the training of students, post-doctoral fellows and junior faculty in the conduct of agricultural health research. The research focus of the Toxicology Core is inhaled toxicants with the lung and immune system as the principal target organs of interest. However, dermatotoxicity and pesticide toxicity were areas supported by the Toxicology Core in terms of outreach and education efforts. Very broadly, the xenobiotics of interest include the following:

Microorganisms	Bacteria, fungi, viruses
Toxins	Endotoxins, exotoxins, mycotoxins, phytotoxins
Microbial constituents	glucans, peptidoglycans, teichoic acids, etc
Nucleotides	Prokaryotic DNA
Antigens	Grain storage mites, house dust mites, urine & avian proteins, epidermal antigens
Chemicals	Pesticides, disinfectants, solvents, fuels

Gases and vapors	Ammonia, hydrogen sulfide, carbon monoxide, nitrogenoxides, mercaptans

The research focus of the Toxicology Core was inhaled toxicants with the lung and immune system as the principal target organs of interest.

Goals:

The GPCAH has conducted a variety of research projects to evaluate the toxicological effects of agricultural exposures and health effects associated with these exposures. The purpose of this research was the following.

1) Develop improved experimental and analytical techniques for evaluating the mechanisms by which agricultural dusts and gas exposures cause disease.
2) Evaluate the disease risks caused by emerging toxic agents, such as inhalation of bacteria, fungi, and viruses.
3) Develop improved methods for measuring exposures to dusts and bioaerosols.
4) Develop recommendations for reducing dust and gas exposures and preventing disease.

The results of this research has led to numerous publications, presentations, and understanding on how agricultural exposures cause disease.

Input:

The budgets for the work done on pesticides are presented in the attached database.

Supplemental funding was obtained from several research studies which were obtained by GPCAH staff. In conducting toxicological research, the GPCAH partnered with researchers from NIOSH, the National Cancer Institute (NCI), the National Institute for Environmental Health Sciences (NIEHS), and the Environmental Protection Agency.

The primary staff for conducting this work included:

Peter S. Thorne, M.S., Ph.D.	Core Director and Toxicologist
Patrick O'Shaughnessy, Ph.D.	Aerosol Physicist
Marsha O'Neill, B.S.	Research Assistant III
John Phipps, M.S.	Research Assistant I
Connie Spurgeon, B.S.	Research Assistant I
Chad Roy, MPH	Graduate Research Assistant and Doctoral Student

The facilities used for the research included the University of Iowa's Institute for Rural Environmental Health and the University Hygienic Laboratory. Off site field stations and clinics were also used to conduct research.

Activities:

The following are the primary activities of the Toxicology Core over its inclusion in the GPCAH from 1990 until 2001. However, it provided research, analytical, and educational support to a variety of other activities during its inclusion in the GPCAH.

Grain Dust Studies: The Toxicology Core performed inhalation toxicology studies of grain dust contaminants and agricultural bioaerosols in animal models of pulmonary inflammation and

hypersensitivity pneumonitis and published studies comparing the kinetics of human and mouse grain dust-induced lung inflammation and the production of proinflammatory cytokines. The concentration-time profiles for tumor necrosis factor α, interleukin-6, and interleukin8/MIP 2 were analogous and served to further validate our murine model for grain dust lung injury.

Toxicity of White Mold: The Toxicology Core conducted studies investigating the toxicity of inhaled soybean white mold, *Sclerotinia sclerotiorum*. This substance is an emerging fungal contaminant affecting soybeans in the upper midwest. It causes malaise and pulmonary injury upon exposure during soybean combining. While the exact toxicant is not known, beta glucans are a cell wall component of this organism and a candidate inflammatory agent. Dr. Thorne worked with colleagues at the Agricultural University Wageningen, Netherlands on further development of their immunoassay for glucans and in developing ELISA inhibition assays for grain mite aeroallergen. He performed glucan assays on breathing zone samples collected in combines during the 1997 soybean harvest. Air and bulk samples were collected during combining in both white-mold contaminated fields and control fields. An exposure assessment was performed on Iowa farms in response to concerns raised by farmers, Air samples were collected in multiple locations during soybean harvesting using open-faced filter cassettes and cascade impactors. Airborne concentrations of collected airborne dust were quantified by gravimetric analysis. Microbiological analysis of bacteria and fungi were performed using both conventional culture methods and flow cytometry. Bacterial endotoxin was quantified by the *Limulus* Amebocyte Lysate assay and fungal glucans by enzyme linked immunosorbent assay (ELISA). High levels of total and inhalable dust were measured and many of the ambient sites exceeded threshold limit values for total and inhalable dust. The estimated mass median aerodynamic diameter, MMAD, of the airborne dust during the soybean harvest in both personal (3.8 μm, σ_g 1.3) and ambient samples (6.5 μm, σ_g 2.0) was much smaller than values reported previously in the literature for corn harvest. Bioaerosol analysis revealed exceedingly high concentrations of bacteria, fungi, endotoxins, and glucans. Mean concentrations of total bacteria inside the combine cab in year I and II of $1.4x10^3$ and $2.4x10^3$ CFU/m^3, respectively, were substantially lower than previously reported levels of airborne bacteria for wheat and barley harvests. Similarly, mean airborne fungal concentrations in year I ($4.4x10^4$ CFU/m^3) and year II ($4.9x10^5$ CFU/m^3) were slightly lower than previously measured levels during grain harvest. The mean fungal concentrations inside the combine cabin in year I and II ($2.0x10^3$ and $1.2x10^4$ CFU/m^3) were also lower than reported mean levels inside the combine cabin. The mean levels of bacterial endotoxins detected in ambient air for years I and II (4,438 and 459 EU/m^3, respectively) were higher than the range reported in other agricultural environments such as grain handling whereas the personal samples in year I and II (310 and 8 EU/m^3, respectively) were lower than reported values for other enclosed work environments such as swine confinements. Both personal and ambient endotoxin concentrations were significantly correlated with airborne bacteria.

Concurrent with the exposure assessment, a series of animal toxicology experiments was performed to characterize the response kinetics and pulmonary toxicology of soybean dust extract, bacterial endotoxin, fungal glucans, or pure culture of *SS*, either neat or within a mixture. Mice were acutely exposed by intratracheal instillation or via inhalation of a nebulized extract, lyophilized extract, or dry dust. Importantly, the results of the exposures showed that *S.sclerotiorum* induced pulmonary inflammation, although the toxicokinetics proved different than that of other organic dust components such as endotoxin. This conclusion is based on the significantly higher levels of bronchoalveolar lavage (BAL) fluid neutrophils and increased proinflammatory cytokines at 12 and 24 hours post exposure over that of sham exposed animals. Mixed exposures with endotoxin and either *SS* or glucans showed that endotoxin-induced pulmonary inflammation is affected by the presence of fungal glucans, marked by the

reduction of total and inflammatory cells and cytokines in the endotoxin + *SS* or glucan exposure groups when compared to the group exposed to endotoxin only. In the endotoxin + *SS* group, both total BAL fluid cells and neutrophils were significantly increased over controls, whereas only total cells were significantly increased in the endotoxin + glucan group. This may indicate that another yet unidentified component of *SS* may further inhibit chemotaxis. This is contrary to the significantly lower concentrations of chemokines in the endotoxin + glucan group than the endotoxin + *SS* group. In summary, the toxicology results showed that 1) *S.sclerotiorum* and glucan caused a delayed (24 hour) inflammation of the lower lung, 2) co-administration of glucan and endotoxin blunted neutrophil influx and inflammatory mediator production in the lung, and 3) fungal glucan content likely contributed to fungal bioaerosol-induced pulmonary inflammation.

Tractor Tire Ballast: The Toxicology Core conducted a study of ocular injury from tractor tire ballast fluid. This study was initiated by an investigation of a preventable eye injury case in which a tire service employee was blinded while observing the charging of ballast fluid into a tractor tire on a farm. Our studies used a rabbit model and demonstrated that the injury was caused by a combination of mechanical trauma and osmotic injury. Prevention strategies included the use of shielding and eye protection when placing ballast inside tires.

Bioaerosol Assessment Methods: A series of studies was conducted by the Toxicology Core in which we developed bioaerosol exposure assessment methodology using fluorescent *in situ* hybridization (FISH). Flow cytometry and FISH were effectively employed for the assessment of exposures to airborne bacteria. Laboratory-generated two-component bioaerosols in exposure chambers and complex native bioaerosols in swine barns were sampled and aliquots of collection media were processed and enumerated by standard culture techniques, by quantitative microscopy or flow cytometry after nucleic acid staining with 4',6-diamidino-2-phenylindole (DAPI), and by FISH using fluorochrome-labeled nucleic acid probes targeted to specific ribosomal RNA nucleotide sequences. DAPI-labeled impinger samples yielded comparable estimates of bioaerosol concentration when enumerated by quantitative microscopy or flow cytometry. FISH allowed quantitative identification of *Pseudomonas aeruginosa* and *Escherichia coli* bioaerosols in the exposure chamber without measurable non-specific binding. Impinger samples from the swine barn demonstrated the efficacy of the FISH method for the identification of *Pseudomonas aeruginosa* in a complex organic dust. This work demonstrated the potential of FISH to compliment traditional methods of bioaerosol exposure assessment. We then extended that work to organisms other than Gram negative bacteria and began studies using real time PCR and the TaqMan system for bioaerosol quantitation. We have demonstrated the effectiveness of this technique for quantification of laboratory bacterial samples and are now poised to extend this work to field samples.

Real-Time Aerosol Monitoring: The Toxicology Core expended considerable effort to improve the generation of dry grain dust and liquid extracts of grain dust under the leadership of Dr. Patrick O'Shaughnessy. The primary goal of this effort was the development of real-time aerosol monitoring and feedback control of the aerosol generators using various optimization techniques for controlling chamber concentration. Importantly, it was demonstrated that these systems were capable of producing an aerosol with a constant size distribution and concentration over time across a range of generated concentrations. This is important for research associated with the use of an animal model to determine the toxicological effects of an inhaled aerosol since particle size and amount determine the quantity and placement of dust deposited in the lung. The purchase of a Wright dust-feed aerosol generator has also added another dimension to our abilities to produce a dry grain dust aerosol. A portion of this work involved the purchase and installation of equipment associated with two recently acquired $1m^3$

inhalation chambers for the purpose of automatically controlling the chamber airflow rate and static pressure. These chambers can house up to 96 mice for acute or chronic exposures. Ongoing work is now concerned with characterizing the performance of these chambers under different flow regimes. A separate exposure-chamber system used specifically for the development of a liquid aerosol atmosphere was also upgraded to allow for computer control of the aerosol sampling procedure and computerized measurements of the sample flow rate. These additions have standardized the time-sequence of aerosol measurements taken during an exposure and ensured even flow rates to more accurately determine aerosol concentration. An electrostatic precipitator was purchased, to more closely approximate environmental dust exposures within the laboratory. This device is capable of collecting airborne dust from sites of interest, (such as grain mills) in a fashion that allows us to aerosolize the dust in exposure chambers. This is an improvement over other collection methods that tend to perform poorly in the capture of the biologically relevant smaller particles.

Endotoxin Assay: The Toxicology Core participated in two round robin studies for endotoxin assay: one for grain and barn dusts and a second for vertically elutriated cotton dust. Both of these are now in the data analysis phase. In the cotton dust studies, results from our laboratory along with one other demonstrated the lowest standard error in the assays. The initial laboratory phase of a study was completed in humans and mice to establish urine biomarkers for organic dust-induced pulmonary disease. Methods were developed to quantify leukotriene E_4 in urine at various times following inhalation of corn dust or E. coli endotoxin in both humans and mice. Field studies monitored farmers for their inhalation exposure to grain dust during grain bin clean out. Urine bioassays will be performed for creatinine and leukotrienes and exposure-response relationships were investigated.

Asthma Research: The Toxicology Core conducted research in asthma using murine models by developing improved methods for physiologic monitoring of airway hyperreactivity in unrestrained mice. The measurements involved whole body plethysmograph measurements of pressure and volume changes during baseline breathing and as a function of methacholine challenge dose. Special apparatus and software were developed to perform these measurements.

Animal Confinement: The Toxicology Core conducted a study of in barn and ambient dust, bioaerosols, vapors and odors emanating from two types of concentrated animal feeding operations (CAFOs) housing swine. The toxicants studied are common hazards of employment in this type of agricultural operation and these exposures can lead to significant morbidity among swine farmers. Important toxicants include gases and vapors (ammonia, hydrogen sulfide, carbon monoxide, nitrogen oxides), infectious and non-infectious bioaerosols (bacteria, fungi, viruses, parasites), products of microorganisms (endotoxins, peptidoglycans, glucans) and aeroallergens of animal, plant, or microbial origin. Lung diseases arising from exposures in swine barns are often not discreet diseases but may include several conditions with overlapping symptomatology. Most lung injuries result from exposures that are not immediately dangerous to life and health, but consist of acute lung insults that may lead to chronic declines in lung function. Respiratory problems associated with this environment include upper and lower airway diseases and interstitial lung disease. Immunologic hypersensitivity appears to be uncommon in swine workers and the pathogeneses is primarily associated with acute and chronic inflammatory processes. We tested hypotheses regarding differences between worker exposures to particulates, bioaerosols, endotoxins, vapors or noise in hoop structures vs. conventional confinement facilities; differences across seasons in worker exposure to particulates, bioaerosols, endotoxins, vapors or noise in swine facilities; differences in microbial flora between hoop structures and conventional confinement facilities; and differences in analyte

exposure levels between barns within barn type after controlling for season, wind speed and pig density. These factors all influenced the concentration of dusts and gases in the swine barns.

The Toxicology Core performed a study of three commercially-available liquid impingers for bioaerosol exposure assessment. Exposure to hazardous bioaerosols, including viruses, bacteria, and fungi are associated with a high burden of morbidity and mortality. The specter of emerging and re-emerging airborne diseases, bioterrorism, and fungal allergen-induced asthma intensifies the importance of improving methodology for bioaerosol exposure assessment. Currently, there are no definitions of acceptable exposure or enforceable standards. Improvements will require characterizing the capabilities and limitations of existing methodology and the development of new techniques. Current sampling methods employ filtration, impaction, electrostatic precipitation or impingement into liquid. Impinger samplers hold promise for current assessment, as they possess high collection efficiency and sample analysis flexibility. Emerging molecular biology methods for bioaerosol assessment employ liquid impingement allowing the liquid to be optimized for the organism of interest and to undergo multiple analyses combining traditional identification methods with newly developed ones. This study characterized the collection efficiencies of three commercially available impinger samplers using culture based and non-culture based methods of analysis. A manuscript describing this work is in preparation.

The Toxicology Core made substantial progress in performing inhalation toxicology studies of grain dust contaminants and agricultural bioaerosols in animal models of pulmonary inflammation and hypersensitivity pneumonitis. The Toxicology Core has collaborated with Dr. Carrie George to complete three one month subchronic endotoxin and corn dust inhalation studies. These studies included evaluation of pulmonary cytokines and adhesion molecules associated with lung inflammation, apototic change, pulmonary function changes and histomorphometric analysis of lung remodeling.

Dr. Thorne's collaboration with Drs. Dick Heederik, Gert Doekes and Jeroen Douwes in The Netherlands on compost workers and their exposures to bioaerosols and aeroallergens led to one publication. This research included field sampling for inhalable dust and bioaerosols in large scale composting facilities in The Netherlands. The Toxicology Core performed analyses of these air samples for bioaerosols. This collaboration is continuing with development and validation of a whole blood assay. This assay uses fresh blood collected from compost workers and control subjects that is then stimulated *in vitro* with endotoxin or β-glucans. Cytokine production is then monitored over time in culture.

The Toxicology Core provided assistance to Dr. Steve Hrudy and Irene Wenger at the University of Alberta in collecting air samples from very intensive, factory-style swine houses. This collaboration allows us to have access to an industry that has been difficult to study in the United States. Alberta's pork industry requires a highly skilled, stable labor force. Over the past 10 to 15 years, pig barn work has evolved from operations in which workers were only required to spend a portion of their day in the barn, to the current situation where full-time work is required in intensive housing facilities. The increase in the number of hours worked per day in the barn, along with demonstrated levels of airborne particulate and gases inside these facilities, has resulted in net increases in daily exposures for workers to air contaminants in these facilities. Previous investigations into the respiratory health of pig barn workers identified a number of environmental contaminants present in the pig barn environment, including dust (inhalable and respirable), gases (NH_3, H_2S, and CO_2) and endotoxin. Studies have shown that endotoxins can induce bronchoconstriction, organic dust toxic syndrome, or mucous membrane irritation. Other chemicals, including disinfectants, are routinely used in pork production facilities. However, exposures to these compounds, have not been adequately categorized. Previous

investigations to determine the relationship between barn environment exposure and respiratory health of pig barn workers have focused on workers from small scale operations, who often have responsibilities outside the barn and spend, on average, four hours in the pig barn daily. In modern, large scale facilities, many operations have a shower-in policy, such that workers often remain inside the barn for the duration of their 8 to 10 hr work shifts. To date, no research has reported on the exposures of specialty career pig barn workers to dust, gases and endotoxin. In addition, limited information exists on the workers' daily activities, and the effects that these activities have on exposures to barn contaminants. Large intensive pig facilities and their workers have been previously inaccessible to researchers due to their stringent biosecurity requirements. In this project, Dr. Hrudy has developed and validated a rigorous biosecurity protocol that allows exposure assessment instrumentation to be transported to independent pork production facilities across Alberta. The current study is a two-phase collaboration between Dr. Hrudy and the Toxicology Core to classify and quantify the exposures of specialized career pig barn workers over the course of their daily work-shifts, and to determine the relationship between worker activities and peak contaminant exposures. Specific objectives of the study are: 1) to thoroughly characterize the range of exposures to airborne contaminants faced by the workers, 2) to identify which activities lead to peak exposures to airborne contaminants, and 3) to analyze the foregoing evidence to provide a rational basis for managing health risks to career pig barn workers. The Toxicology Core has prepared and pre-weighed all their sampling cassettes and will post-weigh them and analyze all the air samples for endotoxin. Field work for this project is ongoing.

Outputs:

The GPCAH has produced numerous publications, presentations, and technical products which are included in the Appendix and the list of publications. Other items include:

- More accurate analytical methods for measuring agricultural dusts and bioaerosols
- Experimental and analytical methods for evaluating the mechanism by which agricultural dusts cause disease
- Assessment of how tractor tire ballast may cause eye injuries
- A better understanding of how exposures in animal confinement facilities and dust exposures when harvesting grain cause respiratory disease
- Recommendations for reducing worker exposures to dusts and gases
- Greater awareness about the health hazards associated with agricultural dust and gas exposures.

Outcomes:

There has been considerable effort put forth to improve the design of swine barns such that animal and farmer exposures to these inhaled toxicants are reduced while limiting additional capital and operating costs. Hoop barns represent an important alternative to conventional confinement housing. Hoop barns typically resemble a 2000 ft^2 Quonset-type hut that is roofed with coated fabric supported by arched metal tubing. Typically 200 to 250 feeder pigs are housed within each structure. Since hoop barns are open at both ends in warm weather and on one end in cold weather, air exchange rates are high and toxicant concentrations are likely lower. This, combined with less time required for farmers to spend in hoop barns, means that exposures are possibly much lower. If true, this could reflect lower respiratory morbidity among farmers and an additional benefit of hoop barns. This study included quantification of airborne contaminant concentrations and exposure durations in hoop barns and conventional confinement barns controlling for location, season, micrometeorological conditions, animal

density in the barns and other factors. GPCAH research helped to guide the design of swine barns to reduce worker exposures.

The GPCAH Toxicology Core conducted and facilitated research to characterize exposure-response relationships for toxicants that affect farmers and rural populations and explored the mechanisms by which these toxicants cause disease. The Toxicology Core also developed novel techniques for bioaerosol exposure assessment and improved analysis methods for aeroallergens. The Toxicology Core also trained students, post-doctoral fellows and junior faculty in the conduct of agricultural health research.

The results of the toxicology studies provided important information on the acute toxicity of inhaled mold and fungal glucans and their interaction with bacterial endotoxin. GPCAH studies discovered that cell signaling and key mediators that regulate inflammation during exposures to whole organisms and individual cell wall components of those organisms were the models for pulmonary inflammation. These studies characterized the cytokine and cellular response time course to inhalation of endotoxin, glucan, peptidoglycan, lipoteichoic acid, two Gram negative bacterial species (*Pseudomonas aeruginosa, Enterobacter agglomerans*), and two Gram positive bacterial species (*Micrococcus luteus, Bacillus megaterium*). This research showed that the Gram-negative organisms and much more potent inducers of inflammation than the Gram-positive organisms. Further the endotoxin content accounts for this greater potency of the Gram-negative organisms. Peptidoglycan, glucan, and lipoteichoic acid induce only a low level of neutrophil recruitment and cytokine signaling, even at high lung doses.

The Toxicology Core showed that the fungal glucans from the emerging contaminant of soy beans—the white mold *Sclerotinia sclerotiorum*—caused a respiratory response in humans and was a contributor to respiratory symptoms during soy been harvest. A health alert was provided to grain farmers advising them of methods to reduce their dust inhalation exposures during grain harvest.

The Toxicology Core developed improved methods for sampling and analyzing airborne endotoxins and fungal glucans. These methods have led to a better characterization of the exposures and disease risks of agricultural workers. The GPCAH continues to collaborate with other investigators to further improve these methods. A number of current researchers received their academic training working on these projects.

Great Plains Center for Agricultural Health

Agricultural Respiratory Disease Prevention Projects

Background:

Respiratory exposures to farmers and farm family members have been a major focus of GPCAH research. Significant exposures to organic dusts are the common denominator of respiratory exposure to agricultural workers. Studies of farm families in Iowa have documented that 80% of farm women, as well as a large proportion of children, are engaged in agricultural operations and therefore experience agricultural exposures. In addition to organic dusts from a variety of vegetable products, farmers are commonly exposed to multiple insecticides, herbicides and fungicides which are frequently respiratory irritants and are occasionally known to cause pulmonary fibrosis (paraquat and silica). Other important respiratory exposures include animal danders and proteins, irritant gases, antibiotics commonly used in feeds, mites and other insects, and an array of microbial toxins including gram negative endotoxins and a number of mycotoxins. Studies of swine, poultry, dairy, and grain farmers and handlers by GPCAH investigators have documented increased rates of chronic bronchitis, asthma, and functional declines in expiratory flow rates over a work shift compared to non-farm blue collar workers. GPCAH investigators have documented dose-response relationships between grain dust and endotoxin exposure, and cross-shift declines in FEV1 have been observed, as has longitudinal loss in lung function in association with cross-shift declines in lung function among swine confinement workers. Evaluation of the first 400 households from the Keokuk County Rural Health Study has already documented significantly more work-related respiratory symptoms and interaction between pack years and farm residence associated with poorer lung function among farm men and women. Evaluation of specific risk factors within this 1000 family cohort was the target of cross-sectional and prospective evaluation of lung function over the next five years. Case control studies regarding asthma and airway hyperresponsiveness were important priorities. The Agricultural Health Study also provides a unique opportunity to evaluate exposure to agricultural chemicals and pulmonary mortality.

Goals:

The GPCAH has conducted a variety of research projects to evaluate the exposures and health effects associated with respiratory disease among farmers, agriculture workers, and their families. The purpose of this research was the following.

1) Develop improved sampling and analytical techniques for more accurately assessing exposures to dusts and gases.
2) Measure dust and gas exposures associated with agricultural work and evaluate the factors affecting exposure levels.
3) Evaluate the association between dust and gas exposures, exposure risk factors, and health outcomes.
4) Develop recommendations for reducing dust and gas exposures and preventing disease.
5) Evaluate the genetic factors influencing susceptibility to developing respiratory disease from agricultural exposures.

The results of this research has led to numerous publications, presentations, and guidance for the development of interventions to reduce exposures.

Inputs:

The budgets for the work done on respiratory disease are presented in the attached database.

Supplemental funding was obtained from several research studies which were obtained by GPCAH staff. In conducting work on pesticides, the GPCAH partnered with researchers from NIOSH, the National Cancer Institute (NCI), the National Institute for Environmental Health Sciences (NIEHS), the Environmental Protection Agency, and the Iowa Center for Agricultural Health and Safety.

The primary staff for conducting this work included:
Wayne T. Sanderson, PhD
James A. Merchant, MD, DrPH
Peter Thorne, PhD
David Schwartz, MD, MPH
Ann Stromquist, PhD
Gregory Kullman, PhD
Stephen Reynolds, PhD
William Popendorf, PhD
Burton Kross, PhD
Martin Jones, PhD
Risto Rautiainen, PhD
William Groves, PhD
Peter Waldron, MS
Craig Taylor, MS

The facilities used for the research included the University of Iowa's Institute for Rural Environmental Health and the University Hygienic Laboratory. Off site field stations and clinics were also used to conduct research.

Inputs:

Activities:

Oil Mist Generation as a Dust Reduction Method in Swine Confinements: This study investigated the effectiveness of an oil sprinkling system as a dust reduction method in swine confinements. The control system achieved a 23-34% reduction in total dust using 5% oil-water emulsion automatically applied at the rate of 3 and 5 g/pig/day. An increased oil application rate of 7 and 8 g/pig/day, and modifications in the sprinkler heads reduced dust by 54% ($p = 0.005$) using either soybean or rape seed oils. The use of oil to reduce dust exposures in swine barns has been used by some producers. The aim of this project was to investigate the effectiveness of an oil sprinkling system as a dust reduction method in swine confinements. The experiment was conducted during two winter seasons (1997-98 and 1998-99) at Kirkwood Community College swine facility in Cedar Rapids, Iowa. A low-pressure sprinkling system using regular water line pressure was designed and installed by Fabrikken Unni from Denmark. This company has significant experience in building such systems on Danish swine farms. The sprinkling system consists of an oil mixing device, timer, water lines, and sprinkler heads above each pen. There were six pens in each treatment and control room with approximately 100 finishing pigs in each room. Two oil treatments were compared; rape seed oil was sprinkled in one room and soybean oil was sprinkled in another room and two untreated rooms were used as controls. A 5% oil-water emulsion was automatically applied at the rate of 3 and 5 g/pig/day. The oil application rate was increased to 7 and 8 g/pig/day, and sprinkler heads were replaced to

achieve a smaller droplet size and a more direct spray pattern on pen floor surfaces. Concentrations of several environmental contaminants were measured. The average total dust levels for controls were 1.39 mg/m^3. The average concentrations for treatment rooms were 0.65 mg/m^3. The treatment reduced dust by 54% ($p = 0.005$). The respirable dust concentrations were very low in all rooms and there were no significant differences between rooms in CO2, NH3, temperature, and humidity. Both oils performed equally well in this experiment.
The oil did contribute to increased cleaning requirements between herds since it stuck to rails, walls, and floor slats. In the followup study, soybean oil was applied at a rate of 6.7 grams per pig per day, and rapeseed oil was applied at a rate of 8.1 grams per pig per day. The sprinkling system was altered to a lower pressure and operated 12 times per day. Both oils worked equally as well, and dust levels were reduced by 54%.

Field Evaluation of Respirator Protection for Ammonia in Agricultural Environments: This project has focused on the development and testing of a pressure transducer-based personal sampling system to allow measurement of workplace protection factors. The system was designed to activate two sampling pumps during inspiration, thus allowing ammonia concentrations inside and outside the respirator to be measured. This approach addresses two potential problems associated with contiguous sampling: biased results due to lower contaminant concentrations in exhaled air, and high humidity. Ambient ammonia concentrations during the field tests averaged about 14 ppm in swine and poultry buildings. Remarkably high ammonia levels (~400 ppm) were measured in one emptied turkey building immediately following tilling of the ground in preparation for the next lot of turkeys. Workplace protection factors of 31, 34, and 90 were measured for the full face respirators initially tested. However, these results appear to be biased low. Since sensitivity has been a problem in general for the analysis of ammonia, implementation of a new analytical method is needed. Improved analytical sensitivity was achieved using ion chromatography. Testing respirator efficiency for a gas, such as ammonia, rather than particulates has only been attempted by a few other investigators and raises some unique technological issues. Sampling during exhalation versus inhalation raises a question of accuracy of the in-mask measurement, and the high moisture content of exhaled breath poses a potential concern for the direct reading ammonia sensing devices. This technique improved industrial hygiene sampling and analytical capabilities for ammonia.

In-Field Anhydrous Ammonia Applications: Anhydrous ammonia is a widely used agrichemical. Sampling was conducted on 19 field sites in Iowa during the application of anhydrous ammonia. Sampling sites were coordinated with a Co-Op distributor of anhydrous ammonia located in southern Iowa. Time-weighted average results from diffusive samplers and the concentration exposure profile from direct reading instrumentation with data-logging capability show significant exposures (>50 ppm) to ammonia during these applications. Correlations of ammonia concentrations with observations to identify tasks with the largest exposure potential, e.g., changing/repairing knives on the tool bar, were conducted. This work showed that anhydrous ammonia applicators experience periods of intensive exposure to anhydrous ammonia, particularly during hook-up and disconnecting operations. Recommendations were made to reduce exposures and protect workers during these operations.

Evaluation of Occupational Exposures at Composting Facilities: Activities on this project included identification of all compost/recycling facilities in the state of Iowa, and summary of available data on sources of materials, method of composting, and size of facilities. Evaluation included measurements of dust, bioaerosols, and noise, ergonomic assessment, and questionnaire ascertainment of work practices and health outcomes. Leaf piles at curbside

were collected using a Giant Vac collection system. Workers reported using dust masks less than 70% of the time, and were not observed using dust masks or hearing protection. Frequently reported symptoms that were work related included: dry cough (50%), cough with phlegm (31%), throat irritation (33%), headache (44%), tiredness (33%), joint pains (53%), and eye irritation (47%). Personal dust exposures were low on the one day measured - all less than 1 mg/m3. Bioaerosols measured using a direct count (modified CAMNEA) method ranged from 23,000 to 500,000 microorganisms/m3 for personal samples and 530,000 to 2,000,000 microorganisms/m3 for area samples. Area noise measurements ranged from 86 to 98 dBA, with most sound energy in frequencies between 125 to 8,000 Hz. Personal TWA noise measurements ranged from 83 to 91 dBA, with maximum levels reaching 137 dBA for short time periods. Ergonomic evaluations identified problems primarily for knees, shoulders, and lower backs. Specific recommendations for implementation of medical monitoring, hearing conservation, and engineering remediation were made.

Design of Tractor Cabs to Reduce Exposure to Dusts and Pesticides: The goal of this project was to use state of the art sampling/analytical methods to collect baseline information required to define criteria for certification of tractor cabs to comply with the U.S. EPA Worker Protection Standard for pesticide applications. Field sampling was conducted onsite in northern California from May 14 to 23, 1996. Polyurethane foam (PUF) Tubes, and one Marple® six stage dust impactor were used to collect air samples for pesticides inside and outside of test tractors. Pesticide deposited onto surfaces was also measured using gauze pads (3 x 3 inches, with a total exposed area of 24.6 cm^2). Analysis of PUF and Marple air samples, and gauze positional samples was conducted by The University of Iowa's Hygienic Laboratory using EPA Method TO10. Air sampling results outside of applicator and test tractors were low (0.33-31 ug/m^3). Air samples inside the test tractor cab were much lower than outside levels ranging from less than 0.2 - 0.42 ug/m^3. The ratio of outside to inside airborne concentrations ranged from 6.7 to 120. Positional samples provided results similar to air samples, with outside concentrations ranging from 4.8-180 ug/filter, inside concentrations ranging from less than 0.2 to 0.3 ug/filter, and ratios of outside vs. inside of 16 to 230. Particle sizes of pesticides for Sites 1, 2, and 5 were larger than 42.6 microns (μ). However, at Sites 3, and 4 (both with application of Dicofol to cotton) the size range was smaller with 16% to 26% of the aerosol smaller than 42.6 microns (determined by the difference between the mass collected on PUF Tubes vs. the mass on the Marple Impactors. For the aerosol fraction detected on the Marple Impactors, the Mass Median Aerodynamic Diameters (MMAD) were 9.5 and 14 μ. It is apparent that there may be wide variation in the particle size distributions of pesticide aerosols depending on several factors (formulation, pressure, evaporation, attachment to dust, wind velocity). While in many applications, the initial pesticide containing spray will have a mean particle size in excess of 50 microns, there are formulations and application procedures that can produce a smaller mean particle size. The small number of field tests conducted in this project demonstrated a potential for significant variation in aerosol size distribution, although the airborne and deposited concentrations of pesticides were consistent within an order of magnitude. Reduction in costs for further certification testing might be accomplished in two ways, if acceptable to regulators: If the relationship between positional and air samples is consistent, the use of only positional samples will reduce personnel time and equipment needs. A greater cost reduction could result from the use of a fluorescent tracer dye as a surrogate for the pesticides, thus eliminating significant analytical costs. In addition this would eliminate the risk of exposure to the pesticide, and allow testing to be conducted at any season or location. Further work using fluorescent tracer dye was conducted in late 1996 and 1997 demonstrating the feasibility of this approach.

International Interlaboratory Comparison of Endotoxin Assays: The goals of this project were: 1) to evaluate and compare the performance of different laboratories currently analyzing endotoxin air samples from various agricultural environments; 2) and to provide data to help develop a consensus on a standardized method for analyzing airborne endotoxin in agriculture. Bulk samples of dust from swine, chicken, and grain handling (corn) environments were used to generate homogenous aerosols in the laboratory using a one-cubic meter exposure chamber. Side-by-side samples were collected on 14 glass fiber filters and shipped to the participating laboratories including: NIOSH, the University of Iowa, Harvard, Sweden (R. Rylander), Sweden (P. Malmberg), Netherlands (D. Heederick), Australia (Connaughton). There were significant differences between laboratories for all three dust types ($p < 0.01$). The pattern of differences between labs varied by dust type. For chicken dust, labs using the endpoint method reported higher results than those using kinetic methods. For swine and corn dusts, the labs using the kinetic method reported the highest endotoxin values. For chicken dust, results from all six labs were highly correlated ($r = 0.85$ to 0.99). For swine dust, one lab (E) was not correlated, but the others were again highly correlated. For corn dust four of the labs were significantly correlated. All labs demonstrated excellent precision in analysis of duplicate samples. Statistical differences in performance between laboratories were apparent and may be related to the extraction and analytical methods.

Analysis of assay results from laboratories participating in this round-robin study using chicken, swine, and corn dust showed significant differences between laboratories for all three dust types ($p < 0.01$). The pattern of differences between labs varied by dust type. For Chicken dust, labs using the Endpoint method reported higher results than those using Kinetic methods. For Swine and Corn dusts, the labs using the Kinetic method reported the highest endotoxin values. For Chicken dust, results from all six labs were highly correlated ($r = 0.85$ to 0.99). For Swine dust, one lab (E) was not correlated, but the others were again highly correlated. For Corn dust four of the labs were significantly correlated. Most labs were within one standard deviation of the mean result for individual experiments. All labs were well within two standard deviations of the mean result for individual experiments. Statistical differences in performance between laboratories were apparent and may be related to the extraction and analytical methods.

Child Asthma: Three projects were built upon the Keokuk County Rural Health Study. The "Childhood Health Outcomes in a Rural Cohort (Asthma Case-Control Project)" directed by Dr. Merchant, involved a case-control study of asthma and asthma risk factors among children in this rural cohort. In addition to respiratory measures, skin reactivity to a panel of antigens was measured along with WBC and differential, and total IgE. Environmental assessments included evaluation of carbon dioxide, carbon monoxide, temperature, relative humidity, particulates, nitrogen oxides, and antigens of house dust mites, storage mites, cockroaches, cat, dog, mice and rats from surface samples. To characterize and validate the surface sampling method used in this project, a laboratory study was conducted of "Factors Influencing Surface Sampling of House Dust Mite Allergens from Worn Carpets. The collection efficiency of the High Volume Small Surface Sampler (HVS3) was evaluated under differing conditions including: degrees of carpet wear, relative humidity of the worn carpets during sampling, the house dust loading concentration, carpet construction characteristics, and differences in electrostatic charge. The goal of this study is to develop, implement, and test a community-based, multi-component model for the prevention of asthma among rural children. This study included environmental interventions.

Poultry Workers: The GPCAH worked colleagues at the University of Saskatchewan on a study of respiratory disease in poultry producers in three Canadian provinces. The aim of the proposed study is to investigate the mechanisms of acute health effects among poultry workers

from exposure to the indoor environment of caged and floor-based poultry barn operations and to compare the results with those of control subjects. As part of this project, 183 workers from floor-based poultry barns (broiler/breeder and turkey), 114 from cage-raised poultry barns (egg/pullet), 197 non-farming control subjects and 235 grain farmers were recruited from the Provinces of Saskatchewan, Alberta and Manitoba. This work showed that poultry workers were exposed to high concentrations of bioaerosols and experience acute respiratory problems.

Toxicology Core: The Toxicology Core of the GPCAH was formed to conduct and facilitate research to characterize respiratory exposure-response relationships for toxicants that affect farmers and rural populations and to explore the mechanisms by which these toxicants cause disease. The Toxicology Core worked to develop novel techniques for bioaerosol exposure assessment and improved analysis methods for aeroallergens. The research focus of the Toxicology Core is inhaled toxicants with the lung and immune system as the principal target organs of interest. Very broadly, the xenobiotics of interest included the microorganisms, endotoxins, exotoxins, mycotoxins, phytotoxins, glucans, peptidoglycans,and teichoic acids. This core also evaluated exposures to grain storage mites, house dust mites, molds, thermophilic organisms, urine and avian proteins, epidermal antigens, and pesticides, disinfectants, solvents, fuels, and the gases ammonia, hydrogen sulfide, carbon monoxide, nitrogenoxides, mercaptans.

The Toxicology Core completed toxicology studies investigating the pulmonary effects of inhaled soybean white mold, *Sclerotinia sclerotiorum* (SS). SS is an emerging phytopathogenic soybean fungus rich in (1→3)β-D glucans identified by focus groups. In response to this concern, an exposure assessment was performed on Iowa farms in 1997 and 1998. Air samples were collected in multiple locations during soybean harvesting using open-faced filter cassettes and cascade impactors. Airborne concentrations of collected airborne dust were quantified by gravimetric analysis. Microbiological analysis of bacteria and fungi were performed using both conventional culture methods and flow cytometry. Bacterial endotoxin was quantified by the *Limulus* Amebocyte Lysate assay and fungal glucans by enzyme linked immunosorbent assay (ELISA). Results indicated high levels of total dust present. Many of the ambient sites sampled exceeded the American Conference of Governmental Industrial Hygienists recommended threshold limit value for total and inhalable dust of 15 and 10 mg/m^3, respectively. The estimated mass median aerodynamic diameter, MMAD, of the airborne dust during the soybean harvest in both personal (3.8 μm, σ_g 1.3) and ambient samples (6.5 μm, σ_g 2.0) was much smaller than the mean MMAD of 49 μm and σ_g of 1.2 reported in the literature for corn harvest. Bioaerosol analysis revealed exceedingly high concentrations of bacteria, fungi, endotoxins, and glucans. Mean concentrations of total bacteria inside the combine cab in year I and II of 1.4x10^3 and 2.4x10^3 CFU/m^3, respectively, were substantially lower than previously reported levels of airborne bacteria for wheat and barley harvests. Similarly, mean airborne fungal concentrations in year I (4.4x10^4 CFU/m^3) and year II (4.9x10^5 CFU/m^3) were slightly lower than previously measured levels during grain harvest. The mean fungal concentrations inside the combine cabin in year I and II (2.0x10^3 and 1.2x10^4 CFU/m^3) were also lower than reported mean levels inside the combine cabin. Fungal speciation showed that *Cladosporium* spp. and to a lesser extent *Alternaria* spp. were the predominant mold spores in the air during soybean harvest.

The mean levels of bacterial endotoxins detected in ambient air for years I and II (4,438 and 459 EU/m^3, respectively) were higher than the range reported in other agricultural environments such as grain handling whereas the personal samples in year I and II (310 and 8 EU/m^3, respectively) were lower than reported values for other enclosed work environments such as

swine confinements. Both personal and ambient endotoxin concentrations were significantly correlated with airborne bacteria. In addition to endotoxin determination, (1→3)β-D glucan concentrations for year I were much higher than year II. Ambient glucan concentrations were approximately 1 order of magnitude higher in year I despite an increase of airborne fungi of approximately 1 order of magnitude in year II.

Concurrent with the exposure assessment, a series of animal toxicology experiments was performed to characterize the response kinetics and pulmonary toxicology of soybean dust extract, bacterial endotoxin, fungal glucans, or pure culture of *SS*, either neat or within a mixture. Mice were acutely exposed by intratracheal instillation or via inhalation of a nebulized extract, lyophilized extract, or dry dust. Importantly, the results of the exposures showed that *S.sclerotiorum* induced pulmonary inflammation, although the toxicokinetics proved different than that of other organic dust components such as endotoxin. This conclusion is based on the significantly higher levels of bronchoalveolar lavage (BAL) fluid neutrophils and increased proinflammatory cytokines at 12 and 24 hours post exposure over that of sham exposed animals. Mixed exposures with endotoxin and either *SS* or glucans showed that endotoxin-induced pulmonary inflammation is affected by the presence of fungal glucans, marked by the reduction of total and inflammatory cells and cytokines in the endotoxin + *SS* or glucan exposure groups when compared to the group exposed to endotoxin only. In the endotoxin + *SS* group, both total BAL fluid cells and neutrophils were significantly increased over controls, whereas only total cells were significantly increased in the endotoxin + glucan group. This may indicate that another yet unidentified component of *SS* may further inhibit chemotaxis. This is contrary to the significantly lower concentrations of chemokines in the endotoxin + glucan group than the endotoxin + *SS* group. In summary, the toxicology results showed that 1) *S.sclerotiorum* and glucan caused a delayed (24 hour) inflammation of the lower lung, 2) co-administration of glucan and endotoxin blunted neutrophil influx and inflammatory mediator production in the lung, and 3) fungal glucan content likely contributed to fungal bioaerosol-induced pulmonary inflammation.

An investigation to assess the utility of urinary leukotriene E_4, LTE_4, as a minimally invasive response biomarker of acute pulmonary inflammation was performed. LTE_4 levels were quantified by ELISA in experimentally-exposed human subjects and mice, and occupationally-exposed humans. In addition, the mRNA of 5-lipoxygenase was measured in whole lung homogenate from mice exposed to different organic dusts. 5-lipoxygenase is a primary participant in the arachidonic acid cascade, the process responsible for the formation of leukotrienes *in vivo*. Measuring the mRNA for 5-lipoygenase allows an indirect determination of the quantities of this molecule being expressed in the tissue, and may help to illuminate the LTE_4 results observed. The results of the leukotriene analysis further defined the susceptibility of the host to environmental insult. Although LTE_4 did not prove to be a very stable or specific response biomarker, the results, nevertheless, showed that leukotrienes are powerful mediators of inflammation and do play a role in organic dust-induced lung inflammation. Importantly, the results of the analysis established that murine and human levels of urinary LTE_4 will increase after exposure to certain constituents of organic dusts, although it remains unclear which component caused the increase.

The results of the toxicology studies provided important information on the acute toxicity of inhaled mold and fungal glucans and their interaction with bacterial endotoxin. In current studies we are investigating cell signaling and key mediators that regulate inflammation during exposures to whole organisms and individual cell wall components of those organisms using an established murine model for pulmonary inflammation. These studies have characterized the

cytokine and cellular response time course to inhalation of endotoxin, glucan, peptidoglycan, lipoteichoic acid, two Gram negative bacterial species (*Pseudomonas aeruginosa, Enterobacter agglomerans*), and two Gram positive bacterial species (*Micrococcus luteus, Bacillus megaterium*). A report on this work is in preparation. This research has shown that the Gram-negative organisms and much more potent inducers of inflammation than the Gram-positive organisms. Further the endotoxin content accounts for this greater potency of the Gram-negative organisms. Peptidoglycan, glucan, and lipoteichoic acid induce only a low level of neutrophil recruitment and cytokine signaling, even at high lung doses.

Another project conducted in conjunction with funding from the Iowa Center for Health Effects of Environmental Contamination and the Leopold Center found inhalation of toxicants is a common hazard of employment in agriculture and these exposures lead to significant morbidity among swine farmers. Important toxicants include gases and vapors (ammonia, hydrogen sulfide, carbon monoxide, nitrogen oxides), infectious and non-infectious bioaerosols (bacteria, fungi, viruses, parasites), products of microorganisms (endotoxins, peptidoglycans, glucans) and aeroallergens of animal, plant, or microbial origin. Lung diseases arising from exposures in swine barns are often not discreet diseases but may include several conditions with overlapping symptomatology. Most lung injuries result from exposures that are not immediately dangerous to life and health but consist of acute lung insults that may lead to chronic declines in lung function. Respiratory problems associated with this environment include upper and lower airway diseases and interstitial lung disease. Immunologic hypersensitivity appears to be uncommon in swine workers and the pathogeneses is primarily associated with acute and chronic inflammatory processes. There has been considerable effort put forth to improve the design of swine barns such that animal and farmer exposures to these inhaled toxicants are reduced while limiting additional capital and operating costs. Hoop barns represent an important alternative to conventional confinement housing. Hoop barns typically resemble a 2000 ft^2 Quonset-type hut that is roofed with coated fabric supported by arched metal tubing. Typically 200 feeder pigs are housed within each structure. Since hoop barns are open at both ends in warm weather and on one end in cold weather, air exchange rates are high and toxicant concentrations are likely lower. This, combined with less time required for farmers to spend in hoop barns, means that exposures are possibly much lower. If true, this could reflect lower respiratory morbidity among farmers and an additional benefit of hoop barns. This study includes quantification of airborne contaminant concentrations and exposure durations in hoop barns and conventional confinement barns controlling for location, season, micrometeorological conditions, animal density in the barns and other factors. These data will allow us to determine the relative health risks associated with hoop barns versus conventional swine operations. A large Eastern Iowa pork producing farm with both hoop structures and conventional confinement swine barns on a nearby site has been selected for the study. Descriptive data will be generated for exposures and environmental conditions across seasons for both barn types. In addition, we will test hypotheses regarding differences between worker exposures to particulates, bioaerosols, endotoxins, vapors or noise in hoop structures vs. conventional confinement facilities; differences across seasons in worker exposure to particulates, bioaerosols, endotoxins, vapors or noise in swine facilities; differences in microbial flora between hoop structures and conventional confinement facilities; and differences in analyte exposure levels between barns within barn type after controlling for season, wind speed and pig density.

The Toxicology Core has made substantial progress on inhalation toxicology studies of grain dust contaminants and agricultural bioaerosols in animal models of pulmonary inflammation and hypersensitivity pneumonitis. Corn dust inhalation studies included evaluation of pulmonary cytokines and adhesion molecules associated with lung inflammation, apototic change, pulmonary function changes and histomorphometric analysis of lung remodeling.

The Toxicology Core provided assistance to Dr. Steve Hrudy and Irene Wenger at the University of Alberta in collecting air samples from very intensive, factory-style swine houses. This collaboration allowed us to have access to an industry that has been difficult to study in the United States. Alberta's pork industry requires a highly skilled, stable labor force. Over the past 10 to 15 years, pig barn work has evolved from operations in which workers were only required to spend a portion of their day in the barn, to the current situation where full-time work is required in intensive housing facilities. The increase in the number of hours worked per day in the barn, along with demonstrated levels of airborne particulate and gases inside these facilities, has resulted in net increases in daily exposures for workers to air contaminants in these facilities. Previous investigations into the respiratory health of pig barn workers identified a number of environmental contaminants present in the pig barn environment, including dust (inhalable and respirable), gases (NH_3, H_2S, and CO_2) and endotoxin. Studies have shown that endotoxins can induce bronchoconstriction, organic dust toxic syndrome, or mucous membrane irritation. Other chemicals, including disinfectants, are routinely used in pork production facilities. However, exposures to these compounds, have not been adequately categorized. Previous investigations to determine the relationship between barn environment exposure and respiratory health of pig barn workers have focused on workers from small scale operations, who often have responsibilities outside the barn and spend, on average, four hours in the pig barn daily. In modern, large scale facilities, many operations have a shower-in policy, such that workers often remain inside the barn for the duration of their 8 to 10 hr work shifts. To date, no research has reported on the exposures of specialty career pig barn workers to dust, gases and endotoxin. In addition, limited information exists on the workers' daily activities, and the effects that these activities have on exposures to barn contaminants. Large intensive pig facilities and their workers have been previously inaccessible to researchers due to their stringent biosecurity requirements. In this project, Dr. Hrudy has developed and validated a rigorous biosecurity protocol that allows exposure assessment instrumentation to be transported to independent pork production facilities across Alberta. The current study is a two-phase collaboration between Dr. Hrudy and the Toxicology Core to classify and quantify the exposures of specialized career pig barn workers over the course of their daily work-shifts, and to determine the relationship between worker activities and peak contaminant exposures.

Grain Handlers Study: The GPCAH performed inhalation toxicology studies of grain dust contaminants and agricultural bioaerosols in animal models of pulmonary inflammation and hypersensitivity pneumonitis. We compared the kinetics of human and mouse grain dust-induced lung inflammation and the production of proinflammatory cytokines. The concentration-time profiles for tumor necrosis factor α, interleukin-6, and interleukin-8/MIP 2 were analogous and served to further validate our murine model for grain dust lung injury. The GPCAH also performed two 3 month subchronic inhalation toxicology studies of grain dust in parallel with endotoxin inhalation and saline inhalation groups. Mice were serially sacrificed in monthly intervals post-exposure. Analysis of pulmonary cytokines and histopathology demonstrated ongoing inflammation with progressive fibrosis that continued to progress several months after exposure had stopped. This work followed publication of our studies comparing the kinetics of human and mouse grain dust-induced lung inflammation and the production of proinflammatory cytokines. The concentration-time profiles for tumor necrosis factor α, interleukin-6, and interleukin-8/MIP 2 were analogous and served to further validate our murine model for grain dust lung injury.

The Genetic Determinants of Organic Dust Induced Airway Disease: The overall hypothesis of this investigation was that genetic factors predispose individuals to develop airway disease following inhalation of organic dust. Our previous studies indicated that endotoxin appears to be

the principal component of organic dusts responsible for the development of airway inflammation and airflow obstruction, and that alveolar macrophages and airway epithelia actively participate in this inflammatory response by releasing specific cytokines following inhalation of organic dust. In addition, our previous studies indicated that individuals occupationally exposed to endotoxin can be categorized as either high responders or low responders based on their exposure to endotoxin and the cross shift change in airflow. Interestingly, specific strains of mice have also been found to be high and low responders to endotoxin and this trait has been mapped to a region on chromosome 4 which overlaps with the interferon α and β genes. Based on the genetic information from this animal model, we attempted to determine the genes and/or genetic loci that are associated with high and low endotoxin responders in grain workers. The goal of this research project was to identify a group of genes and genetic loci that play a role in the development of organic dust induced airway disease in humans.

Several lines of evidence indicated that the physiologic response to grain dust is mediated by an acute inflammatory response in the lower respiratory tract that is primarily induced by endotoxin. First, the atopic status and the presence of specific antibodies have not been consistently associated with either acute or chronic airway responses to inhaled grain dust. Second, in vitro, grain dust can activate complement through the alternate and classical pathways, however, activation of complement does not appear to be important in the development of grain dust induced airflow obstruction. Third, in vitro studies have demonstrated that grain dust can induce macrophages to release neutrophil chemotactic factors and IL-1, and animal studies have shown that inhaled grain dust causes a neutrophilic response in the lower respiratory tract Fourth, human inhalation studies have shown that grain dust can induce airflow obstruction in previously unexposed individuals, grain dust induced airflow obstruction occurs within 30 minutes of exposure, and this response is dependent on the inhaled dose of grain dust. Humans challenged with aerosols of grain dust extract will rapidly accumulate neutrophils in the upper and lower respiratory tract. Fifth, we have shown that the concentration of endotoxin in the bioaerosol is the most important occupational exposure associated with the development and progression of airway disease in agricultural workers. We have also shown that when compared to endotoxin sensitive mice, mice resistant to endotoxin either by genetic or acquired mechanisms have a reduced inflammatory response to inhaled grain dust.

Results from our population-based survey of grain handlers in Eastern Iowa indicate that endotoxin appears to play an important role in the development of respiratory symptoms and airflow obstruction in grain handlers. However, when we looked at the cross-shift change in forced expiratory volume, we found that the change in airflow was not related to the concentration of endotoxin in the bioaerosol. Examining this further we found that some individuals had a paradoxical response to endotoxin. In other words, some individuals had a marked decline in airflow when challenged with low concentrations of endotoxin in the workplace while other individuals had a marked decline in airflow when challenged with minimal concentrations of endotoxin in the workplace. Using our population-based sample of 410 grain workers, we identified 60 individuals that had at least a 5% decline in airflow across a four hour workshift with minimal endotoxin exposure (less than 500 Eu/m^3) and 60 individuals with a minimal response to endotoxin in the workplace (an improvement in FEV_1 across a four hour workshift while being exposed to greater than 1,000 Eu/m^3 of endotoxin). For the purposes of this study, we have characterized the former group as high endotoxin responders and the latter group as low endotoxin responders. The genetic material from these two study groups will serve as the basis for this investigation.

In parallel with these clinical observations in grain workers, lipopolysaccharide (LPS) resistance has been clearly documented in mice. Some time between 1960 and 1965, a spontaneous mutation occurred within the C3H/HeJ colony that has rendered this strain profoundly refractory to the toxic effects of LPS. Analyses of the inheritance of LPS responsiveness in recombinant inbred strains have established that the gene for LPS resistance is located on chromosome 4 between Mup1 and Ps, suggesting the possibility of physical overlap of the LPS gene with the interferon-α and interferon-β genes on chromosome 4. Importantly, the C3H/HeJ mice fail to produce normal levels of endogenous interferon, and interferon-α and interferon-β has been shown to promote macrophage differentiation. The α and β interferon genes in mice and humans are similar structurally and have a high degree of sequence homology, indicating that these genes (and the surrounding genetic material) are highly conserved between mice and humans.

In aggregate, these findings indicate that endotoxin may be primarily responsible for the development of grain dust induced airway disease and that humans and mice appear to have a variable response to endotoxin. Moreover, the proximity of the α and β interferon genes to the LPS resistant loci in mice, as well as the biologic importance of interferon-α and interferon-β suggests that these genes may account for the differential response to LPS in humans. Alternatively, the proximity of the α and β interferon genes to the LPS resistant loci in mice may help define the location of the LPS resistant gene in humans. Thus, our initial strategy to identify the genetic determinants of organic dust induced airway disease is to focus on the interferon-α and interferon-β genes and their homologous loci in humans.

Assessment of Respiratory Disease Among Dairy Farmers: This study constituted the most comprehensive environmental study of dairy farming to date. In addition to the in-depth assessment of exposures, it also allowed comparison of immunologic and respiratory findings to exposures in dairy farming with special attention to organic dusts. The medical portion of this study culminates several years of investigations with this population of dairy farmers while the environmental measurements portion contributes a thorough exposure assessment and evaluation of the work environment and practices. A general survey at 61 farms included a detailed questionnaire covering the farm operations, personal and area air sampling for total dust, inhalable dust and respirable dust, determination of particle size distribution, airborne microorganism concentration, endotoxin concentration, aeroallergen concentrations (mites, cattle epithelium, etc.), gas concentrations (CO_2, NH_3, H_2S, CO), temperature, humidity, and barn ventilation. Each of these farms was visited once beginning before the morning milking. Twenty-five sites included in a detailed survey were visited once in the summer and once in the winter and included all the analyses of the general survey plus an extensive evaluation of the viable microbial environment using multiple methods in duplicate.

All of the field work, laboratory analyses, and medical evaluations are completed and this study is in the last stages of data analysis. Specific aims 1 and 2 above are completed and we are now linking the exposure data with the medical data to begin analyses to address specific aims 3 and 4. The study cohort included a stratified random sample of farmers drawn from a larger prospective cohort study. The sample included 101 farmers on 85 different farms from a 3 county area in central Wisconsin. Field surveys were done at all 85 confinement barns to characterize occupational exposures and environmental conditions. 25 of these farms were studied in both summer and winter to assess seasonal differences in bioaerosols and aeroallergens. Environmental analytes included those shown in the table below. Information on farm demographics, farming practices and barn characteristics was also collected from each study site. Time-weighted average dust concentration from the 159 personal inhalable samples

ranged from below detectable limits (0.01 mg/m^3) to a high of 53.6 mg/m^3. The geometric mean (GM) concentrations for airborne toxicants are listed below. Endotoxin exposures from the personal inhalable samples ranged from 41.8 mg/m^3 to 34,800 mg/m^3. The GM endotoxin exposure from these samples, 742 EU/m^3, exceeds estimated threshold exposure levels for respiratory health effects.

Farming activities and barn characteristics were found to impact both barn concentrations and personal exposures to these analytes. These data demonstrate the complex nature of organic dusts and provide a description of the exposures to organic dust constituents during routine confinement farming activities. The exposure databases provide the information needed to elucidate dose response relationships in the dairy environment and will allow us to document the effectiveness of various control approaches.

One additional component of this study was a nested examination of the reliability of shipping bioaerosol samples to a distant lab for analysis. Three methods of sampling were studied in a pairwise fashion with duplicate, simultaneous side-by-side sampling. The all-glass impinger (AGI) was used in two methods, but with different collection media (peptone solution in both seasons and betaine solution in winter). The third method, NFE (Nuclepore filtration and elution), used air filtration with subsequent elution and culturing. For each sample, one of the duplicates was analyzed within 2 hours in a laboratory less than 50 km from the sampling site (Field Lab), while the other was express mailed to our own laboratory (Home Lab). This study was undertaken to examine the relationship of sample storage and shipping in determining bioaerosol concentrations separately for yeasts, molds, mesophilic bacteria and thermophilic organisms. Concentrations of all microorganisms determined by sampling with the AGI peptone method were unaffected by mailing in winter, but mesophilic bacteria increased in the summer. AGI betaine samples were also unchanged except for increased concentrations of molds after mailing in winter, while yeasts and mesophilic bacteria concentrations significantly decreased after mailing of the NFE. Another goal of this study was to systematically compare the performance of the three sampling methods for these organism classes. Pairwise comparison of the 3 sampling methods in the winter yielded no significant differences in airborne concentrations for the yeasts, mesophilic bacteria, and thermophilic bacteria. Both AGI betaine and NFE methods had significantly greater concentrations of molds than AGI peptone. In summer, concentrations of yeasts and mesophilic bacteria were significantly greater with AGI peptone as were molds with the NFE method. Overall, this study supports the notion that bioaerosol samples can be reliably collected in the field and shipped on ice overnight to a distant laboratory with certain restrictions. The NFE method is recommended for molds and thermophilic organisms although the AGI peptone method was also good. For yeasts and mesophilic bacteria concentration measurements, the AGI was better than the NFE. Differences of performance between collection media in AGI were minimal.

Experimental Exposures to Grain Dusts: The goal of this research was to investigate the possible roles of airways inflammation and pulmonary hypersensitivity in the pathogenesis of grain dust-induced pulmonary disease using inhalation animal models. Inhalation studies using guinea pig and mouse models allowed us to successfully identify sensitive response indicators in bronchoalveolar lavage fluid and serum that correlate with histopathology in the mouse and guinea pig and pulmonary function changes in the guinea pig. Two principal animal models were used to evaluate airway inflammation due to inhalation of grain dust--guinea pigs and mice to characterize the dose-response relationships for grain dust-induced pulmonary diseases. We identified several key biomarkers that serve as indicators of exposure and predictors of disease. Bronchoalveolar lavage fluid obtained from the exposed guinea pigs and mice were analyzed for content of a variety of biomolecules that indicate airway inflammation with profound

peribronchiolar neutrophilia. These include interleukin-1ß (IL-1ß), IL-8, and tumor necrosis factor-α (TNF-α).

To assess the potential for immunologic sensitization to inhaled protein in soybean dust, inhalation studies were conducted in guinea pigs using soybean dust samples taken from an Iowa processing facility. Dry aerosols of the dusts were generated into an exposure system using the acoustical dry aerosol generator elutriator. Quantitative assessment of microbiological makeup, endotoxin, fumonisin, and protein concentration, and particle size distribution for this aerosol was performed and compared to atmospheres sampled at grain sites. Animals were exposed using 3 protocols: single acute 4 hr exposures, 10 consecutive 4 hr weekday exposures, and 20 such exposures. Control groups were either sham exposed or were hyperimmunized with protein extracted from the soybean dust prior to challenge. Animals received inhalation challenges either 2 or 14 days after the exposure protocol or were sham challenged. This soybean dust had significant bioactivity at the concentrations studied. BALF from exposed animals had increased neutrophil chemotactic activity, IL-8 and TNF-α above control animals. Biomarker profiles were different for acute vs. subchronic protocols. Although immunologic sensitization to soybean dust protein developed, the guinea pigs did not develop pulmonary hypersensitivity in the subchronic or hyperimmunized protocols. Thus, immunologic sensitization was not a requirement for the airway responses observed.

Outputs

The GPCAH has produced numerous publications, presentations, and technical products which are included in the Appendix and the list of publications. Other items include:

- More accurate analytical methods for measuring dust and gas exposures in agricultural environments
- Improved analytical methods for measuring the toxic effects of dusts and gases on the respiratory system
- Validated questionnaires for determining dust and gas exposures, work practices, and exposure hazards
- Recommendations for reducing worker exposures to dusts and gases associated with respiratory disease
- Greater understanding of the genetic predisposition of individuals to develop respiratory disease from agricultural exposures.

Outcomes:

GPCAH demonstrated that vegetable oils could be used successfully to reduce dust levels in swine barns. Our investigations showed that dust levels were reduced by over 50%. A few farm operators have adopted this technique for reducing dust levels, but because it does increase clean up efforts it has not resulted in widespread use.

GPCAH investigators developed a pressure transducer-based personal sampling system to allow measurement of workplace protection factors for respirators. This approach addressed two potential problems associated with contiguous sampling: biased results due to lower contaminant concentrations in exhaled air, and high humidity. This technique improved industrial hygiene sampling and analytical capabilities for ammonia. This improved sampling technique was used to assess the exposures of farmers applying anhydrous ammonia and used to evaluate the effectiveness of respirators to control that exposure. Recommendations have been made through a variety of media to reduce exposures and protect workers during these

operations. These recommendations have resulted in training courses, educational materials, and guidance to ammonia applicators. The protective measures employed by these applicators have served to reduce their exposures to ammonia.

Numerous studies were conducted to evaluate the exposures and associated health hazards of workers in a variety of agricultural operations. These studies included measurements of dust, bioaerosols, and questionnaire ascertainment of work practices and health outcomes associated with composting facilities, livestock farms, dairies, and grain production. In addition to work operations, the respiratory disease risk children living on farms and in rural areas. These studies resulted in a greater understanding of how exposures cause disease and recommendations to reduce these exposures. Farm families and agricultural workers now have a greater understanding of their respiratory disease hazards.

Coupled with describing disease risks has been an on-going effort to develop and evaluate preventive measures to reduce disease risks. In particular, GPCAH researchers demonstrated that farm machinery cabs—when properly designed and maintained have the ability to dramatically reduce operator exposures to dusts and pesticides.

The GPCAH has been a leader in developing new techniques to more accurately measure exposures to dusts, gases, bioaerosols, and the components of bacteria and fungi. The GPCAH led an international interlaboratory comparison of endotoxin assays: Statistical differences in performance between laboratories were apparent and may be related to the extraction and analytical methods. The results of this work has led to great improvements in methods for sampling and analyzing for endotoxins, gases, and dusts. These improved methods have been adopted by other researchers resulting in more accurate determination of exposure levels. This makes for more accurate assessment of disease risks and the progress towards developing criteria for safe levels of exposure.

A interesting development from the GPCAH work has been the discovery that genetic factors predispose individuals to develop airway disease following inhalation of organic dust. Our studies indicated that individuals occupationally exposed to endotoxin can be categorized as either high responders or low responders based on their exposure to endotoxin and the cross shift change in airflow. Based on the genetic information from animal models, we have helped to determine the genes and/or genetic loci that are associated with high and low endotoxin responders in grain workers and to identify a group of genes and genetic loci that play a role in the development of organic dust induced airway disease in humans.

Great Plains Center for Agricultural Health

Agricultural Pesticide Exposure Projects

Background

Since about 1930, the growing use of chemicals in farming practice has brought new hazards to farming. Chemical fertilizers, insecticides, herbicides, fumigants, biocides, and bioactive feed additives have all served to increase productivity (and in some cases improve public health through control of vector-borne disease) but have led to increased incidence in diseases that were previously rare in farming. Agricultural chemical use is associated with systemic poisoning, dermatitis, pulmonary injury, neurotoxicity, chemical burns, cancer, immunosuppression, alterations in neuroendocrine function, and occasionally hypersensitivity. Cases of acute systemic poisoning arising from spills, improper use, or premature re-entry to sprayed or fumigated locations, have been associated with organic mercury, arsenicals, endrin, dieldrin, DDT, chlorpyrifos, parathion, atrazine and aldecarb. The wide array of pesticides in use, a $30 billion business worldwide, are associated with a host of acute toxic effects such as cholinesterase inhibition for organophosphates and carbamates, neurotoxicity of the organochlorine and organometal pesticides, severe cardiopulmonary effects and lung fibrosis of bipyridyl compounds such as paraquat. Some of the pesticides are more often associated with chronic diseases. For instance the chlorophenoxy herbicides such as 2,4-d and 2,4,5-T were found to be teratogenic and carcinogenic, largely due to trace contamination with 2,3,7,8-tetrachlorodibenzo-p-dioxin or TCDD. Other pesticides have been linked to neurological impairment or Parkinsonian-like syndromes. Interestingly the route of exposure may not be related to the target organ. More recently, the immunomodulatory effects of pesticides have been studied. While immunosuppression is the primary immunomodulatory effect observed at least one class of pesticides (quaternary ammonium compounds) have been found to have adjuvant effects. There is currently considerable debate among toxicologists regarding the human health significance of environmental estrogens. Endocrine disruption by pesticides has been demonstrated to occur by estrogenic and anti-estrogenic effects as well as by anti-androgenic mechanisms. Examples include TCDD with its anti-estrogenic potency and estrogenic action, the fungicide vinclozolin with anti-androgenic effects, and the pesticide chlordecone (Kepone) which exerts estrogenic potency. It should be noted that some of the mycotoxins can also act as endocrine disrupters (e.g. zearalenone). Significant pesticide exposures can arise during a variety of agricultural tasks. Dermal exposures with subsequent percutaneous absorption are generally the most important for pesticides. These have been shown to arise particularly during mixing, loading, and unloading. Inhalation exposure due to drift during application, inadequate respirator use, or exposure in tractor cabs lacking proper air filtration also occurs. Premature reentry of farm laborers to sprayed fields, groves or orchards has led to significant morbidity and even death.

Goals:

The GPCAH has conducted a variety of research projects to evaluate the exposures and health effects associated with pesticide use in agriculture and rural areas. The purpose of this research was the following.

1) Develop improved sampling and analytical techniques for more accurately assessing pesticide exposures.
2) Measure the inhalation and dermal exposures and absorbed doses associated with pesticide use and evaluate the factors affecting exposure levels.
3) Evaluate the association between pesticide exposures, exposure risk factors, and health outcomes.
4) Develop recommendations for reducing pesticide exposures and preventing disease.

The results of this research has led to numerous publications, presentations, and guidance for the development of interventions to reduce exposures.

Inputs:

The budgets for the work done on pesticides are presented in the attached database.

Supplemental funding was obtained from several research studies which were obtained by GPCAH staff. In conducting work on pesticides, the GPCAH partnered with researchers from NIOSH, the National Cancer Institute (NCI), the National Institute for Environmental Health Sciences (NIEHS), and the Environmental Protection Agency.

The primary staff for conducting this work included:
Wayne T. Sanderson, PhD
Stephen Reynolds, PhD
William Popendorf, PhD
Burton Kross, PhD
Martin Jones, PhD
Risto Rautiainen, PhD
William Groves, PhD
Peter Waldron, MS
Craig Taylor, MS
Brian Curwin, MS
Vijay Golla, MS

The facilities used for the research included the University of Iowa's Institute for Rural Environmental Health and the University Hygienic Laboratory. Off site field stations and clinics were also used to conduct research.

Activities:

Methods for Monitoring Agrichemicals: The GPCAH developed efficient and reliable methods for both environmental and biological monitoring of occupational exposure to agricultural chemicals, natural toxins and life threatening gases. The methods developed included standard quality control and quality assurance protocols and analytical methods.
The wide spread use of agricultural chemicals creates an urgent need for assessing the health risk to farmers during field application. The GPCAH developed the application of online

supercritical fluid extraction and supercritical fluid chromatography (SFE/SFC) to the analysis of chemicals. SFE/SFC will then be used to collect an initial exposure data base for epidemiologic assessment of the cancer risk. This state-of-the-art method ensured accurate assessment of the occupational exposure.

Dermal exposure to chemical agents is a significant hazard in many occupations. In agriculture, dermal exposure to pesticides is often more important than other routes of exposure. Since at least the 1950's, assessment of dermal exposure has relied primarily on patch sampling techniques which may not provide an optimally accurate measure of dermal dose. Richard Fenske, at the University of Washington, first developed and described a radically new approach to dermal exposure assessment using fluorescent tracer dyes and a video imaging system. In the original concept, fluorescent dyes are added to, or used in place of pesticide solutions and subjects then performed their normal work tasks. Following exposure, subjects were illuminated using a flat UV light panel and the quantity of fluorescence is detected using a video camera and quantified with a computer program with calibration of gray scale values to standard dye concentrations. The investigators, particularly Drs. Kross, built a VITAE system multi-lamp UV system based on Fenske's original design and have conducted experiments on calibration and application in agricultural settings. Several problems with this system became evident, and needed to be resolved to improve performance. In particular the quality of lighting, distribution of illumination, angle of illumination relative to the curvature of body components, and stability were improved. Variations in discrimination of fluorescence depending on skin tone are dramatic, and affect the calibration curve. At the recent workshop on Design of Pesticide Control Technologies Based on Improved Exposure Measurement Methods, Dr. Martin Roff of the UK described a new type of illumination system which surrounds the subject with light, thus eliminating several illumination problems and the need for correction factors. In this project, the GPCAH expanded upon Dr. Roff's work by designing, building, and validating an improved illumination system for the VITAE system at the University of Iowa. Initial work entailed the design and construction of a dodecahedral illumination system which will produce a uniform light field in which a test subject is seated. The illumination characteristics of the new system and redesign were conducted and the VITAE system was calibrated using standard concentrations of fluorescent dye. The mathematical form of the calibration curve was particularly important, and calibrationinvolved modification of the existing computer software. Calibration of new VITAE system for various skin tones using human subjects will be an integral component of this work. The new system was mobilized to field testing of exposures among pesticide applicators. In particular, it was used to support the work of companies such as Deere and Company and Toro in using this system to evaluate the effectiveness of equipment design improvements in reducing worker exposures.

The VITAE* Technique estimates the exposures that workers receive while working with liquid pesticide during their normal work activities. This system, originally studied by Dr. Richard Fenske (University of Washington), was modified to be applicable to the agricultural setting. A series of photographs are taken of the applicator before beginning work with the pesticide. The series includes the front, left side/right side/back views of the head, arms, legs, and torsoes of the applicator. The fluorescent tracer dye is placed into the pesticide tank or other spray equipment at the beginning of each mixing cycle. At the end of the day, the applicator again enters the mobile laboratory where the black light source illuminates the fluorescent tracer on the clothing and body

where pesticide exposure occurred. A computer program analyzes a series of 46 digitized photo-frames of the applicator's pre-exposure and post-exposure to various body locations. VITAE* Technique calculation program determines the μg of tracer dye present on the exposed body areas and a ratio of active ingredient to tracer dye is used to calculate the actual exposure for the pesticide. The results of the validation research indicated the need for use of a surfactant along with the fluorescent tracer. The VITAE® System estimated exposures that workers received while working with common liquid pesticide during normal work activities. VITAE System calculation program determines the μg of tracer dye present on the exposed body areas and a ratio of active ingredient to tracer dye is used to calculate the actual exposure for the pesticide. Validation of the VITAE® System explained variation within the system by assessing:

1. repeated exposure measurement on specific systems (attempting to keep all variables constant).
2. variation of a specified number of measurements and statistical significance.
3. aerosolization and solubility of tracer compound in laboratory and field conditions.

Results of the validation research directed VITAE Technique monitoring. A surfactant was added to maintain the tracer dye in solution. The VITAE® System was calibrated with variation skin tones of caucasian and black skin types. Methods and procedures were developed for the VITAE Technique to be used in other pesticide application settings such as golf course management industry.

A series of experiments continue were conducted to compare the performance of the new lighting system to the original system under similar conditions with the same distance between camera and subject. A light meter has been used to map the intensity of illumination inside the dodecahedron and is being compared to a similar mapping of the original system. Measurements of standard dye applications to a series of forms selected to represent various parts of the human body will be made using both lighting systems and the results compared. Calibration curves will be prepared using both systems and the results compared. Measurements obtained using the dodecahedron lighting system will be made both with and without using the mathematical corrections for geometrical effects. This work continues to be scheduled around other projects using the VITAE system. A pilot project using the VITAE system for a field investigation of pesticide exposures with the intent of validating an exposure algorithm proposed by collaborators at the National Cancer Institute was conducted. Dr. Reynolds and Martin Jones also used the VITAE to evaluate the effectiveness of training on reducing exposure and waste among industrial spray painters in collaboration with the University of Northern Iowa.

Development of Pesticide Exposure Assessment Questionnaire: A questionnaire was developed which identified specific types of application system, and behaviors that related to low frequency - high exposure to pesticides. The exposure assessment questionnaire collected information through dialog with pesticide applicators about their pesticide exposures. The applicators described the one incident or experience while using pesticides that caused their greatest personal exposure. Information identified specific types of pesticide application systems, events, and behaviors that relate to low frequency -- high exposure events. Preliminary analysis demonstrated additional clarification questions to be added to the exposure questionnaire. The questionnaire was also modified for the golf course management industry.

Tractor Cab Design: GPCAH staff worked with engineers at Deere and Company to test the

efficacy of a new tractor cab design during field exposure to pesticides. The intent of the design team was to produce a tractor cab that will meet the requirements of EPA's Pesticide Worker Protection Standard and allow operators to forego the use of a respirator. Initial studies involved the collection of air samples and positional deposition samples inside and outside of the tractor cab during application of pesticides in fruit orchards and in cotton fields. In addition, the size distribution of the pesticide aerosols was evaluated using a Marple cascade impactor. In several case pesticides were found inside the cabs at levels just above the method detection limits. Mass Mediam Aerodynamic Diameters of pesticide aerosols were smaller than anticipated (9 and 14 microns in two cases). The ratio of pesticide outside to that inside the cab ranged from 7 to 60, and positional deposition samples gave results that were similar to the air samples.

Continuing work with Deere and Company included consultation regarding use of fluorescent tracer dye for evaluation of tractor cab filtration efficiency. Risto Rautiainen arranged and chaired a session on Tractor Cab Air Quality at the ASAE Agricultural Machinery Conference, in Cedar Rapids Iowa. This session brought together academic and governmental researchers with agribusiness representatives to discuss the development of a new standard for tractor cabs and experimental work done in support of this effort. Dr. Reynolds participated as a presenter and panelist. This activity helped to stimulate further interaction with agricultural equipment manufacturers and discussion of future collaborations continues.

Agricultural Health Study - Pesticide Exposure Study: Dr. Reynolds and Martin Jones received funding from the U.S. EPA to conduct a study measuring exposure to pesticides among members of the EPA/NCI/NIEHS Agricultural Health Study. The University of Iowa is collaborating with South West Research Institute and Battelle Corporation on this project. Dermal and inhalation exposures were measured on 186 farms in Iowa during 1999 and urine samples were collected to measure metabolites of the target compounds, atrazine and chlorpyrifos. While not directly funded by the GPCAH, this project was made possible by and builds on the resources of the IH Core.

Growing out of the VITAE project, the GPCAH received funding to focus on pesticide exposure studies, primarily pertaining to the Agricultural Health Study (AHS) underway in Iowa and North Carolina. An important component of the AHS is the development of a retrospective exposure assessment algorithm (EAA) for ranking pesticide exposure based on questionnaire responses related to application methods, personal protective equipment use, and work practices. Drs. Groves and Reynolds completed a "Field Evaluation of a Dermal Pesticide Exposure Assessment Algorithm" in collaboration with researchers at the National Cancer Institute. A feasibility study and pilot project were performed in order to evaluate the use of a fluorescent dye/video imaging technique for validation and refinement of the AHS-EAA. Results from this project demonstrated the feasibility of this approach and provided important information relative to the logistics and design of a larger study to validate and refine the AHS-EAA. The primary focus of the Agricultural Health Study-Pesticide Exposure Study (AHS-PES) was to measure and document private farm pesticide applicators exposures resulting from pesticide handling, mixing, loading and application (HMLA) activities. The full study involved collection of dermal, handwipe, breathing zone, and urine samples for applicators and their families on 70 farms in Iowa. Dr. Reynolds and Martin Jones also worked with Cynthia Hines of NIOSH on the

feasibility of studying pesticide exposures among members of the AHS producing livestock and growing orchards.

Take Home Pesticide: The hazards of chronic low-level pesticide exposures of persons in non-occupational settings, have received relatively little attention. A few studies have found that farm homes have a greater frequency of detectable residues of pesticides and higher concentrations of pesticides in dust and in farmer's urine than in reference homes; however the research to date does not provide answers regarding the long-term potential bioavailability of pesticides in homes and risk factors that result in increased pesticide levels. The purpose of this pilot-project was to test sampling, analytical, and survey methods to further investigate pesticide levels in Iowa (a state in which large amounts of pesticides are used) homes during one year and assess the relationship between exposure levels and potential sources of pesticide contamination. The study surveyed homes in rural and non-rural Eastern Iowa to measure pesticide residue at selected locations. The results of this was used to develop more comprehensive sampling, analytical, and survey methods for measuring the total bioavailability of pesticides and to develop interventions and recommendations for reducing long-term pesticide exposures to farmers in homes.

A follow-up research study is currently being conducted to improve upon sampling, analytical, and survey methods for determining pesticide levels in vacuumed dust samples and urine metabolite concentrations, to use dust sampling to measure contamination in private homes for the most commonly used herbicides—atrazine--and urine sampling to determine absorbed doses of this pesticide, to identify potential behavioral and environmental risk factors associated with farmers' long-term pesticide exposures, and to quantify the variation in pesticide levels throughout the year. It is believed that in-home pesticide levels and absorbed doses will be significantly higher for farm families that use the target pesticides, and variation in environmental, work practices--such as application technique—and personal hygienic practices--such as storage of pesticides and changing and cleaning of clothing—will affect these levels. It is also believed that detectable pesticide levels and absorbed doses will be found among families that do not use the target pesticides and these levels will be affected by environmental factors such as location and personal hygienic practices. Detectable pesticide levels have been found among families over six months after the application season and the level of these residual pesticides has been associated with environmental and hygienic practices. Publications describing this work are in progress.

Outputs:

The GPCAH has produced numerous publications, presentations, and technical products which are included in the Appendix and the list of publications. Other items include:

- More accurate analytical methods for measuring pesticide concentrations in air and on the skin
- Analytical methods for measuring pesticide metabolites in the urine
- Improved VITAE system for qualitatively assessing pesticide skin exposures
- Validated questionnaires for determining pesticide usage, work practices, and exposure hazards
- Recommendations for reducing worker exposures to pesticides
- Greater awareness about the health hazards associated with pesticides.

Outcomes:

The result of the GPCAH work on pesticides has led to a greater understanding of the association between exposures and diseases. In particular, GPCAH work has improved upon methods used to assess the exposures and absorbed doses of farmers and agricultural workers to pesticides. These methods have been used to better evaluate the association between these exposures and doses and disease outcomes. These studies are interrelated with the work of other researchers on helped to evaluate the association between cancer, respiratory disease, neurological problems, and reproductive health. Some association has been seen between certain cancers, especially prostrate cancer and non-Hodgkin's lymphoma. To date, no clear associations have been found with reproductive disorders or chronic neurological problems, but research continues in these areas.

The improved exposure assessment methods have also led to a greater understanding of the way workers are exposed. For example, in many pesticide application scenarios it has been found that the greatest exposure occurs through the hands and torso while mixing and applying pesticides. This information has led to recommendations that pesticide workers use gloves, aprons, and protective clothing. Current research indicates that many workers are not employing these protective measures. Intervention research is being developed to encourage workers to use these protective measures and to evaluate the barriers to their use. The exposure assessment methods developed by the GPCAH will be invaluable in evaluating the effectiveness of these intervention efforts.

The GPCAH has also helped develop improved questionnaires for assessing use of pesticides, work practices, and use of protective measures. It is not possible to actively measure the exposures of all workers, so self-reported activities must be used to estimate exposures. The GPCAH work has helped to validate these questionnaires for use in a variety of agricultural health settings.

Chemical analysis of pesticide samples is complex and expensive. The VITAE system which uses fluorescent dyes to estimate exposures, provides an alternative to chemical analysis of skin exposure hazards. This technique is excellent for qualitative analyses and is very useful as a training tool, since it immediately shows workers where and relatively how much pesticide skin exposure they encountered. However, it does not yet provide strong quantitative values for dose construction. This is a useful tool however for a variety of research and training scenarios.

The work that GPCAH has done concerning take-home pesticide exposures has demonstrated that pesticides do migrate into homes and that those pesticides were either brought in by workers or came in through other environmental sources. The primary routes of contamination are not yet clear, but they do show exposure to families. The results of this work has been especially useful to the EPA in estimating the pesticide burdens of children. Further research is being done by building upon the techniques developed in these studies. This work has increased awareness about pesticide exposures and the possible over-use of pesticides around the home.

Pesticide-related research has been an important part of the GPCAH activities since its inception

and it has greatly contributed to what is know about exposures and potential disease risks among agricultural workers and their families.

Great Plains Center for Agricultural Health

Childhood Agricultural Injury Prevention Projects

A. Background and Need

Childhood agricultural injuries were recognized in the late 1980's and 1990's as a serious problem which required increased attention. Since the 1990's, NIOSH agricultural safety and health initiative has made significant investments into research and prevention of childhood injuries on the farm. Great Plains Center for Agricultural Health, in collaboration with Farm Safety 4 Just Kids and other organizations has been an important contributor in this effort.

From 1982-1989, there was an average of 181 agricultural deaths to youth less than 20 years of age annually. Farm machinery, drowning, and firearms accounted for 73% of the fatalities. About 24% of the fatalities occurred to children in the 0-4 year age group, 19% in the 5-9 year age group, 22% in the 10-14 year age group, and 34% in the 15-19 year age group. Machinery and drowning were clearly the main causes of fatalities for children 0-9 years of age. Other important causes were animals, firearms, suffocation, falls, and struck by/against objects (Adekoya and Pratt, 2001).

Approximately 1.9 million youth under the age of 20 years lived or worked on farms in the U.S. during 1998. An estimated 32,808 injuries occurred to youth on farms; 44% of them were work-related and 56% non-work-related. Household youth, visitors, and hired workers accounted for 72%, 21%, and 7% of the injuries respectively. Youth less than 10 years of age accounted for 34% of the injuries with the rate of 2 injuries per 100 youth. Geographically, the Midwest had the highest number of injuries (16,443; 52%). Livestock operations reported a high number of injuries (16,981; 52%; Myers and Hendricks, 2001).

In 1990-1999, 93 deaths and 6,516 injuries to children under the age of 20 were reported to the Iowa Department of Public Health. The youngest age groups had high numbers of fatalities. Farm work-related injuries increased with age. Both injury and fatality frequencies were highest in the 15-19 year age group. Machinery and vehicles represented a high proportion of fatalities. Suffocations, weapons, struck by, and electrocutions were common as well. In non-fatal injuries, animals were another common cause of injury (FS4JK, 1997).

The understanding of the magnitude and characteristics of childhood injuries has emerged particularly since the 1990's, largely due to NIOSH funded research. But many health and safety professionals, including GPCAH investigators, recognized this problem earlier before surveillance data were available. The need for childhood injury prevention was brought to the attention of the agricultural community after Marilyn Adams lost her son in a grain suffocation injury and she started a campaign aimed at preventing similar injuries. She founded the Farm Safety 4 Just Kids organization in 1987, which grew to a national organization. Marilyn became the leading voice in a national movement to prevent childhood agricultural injuries.

While there were estimates for injury and illness outcomes for agricultural workers, the understanding of these conditions among farm families and children was lacking. To address the needs of the entire farm family, the Keokuk County Rural Health Study (KCRHS) was undertaken in 1993 with support from NIOSH through The University of Iowa Great Plains Center for Agricultural Health. It provides a very rich database to examine adverse health outcomes among farm and other rural children and to assess the impact of environmental and other risk factors on a number of health outcomes. Three health outcomes were of particular

concern nationally and in Iowa--traumatic injuries, asthma, and suicide/depression. While the estimates for agricultural childhood injuries improved, there was no US estimates for rates of asthma among farm and other rural children. Respiratory diseases and many risk factors were well recognized, and it was also known that farm children were exposed to the same respiratory hazards. Over the last 35 years suicide has increased 300% among young men and 230% among young women and is now the third leading cause of death among adolescents (CDC, 1997a). Because suicide is still a rare event but is highly associated with depression, studies of depression prevalence and depression risk factors offer an opportunity to address suicide/depression as a third health outcome to be investigated.

B. Goals

GPCAH has conducted a line of research and intervention projects addressing childhood agricultural injury. The goals of the main projects are stated below:

Farm Safety 4 Just Kids, 1992-1996
1) Chapter development
Farm Safety 4 Just Kids, 1996-2001
1) Chapter development and nurturing;
2) Develop, implement, and evaluate a safety competition for farm families;
3) Develop, implement and evaluate a health and safety leadership conference.
Farm Safety 4 Just Kids, ATV safety pilot project 2005
1) implement and evaluate ATV safety training in the national FFA convention
1997-2000 Childhood health outcomes in a rural cohort
1) To conduct a prospective assessment of childhood injuries and risk factors among agricultural and other children in a rural cohort;

2) To conduct a cross-sectional study and a case-control study of asthma and asthma risk factors among agricultural and other rural children in a rural cohort;

3) To conduct a cross-sectional and case-control study of depression and depression risk factors among agricultural and other rural children in a rural cohort;

4) To conduct environmental assessments to document specific exposures on farms and in households relevant to injury, asthma and depression health outcomes.

C. Inputs

Annual budgets for the projects are presented in the attached database.

Staff for the GPCAH childhood injury prevention and intervention projects, in collaboration with FS4JK included:
Burt Kross, PhD
Kelley Donham, DVM
Risto Rautiainen, PhD
Murray Madsen, MBA
Barb Pies, MS
LaMar Grafft, MS
Key staff for Farm Safety 4 Just Kids included:
Marilyn Adams
Shari Burgus
David Hanson

David Schweitz

Staff for the Childhood outcomes in rural cohort study included:

James A. Merchant, MD, DrPH, Principal Investigator
Craig Zwerling, MD, PhD, MPH, Co-Investigator
Stephen J. Reynolds, MD, CIH, Co-Investigator
Peter S. Thorne, MS PhD, Co-Investigator
Leon F. Burmeister, PhD, Co-Investigator
Ann M. Stromquist, PhD, Co-Investigator/Coordinator
Kevin M. Kelly, PhD, Co-Investigator/Programmer
Marsha O'Neill, Research Assistant

Facilities available for the GPCHAH studies included:

The University of Iowa, Institute for Rural and Environmental Health
Keokuk County Rural Health Study, Sigourney Office
Farm Safety 4 Just Kids, Earlham Head Office
Farm Safety 4 Just Kids North American Network of Chapters

D. Activities

National initiatives

The "Agriculture at Risk" conference in Iowa was an important milestone in the development of agricultural safety and health activities in the US, including childhood agricultural injury prevention. This conference was held in two parts on September 18-21 and 27-30, 1988 at The University of Iowa in Iowa City and Des Moines, Iowa. The conference involved approximately 170 scientists, policy makers, and private citizens. Dr. Kelley Donham served as conference chairman. A summary of the conference was published in "Agriculture at Risk – A Report to the Nation" (Merchant et al. 1989). This report articulated the problems for the public record and stimulated activities leading to the formation of a national policy addressing agricultural health and safety problems. In 1990, a Congressional mandate to the National Institute of Occupational Safety and Health (NIOSH) turned national attention to understanding and preventing agricultural injuries and illnesses. The agricultural centers and other programs were initiated at that time, establishing a new direction for agricultural safety and health in the US.

The policy document, "Children and Agriculture: Opportunities for Safety and Health: A National Action Plan" (NCCAIP, 1999), initiated new efforts to reduce children's agricultural injuries and illnesses in the US. Following the 1996 action plan, there was a progress review and updated action plan from the 2001 Summit on Childhood Agricultural Injury Prevention (Lee, Gallagher, Marlenga and Hard, 2002). Dr. Kelley Donham (University of Iowa) and Marilyn Adams (Farm Safety 4 Just Kids) were among members of the advisory committee. This report reviewed recommendations from previous policy documents, made new recommendations based on scientific evidence, and identified action steps for relevant organizations. The report generated targeted recommendations for research, education, policy, and evaluation, with the goal of reducing unintentional agricultural injuries to children younger than 18 years. The action plan achieved congressional support which funded the NIOSH children's safety and health initiative in 1997. This initiative has funded the National Children's Center for Agricultural Safety and Health and multiple research projects.

The "North American Guidelines for Children's Agricultural Tasks" developed recommendations regarding agricultural tasks that are appropriate for the age and ability level of a child. These guidelines have been influential in developing awareness about children's involvement in

agricultural work and not exposing them to hazardous situations that they are not capable to manage. GPCAH provided professional input into developing the guidelines. Drs. Cook, Reynolds, Stromquist, and Rautiainen were members of the advisory committee. Marilyn Adams and Shari Burgus with Farm Safety 4 Just Kids were both project advisors.

The National Children's Center for Rural and Agricultural Health and Safety (2003) published a document, "Creating Safe Play Areas on Farms". It is a guide for health and safety professionals and farm parents that describes ways to enhance safe play opportunities for children 2 to 9 years of age. Safe play areas are expected to reduce children's exposures to farm hazards. GPCAH has contributed to this initiative; Dr. Rautiainen (GPCAH) and Shari Burgus (FS4JK) were members of the advisory team and participated in subsequent projects.

Farm Safety 4 Just Kids

In the fall of 1986, Marilyn Adams' son Keith was working on their family farm near Earlham, Iowa. While assisting his step-father on the farm, Keith fell into a gravity flow wagon of shelled corn when it was unloading, causing suffocation. As a result of Keith's death, Marilyn realized that it was important to learn more about gravity flow wagons and how such tragedies can be prevented.

As time passed it became evident that an alarmingly high number of children were being injured and dying on farms. The Adams family was compelled to address the issue of children's farm safety in order to spare others a similar heartache. In response to public demand, Marilyn Adams formed Farm Safety 4 Just Kids (FS4JK) in 1987.

For nearly 20 years, FS4JK has been providing educational programs, resources to individuals and groups, and advocacy for children's farm safety and health. Led by a dynamic board of directors and efficient staff, FS4JK has undertaken a comprehensive program to promote a safe farm environment to prevent health hazards, injuries, and fatalities to children and youth. Today, the organization has volunteer chapters in 32 states and 4 Canadian provinces, with outreach coordinators in Nebraska, Iowa, Missouri, Minnesota, and Illinois. They also have a partnership with the Farm Service Agency (FSA) which allows government staff in all counties across the U.S. the option of delivering local FS4JK programs during the work-day. Numerous corporate ag companies and NIOSH Ag Centers have partnered with FS4JK's efforts to help make attitude and behavior changes on farms across the nation.

The Great Plains Center for Agricultural Health (GPCAH) and Farm Safety for Just Kids (FS4JK) have worked together for nearly two decades. Both have benefited from working together accomplishing joint and varied objectives. NIOSH-funded collaboration with GPCAH during the 1990's was particularly important for the development and growth of FS4JK membership and chapter network. Since the 1980's Farm Safety 4 Just Kids has grown from a single person advocating for reform to a network of chapters providing educational programs throughout North America. Much of the development has been guided by the faculty and staff at the Great Plans Center for Agricultural Health. Dr. Burt Kross and Murray Madsen have made particular contributions chairing the FS4JK board of directors. NIOSH funding through GPCAH has been instrumental in establishing the network of chapters, as well as developing and providing programs to farm children in the United States over nearly two decades.

The success of the chaptering process was initially made possible by the NIOSH funding supplement to the GPCAH Center grant. FS4JK leveraged this funding and obtained additional

support from companies like Pioneer, Cargill, Nationwide Agribusiness, Deere & Co and Successful Farming magazine. Recently, ADM increased their funding to a level that includes support for part-time Outreach Coordinators that are assisting chapters in four states; Iowa, Illinois, Missouri and Minnesota. FS4JK provides a strong network of committed individuals in local communities across North America. It is proving to be a valuable distribution system for educational materials developed by FS4JK and other sources.

All Terrain Vehicle Safety

The All Terrain Vehicle (ATV) has become one of the leading sources of fatal injury on the farm, particularly among youth. GPCAH funded two pilot projects in 2004, addressing this increasing hazard. The projects are described below:

FS4JK highlighted ATV safety for 2-1/2 days for thousands of youth in their booth at the 2004 national FFA convention. In addition, their two workshops helped youth learn how to promote safe ATV among their peers and teach it to younger students through hands-on activities, classroom instruction, and resource materials. Helping with the sessions was the FS4JK youth delegate and a father-daughter ATV safety team from Kentucky. They challenged students and their advisors in a game of ATV safety jeopardy and encouraged them to conduct ATV safety educational training sessions in their home communities. Over 700 students and advisors attended the workshops and over 150 advisor information packets were distributed. Follow-up questionnaires were sent to 345 student attendees in February 2005 and also served as a reminder to do a community ATV safety program. Again in 2005 FS4JK staffed a booth and conducted presentations on ATV safety. A survey was conducted with over 600 FFA youth to determine their attitudes and behavior while using ATVs. Associations among gender, age, residence, use of PPE, allowing passengers, participation in training, and riding on paved surfaces were addressed.

The University of Missouri Extension service provided in-depth 3-day train-the-trainer workshops for seven regional extension specialists on how to teach ATV safety. These workshops focused on how to teach youth age 12 through 16 about safe ATV riding techniques and operating practices. Safe use of ATV's in agriculture was given special emphasis, including loading and unloading ATVs, towing ATV-powered implements, and using ATVs with attached equipment such as sprayers and blades. The workshops consisted of both classroom and hands-on instruction led by a certified ATV Safety Institute instructor using materials from the national 4-H Community ATV Safety Program, the ATV Safety Institute, and FS4JK. Over 1000 youth who visited the University of Missouri Extension area at the Western Farm Show learned more about ATV safety.

Childhood health outcomes in a rural cohort

This study was designed as a nested study within the Keokuk County Rural Health Study, a 20-year prospective study with five four-year rounds of medical examinations, personal interviews, and environmental assessments of 1,004 households. Injury, asthma and depression were the primary outcomes of interest.

Youth, aged 12 to 17 years were asked about their use of farm machinery, work with livestock, pesticide handling and other farm tasks as part of Round 2 of the Keokuk County Rural Health Study. A total of 117 youth and 337 adults completed the questionnaires. There were 92 pairs of parents and youth. Thirty-four percent of youth had performed agricultural work at some time in their life. Fifteen percent of all youth were currently working on farms. Most youths reported that

they have driven all-terrain vehicles and pick-up trucks. Despite the prohibition of hazardous work by children under age 16 several children reported that they have driven a self-propelled combine, worked in silos, handled and applied fertilizers in the past 12 months. Youth reported riding on tractors beginning at age eight. The age for beginning other chores was 10. The ages for driving tractors and all terrain vehicles were 12 and14. Both youth and adults felt that children should begin performing farm tasks at ages older than those at which children actually began. There were also discrepancies between parent and youth reports regarding the frequencies, starting age, and opinions concerning performing agricultural tasks. These results suggest the need for implementing guidelines, particularly with age requirements, for children's agricultural tasks.

The proportion of children with either physician-diagnosed asthma or wheezing symptoms did not differ among farm, rural non-farm, and town residents. Maternal smoking during pregnancy differed significantly among the strata with 10.8% of farm children, 27.4% of rural non-farm children, and 26.9% of town children exposed to cigarette smoke *in utero* (Chi-square=20.2, 2 df, p=0.001). Seven percent of farm children reported current exposure to cigarette smoke at home compared to 14.6% of rural non-farm children and 15.3% of town children. Neither smoking exposure was significantly associated with asthma in an age and gender adjusted logistic regression analysis. Although asthma prevalence did not differ significantly among residential strata in this cohort, farm children had less exposure to cigarette smoke, both *in utero* and in their homes, compared to rural non-farm and town children.

E. Outputs

Farm Safety 4 Just Kids

Chapter Development. NIOSH support through GPCAH has been important in establishing and nurturing FS4JK Chapters. The number of chapters increased from 0 in 1990 to 56 in 1996. During the second funding cycle, the number of chapters increased to 145 in 2001 with chapters in 35 states and 4 Canadian provinces. As of June 2006, there were 2,216 members of FS4JK, 1,659 of those members belonged to FS4JK Chapters. The number of reported chapter activities was 339 in 2005 reaching 1,734,762 children and families. Chapter activities typically include safety day camps, safety fairs, public speaking, manning fair booths, teaching safety classes, encouraging no interest loans to retrofit old equipment, writing editorials and news releases for local papers, conducting radio and TV interviews, and distributing danger decals.

Specific examples of the numerous FS4JK chapter activities include:

- Charlotte Halverson and the Dubuque County FS4JK Chapter conducted seven farm safety session throughout the year at the NECAS facility in Peosta, Iowa. Through these sessions they reached 569 kids ranging in age from 4-18.
- Lisa Forburger and the Kossuth FFA FS4JK Chapter in Algona , IA held a farm safety day camp with seven stations for all 1st graders in Kossuth County. They had 259 kids attend.
- Louise VanErsvelde and the Partners 4 Farm Safety Chapter in Brooklyn, IA held a Safety Hunt and Safety Classes at their county fair. 400 kids were in attendance.
- Sue Robertson and the Reuben's Reason chapter put on a farm safety puppet show for over 300 people at the Akron City Park in Akron, IA.
- The KanOkla 4 Kids Chapter had a farm safety day camp for 200 5th graders in Sumner County, KS.
- Robert Cook and the SEMO FS4JK Chapter in Sikeston, MO perform countless puppet shows for the local schools.

- Beth Horak and the Hand in Hand Safety Across the Land Chapter conducted a Generations of Healthy Farmers presentation in Saline County, NE.
- Patty Camp and the Platte Valley Chapter conducted Farm Safety Pep Rallies in the Wood River, NE school district for over 260 elementary students, during Farm Safety and Health Week.
- A farm safety slide presentation and demonstrations for children and adults at an AgraSafe - First on the Scene meeting in Hays, Kansas
- An educational program on rural roadway safety for 250 high school students in Akron, Iowa
- A classroom presentation to 110 1-4th graders at Nodaway-Holt Elementary School in Barnard, Missouri
- A presentation at Husker Harvest Days reaching over 250,000 participants in Alda, Nebraska
- FS4JK and GPCAH collaborated with Kansas FFA to conduct the youth leadership training in Manhattan, KS. The training covered formation of chapters, conducting day camps, family seminars, booths, walkabouts, and puppet shows. Thirty instructors and youth participated in the training.
- Approximately 3,000 community children participated in demonstrations and a puppet show at an exhibit for the KTVO safety fair at Kirksville, Missouri. A television interview was conducted prior to the event and aired on the local evening news show
- FS4JK and GPCAH in collaboration with state and local FFA conducted youth training events in Iowa, Nebraska, Kansas, and Missouri
- Anderson County, KS, Fair Grounds was the location for a Safety Day Camp where 73 youth age 6 to 11 participated.
- Louise Van Ersvelde and Dawn Smith of the Partners 4 Farm Safety participated in a Health Fair at the HLV school in Victor, Iowa. Over 700 youth stopped by their booth.
- Patty Camp of the Platte Valley FS4JK Chapter, NE, conducted seat belt safety programs to 260 elementary school children during Farm Safety and Health Week.
- Melissa Price with the Show Me Chapter, MO, used a FS4JK activities grant to purchase puppets and now performs the farm safety puppet show on a regular basis for the lower elementary students in Barnard, Missouri.

The FS4JK National Headquarters staff assisted the chapters in the Midwest through various activities. Examples of 2000 support activities include the following: Marilyn Adams spoke to antique tractor owners and their families at the Rusty Acres Tractor Show on July 16, 2005 in Waukee, Iowa. Shari Burgus facilitated training for farm families at the annual NECAS Ag Families Workshop in Peosta, Iowa. Farm families from across the United States learned about farm dangers in the morning and parents learned about ways to keep children safe in the afternoon. Debbie Slusher and Tammy Baier gave an ATV safety presentation and conducted an ATV behavior survey at the National FFA Convention in Louisville, KY. Marnie Moore, Shari Burgus, and Marilyn Adams traveled to Decatur Illinois to conduct a FS4JK Chapter training in March 2005. Mindy Williamson, Marilyn Adams, and Shari Burgus recorded farm safety PSAs for the Iowa State radio group. Marilyn Adams, Mindy Williamson, and Dave Schweitz participated in the Birthday Benefit Run in Waterloo, Iowa. Dave Schweitz, Marilyn Adams, and Debbie Slusher attended the Monsanto VPP Star Status Award Ceremony in Applington, Iowa. Debbie Slusher and Shari Burgus conducted rural health kit evaluations in Iowa, Illinois, Nebraska, Ohio, and Indiana. Mindy Williamson and Tammy Baier staffed a booth at the Dairy Farmers of America Annual Meeting in Kansas City, MO.

Youth Leadership Training. FS4JK and GPCAH conducted a series of youth leadership training events. As an example, on June 7, 2000, Shari Burgus, FS4JK Education Director, and LaMar Grafft, GPCAH Safety Education Specialist, plus LaMar's children Jamie and Kinzy, traveled to Kirksville, MO. They conducted an exhibit for the KTVO safety fair. Approximately 3,000 community children participated in demonstrations and a puppet show performed by LaMar, Shari, and LaMar's kids. A television interview was conducted prior to the event and aired on the local evening news show. FS4JK and GPCAH collaborated with Nebraska FFA to conduct Partners for Safer Community Core Team Training events in Lincoln (June 2, 1998), Kearney (June 16, 98), and Columbus (June 17, 98). The FS4JK presentations were made by Shari Burgus and covered formation of chapters, day camps, family seminars and booths, FS4JK resources for safety days, walkabouts, brochures, decals, activity books, curriculums, demonstrations, watch-it package, and puppet shows. The Great Plains Center presentations were made by Barb Pies and covered center and NIOSH background, research projects and resource materials.

Safety Contest. FS4JK worked with Successful Farming® magazine to encourage farm families to make their farms safer for children who live and visit there. The 2000 campaign was the seventh year for this project. The magazine uses its vast readership base (over 400,000 subscriptions) to publicize the contest. Over the years it has become an anticipated event that families look forward to participating in. Calls come into both FS4JK and SF throughout the year making sure they meet the entry deadline. One winner was 13-year-old Cindy Webb from Hillsville, VA who applied for helmets for ATV helmets to be given away by the local ATV dealer in town. This came about after the death of Cindy's cousin, Bobby. The Schatzles of Brookville, IN bought four heavy-duty rubber wheel chocks. These chokes prevent their hay wagons from moving. Dustin Munson, 14, a 4-Her from Connorsville, IN purchased a warning light system for their tractor driven on narrow, hilly country roads. Each winner received up to $250 for a safety project that they entered into the competition.

Evaluation Support. GPCAH has provided evaluation consultation on several FS4JK projects. FS4JK developed a program entitled Generations of Safe and Healthy Farmers. This program was based the involvement of several generations within one program, encouraging all participants to listen and learn from each other. Youth and older farmers from the community, many of which were grandparents to the youth, openly discuss farm dangers and ways to prevent injury. The pilot programs were a success. With funding from USDA RMA, the program expanded into other locations. GPCAH staff gave advice on survey design, data collection, and data analysis.

GPCAH and FS4JK collaborated on a pilot project, funded by the National Children's Center, evaluating he distribution of Safe Play Area resource materials, and conducting focus groups related to safe play areas on farms. GPCAH helped FS4JK develop the focus group questions and format. They performed data entry and analysis functions.

ATV riding is up and injuries resulting from ATV use are increasing. Working together FS4JK and GPCAH conducted a survey of over 600 youth in relation to their behavior while using ATVs. This information is useful when planning ATV safety educational resources and programs. The findings will be presented at the NORA meeting and at the National Institute for Farm Safety (NIFS) meeting in 2006.

Childhood health outcomes in a rural cohort

The childhood health outcomes project was completed during 1997-2000. The results are published in the presentations and publications listed below.

Presentations

Kelly KM, Reynolds SR, Moore G, Stromquist AM, Merchant JA. Developing Age-based Standards for respirators. Accepted for oral presentation. American Industrial Hygiene Conference and Exposition, New Orleans. 2001 Jun 6.

Mudipalli VR, Reynolds SJ, Kelly KM, Burmeister LF, Stromquist AM, Zwerling C, Merchant JA. Characteristics of Hearing Loss Among Children in a Mid-western Rural Community of the United States. Poster presentation. Central States Agricultural Health and Safety Conference, Kansas City. 2000 Sept 20-22.

Nordstrom D, Zwerling C, Stromquist AM. Frequency, Characteristics, and Child and Parent Risk Factors for Nonfatal Injury in Rural Children. Poster presentation. American College of Epidemiology, Atlanta, 2000 Sept 24-26.

Nordstrom D, Zwerling C, Stromquist A. Comparison of Self-Reported and Expert-Observed Prevalence of Working Smoke Alarms in Rural Homes. Oral presentation. Agricultural Safety and Health in a New Century, New York Center for Agricultural Medicine and Health, Cooperstown, NY. 2000 Apr 29.

Reynolds SJ, Svendsen ER, Merchant JA, Taylor CD, Kelly KM, Stromquist AM, Burmeister LF. Home Indoor Environments in Rural Asthmatic Children: Environmental Assessment Data from the Keokuk County Rural Health Study. AIHCE. 2000.

Stromquist AM. Adolescent Risk Behaviors in Round 1 of the Keokuk County Rural Health Study. Oral presentation. Meeting of the KCRHS Community Advisory Committee, Sigourney, IA. 2000 Nov 30.

Stromquist AM, Zwerling C, Merchant JA, Qian F. Adolescent Risk Behaviors in Round One of the Keokuk County Rural Health Study. Oral presentation. Agricultural Safety and Health in a New Century, New York Center for Agricultural Medicine and Health, Cooperstown, NY. 2000 Apr 29.

Stromquist AM, Zwerling C, Merchant JA, Qian F. Risk Behaviors of Adolescents Living in a Rural Iowa County. Oral presentation. Nordic Meeting of Occupational Agricultural Health, Swedish University of Agricultural Sciences, Alnarp, Sweden. 2000 Sept 25.

Svendsen ER, Reynolds SJ, Taylor CD, Stromquist AM, Kelly KM, Burmeister LF, Merchant JA. Home Indoor Environments in Rural Asthmatic Children: Environmental Assessment Data from the Keokuk County Rural Health Study. Poster presentation. Agricultural Safety and Health in a New Century, Cooperstown, NY. 200 Apr 28-30.

Svendsen ER, Reynolds SJ, Merchant JA, Taylor CD, Kelly KM, Burmeister LF. Home Indoor Environments in Rural Asthmatic Children. Poster presentation. Central States Agricultural Health and Safety Conference, Kansas City. 2000 Sept 20-22.

Wright AL. Perinatal and Early Life Risk Factors for Childhood Asthma in a Rural Cohort. Poster presentation. A Public Health Response to Asthma Conference, Centers for Disease Control and Prevention, Atlanta, GA. 2000 Feb 15-16.

Wright AL, Merchant JA, Stromquist AM, Kelly KM. Childhood Asthma and Tobacco Smoke Exposure in a Rural Cohort. Poster presentation. Agricultural Safety and Health in a New Century, New York Center for Agricultural Medicine and Health, Cooperstown, NY. 2000 Apr 29.

Wright A, Merchant JA, Stromquist AM, Kelly KM. Perinatal and Early Life Risk Factors for Childhood Asthma in a Rural Iowa Cohort. Poster presentation. Society for Epidemiologic Research, Seattle. 2000 Jun 15-17.

Zwerling C, Merchant J, Nordstrom D, Burmeister L, Stromquist A, Kelly K. Risk Factors for Injury in Rural Iowa: Round One of the Keokuk County Rural Health Study. Poster

presentation. Agricultural Safety and Health in a New Century, New York Center for Agricultural Medicine and Health, Cooperstown, NY. 2000 Apr 29.

Publications.

Nordstrom DL, Zwerling C, Stromquist AM, Burmeister LF, Merchant JA. Child and adult risk factors for nonfatal child injury in a rural health study. Submitted for publication in Pediatrics.

Park H, Reynolds SJ, Kelly KM, Stromquist AM, Burmeister LF, Zwerling C, Merchant JA. Characterization of agricultural tasks performed by youth in the Keokuk County Rural Health Study. To be submitted to App Occ & Env Hygienist. Feb 2001.

Wright A, Merchant JA, Stromquist AM, Kelly KM. Perinatal and early life risk factors for childhood asthma in a rural Iowa cohort. Abstract. Am J Epi; 2000 (June suppl).

Dissertations

Wright AL. Early life factors associated with childhood asthma in a rural Iowa cohort: The Keokuk County Rural Health Study. December 2000.

Svendsen ER. Exposure assessment of environmental factors that influence childhood asthma in a rural population. May 2001.

F. Outcomes

The available data show a decrease in childhood agricultural injuries and fatalities. In 1982-1989, there was an average of 181 agricultural deaths to youth less than 20 years of age annually in the US (Adekoya and Pratt, 2001). In 1990-1996, this average reduced to 104 annually. Rivara (1997) also found that the childhood agricultural fatality rate decreased by 39% from 1978-83 to 1990-93. Approximately 1.9 million youth under the age of 20 years lived or worked on farms in the US during 1998. An estimated 32,808 injuries occurred to youth on farms. Results from the 2001 national survey indicated 22,600 injuries annually. The rate of childhood agricultural injuries reduced from 1.7 injuries per 100 farms in 1998 to 1.4 injuries per 100 farms in 2001 (USDA 2001).

The development in childhood agricultural injuries is encouraging. It is not possible to attribute the decrease in injuries and fatalities to any single factor. One could hypothesize that the reduction is due to fewer exposed children, larger farms, fewer livestock farms, general improvement in machinery, buildings, and farm environments, and many other factors. However, NIOSH-funded programs, including GPCAH, FS4JK, and the National Children's Center for Rural and Agricultural Health and Safety have made significant contributions to agricultural health and safety and childhood injury research policy in the US. The contributions of these institutions include producing the policy documents "Agriculture at Risk – A Report to the Nation" (Merchant et al., 1989), and "Children and Agriculture: Opportunities for Safety and Health; A National Action Plan" (NCCAIP, 1996). These documents have been influential in establishing many of the current programs in agricultural health and safety and childhood agricultural injury prevention

NIOSH investments into the Children's Center, Agricultural Centers and individual research projects may be contributors to the favorable development in childhood injuries and fatalities shown by various research and surveillance sources. While the contribution of specific research and prevention programs cannot be documented on the National level, those involved in the initiative since 1990 have reason to be optimistic about the results of their work.

H. References

Adekoya N, Pratt SG. Fatal unintentional farm injuries among persons less than 20 years of age in the United States. Department of Health and Human Services (NIOSH) publication No. 2001-131. July 2001.

Myers JR, Hendricks KJ. Injuries among youth on farms in the United States, 1998. US DHHS, Public Health Service, CDC, NIOSH, 2001-154.

Farm Safety 4 Just Kids. Iowa's children at risk: A summary of farm-related injuries 1990-1996. Earlham, IA: Farm Safety 4 Just Kids 1997

Center for Disease Control and Prevention. Childhood work-related agricultural fatalities – Minnesota, 1994-1997. MMWR – Morbidity & Mortality Weekly Report 1999;48(16):332-335

Merchant JA, Kross BC, Donham KJ, Pratt DS (editors). Agriculture at risk. A report to the Nation. National Committee for Childhood Agricultural Injury Prevention. National Coalition for Agricultural Safety and Health. 1989.

National Children's Center for Rural and Agricultural Health and Safety. North American guidelines for children's agricultural tasks. 1999. Marshfield Clinic, Marshfield, WI.

Lee B, Gallagher S, Marlenga B, & Hard D. (eds). Childhood agricultural injury prevention: progress peport and updated national action plan from the 2001 summit. Marshfield, WI: Marshfield Clinic, 2002.

Keokuk County Rural Health Study
1990 – 2006

> The Keokuk County Rural Health Study is truly one of the "jewels" within the University of Iowa. That the GPCAH has funded it as a center project is a real credit to the foresight of those who designed and shepherded the formation of both the epidemiological catchment area and the GPCAH. . . The future of other catchment areas may be tenuous, thus the Keokuk County Rural Health Study may emerge as the only viable rural epidemiological catchment area in North America.
>
> Dr. Paul Gunderson, in report of his evaluation of the Great Plains Center for Agricultural Health (GPCAH) May 17, 2004

Overview. Funded by NIOSH since 1990, the Keokuk County Rural Health Study (KCRHS) is a prospective cohort study of agricultural and environmental exposures, risk behaviors, and health outcomes of a stable population in a highly agricultural southeastern Iowa county. Row crop farming and livestock production in this county are typical of Iowa and other parts of the rural Midwest. The KCRHS cohort of all members of 1000 households (2,251 individuals in Round 1 and 2,163 individuals in Round 2) provides a highly cooperative population with which to address NORA priorities and advance the goals of NIOSH and the Great Plains Center for Agricultural Health.

The KCRHS addresses 18 NORA high-priority research areas (listed in Section 3 below) through surveillance, epidemiological studies, case-control studies, environmental assessments, exposure measurements, medical testing, and in-person interviews. The study has been successful in meeting its goals and objectives over the 16 years that it has been funded by NIOSH. The primary foci of the study are respiratory disease, injury, and agricultural/environmental exposures, but other areas related to farming and rural living are also included, such as noise-induced hearing loss, mental health and stress, allergies, and farm safety. As described in Section 7 below, the study has contributed to knowledge about health and safety risks of farming faced not only by men, but also by women, children, and the elderly. Among other results, we found high rates of childhood asthma, noise-induced hearing loss, depression, and adult overweight and obesity; young children performing dangerous farm chores; exposure to agricultural chemicals and low usage of personal protective equipment; and the presence of loaded and unlocked firearms in most homes. Such information, collected over the 16 years of the study through surveillance and epidemiological studies, has been the basis of numerous prevention and intervention programs designed to improve the lives of farm families. The study has collaborated with numerous investigators within our region, as well as nationally and internationally (as reported in Section 9c) and has benefited from the input of stakeholders in a variety of ways, as described in Section 6.

1. Statement of the problem, challenges, brief description of the KCRHS.

Rural America is losing farmers and farm family members to agricultural injuries and diseases at an unacceptable rate. This was the essential message of *Agriculture at Risk – A Report to the Nation* (Merchant et al, 1988), the document that characterizes the findings of a major conference held in Iowa City and Des Moines that inspired the funding, by the United States Congress, of four NIOSH Agricultural Centers in 1990.

The first competitive grant for a Center for Agricultural Disease and Injury Research, Education and Prevention (CADIREP) submitted by The University of Iowa stated, in the introduction to the section describing what was to become the Keokuk County Rural Health Study:

> Epidemiological Assessment of Farm Families. While there is limited epidemiological data on the prevalence and incidence of agricultural injuries and disease, there are very few prospective studies of farming populations (such as the Framingham prospective study of heart disease which provided one inspiration for this study) for either injuries or diseases, and almost no population-based intervention studies addressing the many hazards faced by farmers and their farm family members. . .

Originally dubbed “Farmingham,” the Keokuk County Rural Health Study was designed to systematically document the prevalence of cause-specific injuries, respiratory disease, dermatologic and allergic disease, hearing loss, neurologic disease and mental health, reproductive health outcomes, renal disease biomarkers, as well as the environmental and occupational determinants of these disease outcomes. In addition, the study provides a wealth of important demographic, social, functional disability, and health care delivery data in order to measure the economic and combined impact of these injuries and diseases within the population at risk and on the rural community in which the study population resides. The study is comprehensive in that it assesses both farm and other rural risk factors for these several health outcomes and it includes vulnerable subgroups of the rural population at risk for which there is currently very little epidemiolgical data--children, women and the elderly. While epidemiologic data is accumulating on the prevalence of these diseases, the respective importance of these diseases and their risk factors in causing impairment and disability is not well documented. These data are now contributing to the development of comprehensive cost-effective prevention and intervention programs for rural and agricultural communities throughout North America and developed nations.

The study also focuses on the interface between rural health and agricultural health and safety. For instance, access to adequate acute trauma care is a major factor in mortality from traumatic farm injuries. Questions regarding the epidemiology of suicide and rural mental health are highly relevant in consideration of the chronic sequelae of exposure to pesticides. Fire hazards are a very high priority with livestock farmers and are also linked with increased mortality from burns among farm families and others living in rural areas. Firearms are nearly ubiquitous on farms and are considered

essential to deal with predators, and also for hunting, but have been found to be common instruments in suicides among Iowa farm men (Zwerling, et al, 1993). It is the premise of this study that disease and injury among farm family members must be studied in the context of the rural community and the additional rural co-risk factors that influence farm injury and illness.

Brief description of the KCRHS. The Keokuk County Rural Health Study is a population-based, cohort study of health status and agricultural and environmental exposures of a large stratified random sample of residents in one rural Iowa county. The study focuses on injury and respiratory disease, and it monitors health care delivery, geriatric, reproductive, and mental health, and other health outcomes, as well as risk behaviors such as use of personal protective equipment, tractor safety, agricultural chemical storage, smoking, alcohol and drug use, seatbelt use, and firearms ownership. Injury and disease prevalence are investigated in relation to agricultural, occupational, and other environmental exposures. Methods of data collection include comprehensive in-person interviews, medical screenings, and environmental assessments of homes and farms.

2. Primary Goals

The KCRHS was designed with three primary goals (Merchant et al, 2002):

a. to measure rural and agricultural adverse health and injury outcomes and their respective risk factors (surveillance);

b. to design and conduct nested case-control studies and multivariable analyses to define determinants of health and injury outcomes (research); and

c. to provide a basis for the future design, implementation, and evaluation of community-based intervention programs to reduce agricultural disease and injury incidence (prevention/intervention).

To these a fourth goal was added:

d. to provide a comprehensive agricultural disease and injury data resource for students, faculty and other health professionals in Iowa, Federal Region VII, NIOSH and its network of Agricultural Health and Safety Centers, and to others, nationally and internationally, with these research interests.

3. NORA 1 High-Priority Research Areas

In its 15 years of funding, the Keokuk County Rural Health Study has addressed and continues to address 18 of the NORA High-Priority Research Areas, as listed below. Many of these priorities are discussed in the various narratives that follow:

a. Disease & injury

i. Allergic and irritant dermatitis
ii. Asthma and chronic obstructive pulmonary disease
iii. Fertility and pregnancy abnormalities
iv. Hearing loss
v. Infectious diseases
vi. Low back disorders
vii. Musculoskeletal disorders of upper extremities
viii. Trauma

b. Work environment & work force

i. Indoor environment
ii. Mixed exposures
iii. Organization of work
iv. Special populations at risk

c. Research tools & approaches

i. Control technology and personal protective equipment
ii. Exposure assessment methods
iii. Health-services research
iv. Intervention-effectiveness research
v. Social and economic consequences of workplace illness and injury
vi. Surveillance research methods

4. Timeline – history, grant cycles, sub-studies within KCRHS

a. 1990: grant to fund CADIREP received, including as part of the Research Core, funding for the study “Epidemiological Assessment of Farm Families”

b. 1991: coordinator for “Epidemiological Assessment of Farm Families” hired

c. 1991 – 1994: county selected; local Community Advisory Committee formed; research facility remodeled; name of study changed to “Keokuk County Rural Health Study;” staff hired and trained; protocols for medical testing, interviews, and environmental assessments developed; Institutional Review Board human subjects approval obtained; equipment and supplies purchased; household census compiled; random sample of 1,000 households selected and recruited; Round 1 of data collection begun.

d. 1994 – 1999: Round 1 data collection completed on 1640 adults

(ages 18 and older) and 644 children (ages birth – 17)

e. 1999 – 2004: Round 2 data collection completed on 1,588 adults and 575 children.

f. Studies arising from the Keokuk County Rural Health Study, based on data from the KCRHS, or using KCRHS staff and data, all involving collaboration:

i. 1997 – 2000: NIOSH-funded Child Health Outcomes in a Rural Cohort (Child Asthma Case-Control Study) in Keokuk County (Merchant et al, 2005).

ii. 1998 – 2003: NIEHS/NIH-funded Rural Childhood Asthma Study in Keokuk County (Chrischilles et al, 2004).

iii. 1998 – 1999: Iowa Department of Public Health grant to test well water samples. Collaboration with the Keokuk County Public Health Department.

iv. 1999 – 2004: NIOSH-funded Health Tracking of Musculoskeletal Disorders Among Iowa Farmers. Part of KCRHS Round 2.

v. 2000: Collaboration with CDC Nonpersistent Pesticide laboratory, DLS/NCEH/CDC analysis of 100 sera samples for contemporary-use pesticides, organochlorine pesticides, and inert ingredients.

vi. 2000: Community Advisory Committee sub-committee, Improving Seatbelt use in a Rural Community: Research-Outreach partnership (Hammes, 2000).

vii. 2001: NIOSH/NCI-funded Farm Family Pesticide Exposure Study (Curwin et al, 2002; Curwin et al, 2005a; Curwin et al, 2005 b).

viii. 2001 – 2002: Analysis of KCRHS subjects' sera to look for antibodies to Human monocytic Ehrlichiosis, Lyme Disease, Leptospirosis, and Rocky Mountain Fever.

ix. 2001 – 2003: NIOSH-funded Genetic Studies in Non-atopic, Non-smoking Farmers with Airway obstruction. Collaboration with University of Nebraska Medical Center and the University of Arizona (LeVan, Von Essen et al, 2005).

x. 2001 – 2003: NIOSH-funded (Heartland Center) Whole Blood Cytokine Responsiveness in Farmers with Airway Obstruction. Collaboration with University of Nebraska Medical Center (Lambert et al, 2005).

xi. 2001 – 2006: NIEHS/NIH-funded Louisa-Keokuk Environmental Intervention Project.

xii. 2002 – 2003: CDC/PRC-funded Rural Iowa Diet and Exercise (RIDE) Study (Nothwehr, 2003).

xiii. 2002 – 2005: West Nile Virus Serology Study. Collaboration with Iowa State University.

xiv. 2002 – 2005: Swine Influenza Serology Study. Collaboration with Iowa State University (Myers et al, 2006).

xv. 2002 – 2007: NCIPC/CDC/IPRC-funded Fire Safety/Smoke Detector Project (Peek-Asa et al, 2005).

xvi. 2002 – 2009: CDC-funded Prevention Research Center. Community Health Action Partnership intervention projects in Keokuk County.

xvii. 2003 – 2005: NIOSH-funded School Hearing Conservation Project.

g. 2005: Two projects were undertaken by KCRHS staff in the interim between the end of Round 2 and the beginning of Round 3:

i. Neurobehavioral Study - NIOSH-funded feasibility study within the Great Plains Center for Agricultural Health.

ii. Tractor Overturn Project – follow-up of those who had reported tractor overturns in KCRHS Rounds 1 and 2.

h. 2006 – 2010: Round 3 data collection will begin in July 2006.

5. **Vulnerable populations.** The household is the sampling unit of the KCRHS. Everyone living in the randomly-selected households is invited to participate in the study. Our Round 2 cohort included the following members of vulnerable populations:

   a. Women: 855 women age 21 and older

   b. Children: 504 children age birth through age 20

   c. Elderly: 620 men and women over the age of 60 (70 over the age of 80)

6. **Stakeholder inputs.** The following are examples of the several ways in which stakeholders play a significant role in the KCRHS:

   a. Selecting a county/community meetings. Before selecting the county to study, we spent several months closely examining all counties within 1 ½ hours

driving time from The University of Iowa. We obtained extensive information about these counties from the U.S. Census Bureau, the U.S. Department of Agriculture, the State Department of Public Health, the Iowa Cooperative Extension Service, and others. Using this information we eliminated the counties which were not primarily rural or which were not in some way "typical" Iowa counties. After we had narrowed the field to four apparently typical Iowa counties, we visited each one, talking with farmers, farm women, physicians, hospital administrators, public health nurses, and agricultural extension agents to learn more about the counties and to determine the interest and support of the residents. Keokuk County was chosen as the location of our study for several reasons. It is entirely rural, its agriculture is diverse and representative of the state, and, at the time, no other University studies were being conducted in the county and few, if any, had been in the past. Finally and importantly, the community responded to our initial inquiries and visits with interest and enthusiasm. In a meeting with community members, one elderly farmer said, "This study probably won't help me; I'm too old. But, if it might improve the health of my children and grandchildren, I'm all for it!"

b. **Community Advisory Committee**. From the beginning of the study we have had a Community Advisory Committee which serves as a liaison between the study and the community, between University faculty and staff and the research participants. Broadly representative of the geographical and occupational diversity in the county, this committee meets two or three times a year and serves as a sounding board for researchers' ideas. It also serves as a vehicle for researchers to get information to the community, as well as to get feedback from the community to the researchers. This helps to assure ongoing good communication among all involved in the study and contributes to a sense of ownership by people in the community.

c. **Improving seatbelt use: research-outreach partnership.** Round 1 of the KCRHS found a very low rate of seat belt usage, especially for male farmers (~25% reported always using a seatbelt). The overall rate for the county in 1998 was 38.9% (compared to a state average of 70%). A subcommittee of the KCRHS Community Advisory Committee was formed to focus on this issue and to find a way to 1) increase awareness of the issue and 2) to change seatbelt use behavior. Local and state law enforcement officials were asked to "catch" people who were wearing their seatbelts, give them a certificate congratulating them on wearing a seatbelt, and give them a gift. Local businesses pitched in and provided the gifts. In 1999, the annual seatbelt survey reported that usage of seatbelts had increased to 53.3% (Hammes 2000).

d. **Focus groups on obesity.** We have held focus groups in the county to determine the community's perception of their needs (Nothwehr 2003). After the KCRHS found high rates of overweight and obesity in the cohort (65% - 75%), a series of seven meetings investigated concerns about obesity. Participants noted 1) a decrease in physical activity as farmers rely increasingly on

machinery; 2) the lack of exercise facilities in rural areas; 3) the increasing availability of convenience food; 4) the high fat and calorie content of traditional farm meals; and 5) the high cost of fruits and vegetables. They expressed the need for information about good nutrition and for safe places to walk, jog, and bike. From the KCRHS data on obesity and the information obtained from these, and other, focus groups, the CDC-funded Prevention Research Center was born. (See CHAP below.)

e. **Community Health Action Partnership (CHAP).** Several CDC-funded Prevention Research Center projects in Keokuk County emphasize the combination of socio-environmental and individual approaches to bring about behavior change. The mission of the PRC is to improve community health by working toward the elimination of health disparities in rural Iowa and the Midwest through research conducted by the community on issues of importance to them. CHAP, a community partnership in Keokuk County, created three working groups to address specific health concerns of the community: 1) the Nutrition Working Group; 2) the Biking and Walking Trails Working Group; and 3) the Adolescent Alcohol Prevention Working Group. CHAP activities have included installation of dairy vending machines at two area high schools, self-labeling of healthy food choices in the grocery store, menu labeling in area restaurants, planning a hard-surfaced walking and biking trail in the community, a pedometer contest/walk-a-thon and a walk-to-school day. Other activities have included the passage of a county-wide key registration ordinance and creation of a state-wide keg registration coalition to promote state keg registration legislation.

f. **Focus group on farm safety.** "Being careless is addictive." "Humans figure out ways to bypass safety features." "When people see a tractor or combine on the road their brain shuts off." "There's not enough shock value in safety training." "You've gotta throw a lot of mud before it sticks." These are some of the comments made by members of a focus group brought together by the KCRHS to identify farmers' and others' concerns about farm safety. Concerns identified included 1) unsafe rural highways; 2) lack of understanding of Slow Moving Vehicle (SMV) signs; 3) farm machinery that is not adequately equipped, e.g., tractors with no Rollover Protection Structures (ROPS) and power take offs with shields removed; 4) and Personal Protective Equipment (PPE) that is not used properly or not used at all. Most agreed that farmers know what the safe behavior is, but just don't do it. Some in the group indicated that stress, depression, alcoholism, and spouse abuse contribute to the "downfall" of small family farms. Based on the concerns expressed in this focus groups, as well as on data from Rounds 1 and 2 of the KCRHS, we designed several new projects and submitted them in the recent NIOSH competitive renewal proposal. (Described below in Section 8, "New Directions.")

7. Knowledge gained.

a. Childhood asthma. We studied a cohort of 610 rural children from Round 1 of the KCRHS to assess the association between farm and other environmental risk factors with four asthma outcomes—doctor diagnosed asthma, doctor diagnosed asthma/medication for wheeze in the last 12 months, current wheeze, and cough with exercise. The prevalence of doctor-diagnosed asthma was 12%, but at least one of these four asthma outcomes was found in over a third of this population. The high prevalence of asthma outcomes is similar to that found in studies of urban children. Multivariable models of the four asthma outcomes found independent associations between male gender (three asthma outcomes), premature birth (one outcome), early respiratory infection (three outcomes), a personal history of allergies (all four health outcomes), family history of allergic disease (two outcomes), high risk birth (two outcomes), and farm exposure to swine given antibiotics with feed (two outcomes). In spite of their lower rates of atopy and personal histories of allergy, 44% of the children living on farms that raise swine had at least one asthma outcome ($p=0.01$), and nearly 56% of the children living on farms that raise swine and add antibiotics to feed had at least one asthma outcome ($p=0.013$). These findings underscore the need for rural asthma screening programs, for improved asthma diagnosis and treatment, and the need for further population-based studies to assess environmental and genetic determinants of asthma among farm children. (Merchant et al., 2005).

b. Agricultural tasks performed by children. Fifty percent of boys and 18.5% of girls have worked on a farm, and a significant proportion reported having performed several of the 14 farm tasks we asked about, many at an early age. Young children are exposed to risk for injury and disease through participation in dangerous farm tasks. Discrepancies between children and parents in reports of the age at which farm tasks are begun -- children report performing agricultural tasks at an younger age than reported by their parents -- indicate that relying on parent report may result in under-reporting. Age-appropriate guidelines are needed (Park et al, 2003).

c. Risk factors for injury. Farm men (30%) wore seatbelts less often than did farm women (70%) and rural non-farm and town men and women. Farmers were more than twice as likely to use all-terrain vehicles, and farmers and rural non-farmers (77%-90%) were more likely than townspeople (69%-77%) to have firearms in their homes. Nearly 70% of the households had a loaded, unlocked gun (Zwerling et al, 2001). Prevalence of loaded, unlocked guns in farm households was 10.5%, about twice the level in town households, 5.5%. Having taken a gun safety course was associated with more than double the prevalence of a loaded, unlocked gun, 13.5% versus 5.1%. The presence of loaded,

unlocked firearms is of special concern, given existing data suggesting a somewhat increased risk of suicide among farmers (Nordstrom et al, 2001a; Gunderson et al, 1993). These differences in risk behavior in a rural county suggest the possibility of targeting specific rural injury prevention interventions at those with the highest risk of dangerous behavior.

d. Noise-induced hearing loss. The Keokuk County Rural Health Study is the only prospective cohort study in the U.S. that provides data on the association between potential risk factors for hearing impairment and numerous other health outcomes from childhood to old age. We collected self-report data on lifetime exposures to noise and conducted audiometry and tympanometry on all subjects 8 years of age and older. The portion of the population with substantial hearing impairment increases by 13 to 15 percent with each decade of age, beginning during adolescence (baseline rate ~ 10%), with the proportion reaching asymptote in the 70- to 80-year age range. Audiometric notches consistent with noise-induced hearing loss reach a 35% to 60% peak prevalence during the 4th (males) and 3rd (females) decades of life. More than one half of the males in the 5th decade of life (6th decade for females) have hearing losses severe enough to interfere with communication in noisy environments. Approximately 70% of 20 to 29 year old subjects had thresholds that were worse than age- and gender-matched norms.

Analyses of risk factors for hearing impairment suggest that among females, poorer hearing thresholds were associated with age and tobacco use. In the middle frequencies (0.5 – 2 kHz), history of ear infection was also associated with excess hearing impairment. Among males, hearing loss in the middle frequencies was associated with age, tobacco use, and years of exposure to grain feed mills or augers.

Roughly 33% of this rural population can be expected to have hearing difficulty in background noise, and 23% can be expected to have difficulty hearing another person speaking normally in a quiet room. Despite these numbers, fewer than 20% report owning hearing aids. Hearing impairment is a prevalent chronic health condition in Keokuk County, affects the quality of life, and has been linked to higher agricultural injury (Flamme et al, 2005).

e. Farm family pesticide exposure. We collected air, dust, and hard surface wipe samples from various locations inside and around the homes of 25 farm and 25 non-farm homes. Eleven farm homes and 11 non-farm homes were selected from the KCRHS cohort. Farm homes had a greater amount of pesticide residue in the environmental samples than rural non-farm homes. Pesticide residues were found more often in dust from carpets than in the air or on hard surfaces. Farms that had sprayed a particular pesticide had significantly higher

levels of that pesticide than farms that did not spray the pesticide and non-farms. The entrance way, change room and laundry room in farm homes had higher levels of agricultural pesticides, suggesting track-in as a possible source. This study measured effects of low levels of exposure to pesticides, long-term health effects of which are not known (Curwin et al, 2002, 2005a, 2005b).

f. **Use of agricultural chemicals and personal protective equipment.** The occupational survey completed by KCRHS research subjects indicated that 41% of respondents had personally used agricultural chemicals at some time in their lives. The most frequent use was mixing or applying herbicides, chemical fertilizers, livestock insecticides, and crop insecticides. The mean number of years of exposure ranged from 13 for fungicides to 23 for livestock insecticides. While more than half of the farmers reported using gloves during mixing, only 25% reported using gloves during application of farm chemicals, most commonly rubber gloves. Use of other personal protective equipment was very low (Reynolds et al 1998).

g. **Genetic studies related to respiratory disease in male farmers.** Two studies were conducted with 95 non-smoking, non-atopic adult male farmers recruited from the KCRHS cohort. Subjects completed a respiratory symptom and history questionnaire, spirometry, skin prick tests, and blood sampling. One study examined whether whole blood cytokine responsiveness to lipopolysaccaride (LPS) is associated with airflow obstruction, chronic bronchitis, or doctor-diagnosed asthma. A significant association was found between TNF-α hyperresponsiveness and chronic bronchitis. This indicates that the whole blood cytokine assay may be useful in identifying individual responsiveness to LPS (Lambert et al, 2005).

   The other study examined whether carriers of the CD14/-159 T allele who had been exposure to endotoxin had decreased lung function. Farmers with this allele had significantly lower lung function (and reported more wheezing) compared to farmers with the C allele; and farmers with the CD14/-161GG genotype had lower lung function (and more wheezing) than those with the A allele. This indicates that the CD14/-159 and/or CD14/-1619 loci may play a role in modulating lung function and wheeze among agricultural workers (LeVan et al, 2005).

h. **Tractor safety.** Sixty-six farmers in the KCRHS cohort who reported in Round 1 or Round 2 that they or someone in their household had been involved in a tractor rollover were interviewed and their responses were tape-recorded. Detailed questions were asked about the circumstances of the rollover (task being performed, speed, time of day, terrain, weather, etc.), the type (make, model, year) of tractor involved, whether the tractor had ROPS or seatbelts, and

whether there were injuries or fatalities associated with the rollover. Study participants owned an average of 3.1 tractors (range 1-7+) with an average age of 27 years. Only 39% of the tractors had ROPS and tractor age was associated with the presence of ROPS -- 84% of tractors manufactured after 1984 had ROPS whereas only 3% of tractors manufactured before 1960 had ROPS. Thus it is evident that many older tractors without safety equipment remain in use in American agriculture. Expensive incentives would be needed to retrofit all tractors in the U.S., but until there is a dramatic reduction in the number of U.S. farmer-operated tractors without ROPS and seatbelts, the annual incidence of deaths associated with tractor overturns will remain static (Sanderson et al, 2006).

i. **Neurobehavioral effects of agricultural chemicals.** In order to estimate the test-retest reliability of a battery of computer-assisted neurobehavioral tests we conducted a pilot study during the interim between the end of Round 2 and the beginning of Round 3. We wanted to find out if we could use these tests in Round 3 to evaluate the effect of agricultural chemical exposure on the nervous system. These tests were administered on two occasions, separated by approximately 4 weeks, to 54 male farmers were currently farming and who had farmed for at least 5 years. In addition, a pesticide exposure questionnaire was administered on the first testing occasion.

   The neurobehavioral tests provided quantitative scores for the cognitive domains of coding, concept shifting, word finding, short term verbal memory, positive and negative affectivity, and depressed mood. The mean age of participants was 58 years (SD=12.3) and 94% had, at a minimum, completed high school. Intra-class correlation coefficients for the neurobehavioral tests ranged from 0.28 (Pattern Memory Test) to 0.93 (Adult Reading Test) with most correlations between 0.70 and 0.90. Analyses of the pesticide exposure questionnaire are still in progress. Importantly, the questionnaire was successfully completed by all participants. In summary, this pilot study indicates that most of the neurobehavioral tests administered were of adequate or better reliability for use in this rural agricultural population.

j. **Mental health.** Studies of depressive symptoms and suicide thoughts in the KCRHS cohort demonstrate that these mental health issues need to be addressed in the rural/agricultural population. Although rates of depressive symptoms for participants living on farms (20% for females and 15% for males) were lower than those living in rural non-farm households (27% for females and 18% for males), and those living in town (28% for females and 19% for males), they are of concern. Most of the participants who currently live in rural non-farm households and in town households had farmed in the past. Clearly, depression is a concern that needs to be addressed in rural and agricultural communities.

   Numerous factors associated with depressive symptoms were investigated using the 889 rural women in the KCRHS cohort, most of whom are currently farming

or had farmed in the past, and exploring age differences among them in a cross-sectional study using Round 1 data. Data were obtained through in-person interviews and depressive symptoms were measured using the abbreviated 11-item CES-D scale. Although there were no significant differences among the age groups in the prevalence of depressive symptoms (27.6% in women 18-40, 23.1% in women 41-64, and 26.4% in women 65 and older), there were age-group differences in factors associated with these outcomes. While "poor health" and having a "health impairment that limits the kind or amount of work" one can do were commonly associated with depressive symptoms, the relationship with other factors, including age, marital status, education, farm residence, smoking, obesity, stressful events, alcohol abuse, friendships, and activity in clubs or organizations with depressive symptoms varied by age group. Factors associated with depressive symptoms are different for women of different ages. In addition to understanding these age differences, rural primary care physicians should recognize that women who report "poor health" or "health impairments" may be masking depression that requires diagnosis and treatment (Stromquist et al, under revision).

When we investigated suicide ideation ("In the past 12 months, have you had thoughts of taking your own life?), we found that 8.2% (n=133) of our adult participants responded "yes." Seven percent of participants living in farm households, and nearly 9% of those living in rural non-farm and town households responded "yes." Financial loss rather than low income had a significant relationship with suicide ideation, after controlling for depression, which was the strongest correlate. Perhaps change in financial status rather than chronic poverty is the greater risk for suicide ideation (Turvey et al, 2002).

k. Obesity/overweight, nutrition, cholesterol. We examined the associations between fruit and vegetable consumption and two chronic disease risk factors, obesity and hypercholesterolemia. 72.8% of KCRHS participants reported eating fewer than 5 servings per day. Older age participants and those with post-high school education were most likely to eat 5 or more servings per day. More than 75% of KCRHS participants were overweight (36.1%) or obese (40.8%), and 59.6% of participants had a waist circumference considered high risk for chronic diseases. After adjusting for sex, age, smoking, and saturated fat intake, individuals eating less than 5 fruits and vegetables per day were significantly more likely to have a high-risk waist circumference than those who consumed more than 5 fruits and vegetables per day. Consumption of less than 5 servings of fruits and vegetables per day was more common, but not significant, in obese participants. Nearly 57% of adults participating in KCRHS had elevated serum total cholesterol. Only 15% of those with moderately or very high cholesterol reported being treated, and only 17% of those with 2 or more risk factors for cardiovascular disease reported being treated (Tharp PhD dissertation 2006).

8. **New directions.** Knowledge gained from Rounds 1 and 2 of the KCRHS (some of which is described in the previous section -- Section 7) has led us to develop our research in new directions. While we will continue the basic surveillance of farm families that we have done in both of the previous rounds, we will add several new projects that involve prevention, intervention, and education, as well as new areas of research aimed to prevent farm-related disease and injury. Many of these new projects involve collaboration with researchers in other departments or at other institutions.

   a. **Farm Family Intervention Study.** Information provided by farmers participating in Rounds 1 and 2 of the KCHRS indicated that few use personal protective equipment. Those who do, use it inconsistently and not always correctly. We have designed an intervention study that will explore various methods of training farmers (and farm family members) to use PPE consistently and correctly. The interventions include increasing participant awareness of health and safety risks, providing guidance on methods to reduce these risks, and reinforcing a health and safety culture within the home and community. We hypothesize that through repeated communication and the active involvement of farm families in the intervention process, we will observe behavior changes aimed at preventing future injuries. Following the interventions, a rigorous evaluation will be undertaken in order to determine the effectiveness of each type of intervention prior to their widespread dissemination.

   b. **Neurobehavioral effects of agricultural chemicals.** Using information collected during Round 3, we will estimate lifetime exposure to specific organophosphate pesticides, as well as to these OP pesticides as a whole, for each person in the cohort. Information about OP pesticide use available for inclusion in the analyses will include *ever use*, *duration of use* (years), *frequency of use* (days/year), and *decade of first use*. Previous investigations have shown that Iowa farmers provide accurate and reliable data regarding their pesticide use (Blair and Zahm 1993, Blair et al. 2002, Hoppin et al. 2002). The primary exposure variable for use in analyses of neurobehavioral outcome measures will be cumulative lifetime OP pesticide days. Information necessary to estimate this exposure variable will be collected in Round 3. In addition to pesticide use information, we will also obtain detailed information regarding pesticide application methods, use of personal protective gear and closed cab tractors, work hygiene habits, and other characteristics that influence or modify an individual's pesticide dose. Detailed information on work practices (e.g., changing gloves after handling pesticides, removing work boots before entering the home), attitudes towards risk, and high pesticide exposure events (HPEE) will also be collected. This study will be conducted in collaboration with Dr. Fred Gerr, Department of Occupational & Environmental Health, University of Iowa.

c. **Genetic component of respiratory disease.** A very rich source of risk factor data is available on these cohorts from Round 1 and Round 2. The same approach to collection of risk factor data will be continued for Round 3. Data available from the adult questionnaire include respiratory symptoms associated with specific farm and irritant environmental exposures, family and personal allergy history, medical history especially in regard to respiratory diseases, current medication use, smoking history and environment tobacco smoke exposure history, specific home respiratory exposures, and specific farm task exposures and durations and other occupational and rural respiratory exposures available from the occupational and environmental questionnaires. Risk factor data available from medical testing of adults include white blood cell count and differential, hematocrit, sera, skin prick tests using common rural aeroallergens (Merchant, 2005), and methacholine challenge data for those that meet test criteria from Rounds 1, 2 and 3. Risk factor data on children are equally available from questionnaire and medical testing from Rounds 1 and 2. Risk factor data from the adolescent/children's questionnaire include data on atopy/allergies, birth weight, premature birth, early respiratory infection, neonatal intensive care history/oxygen administration, smoking, environmental tobacco smoke exposure, maternal history of smoking during pregnancy, history of being born and living on a farm, whether a parent does farm work, gas or wood stove in the home, humidifier use, parental education, household income, household pets, pesticide use in and out of the home, living on a farm, exposure to livestock, use of antibiotics in animal feed, and specific farm tasks.

   DNA will be extracted from all men, women and children participating in Round 3 from one of three types of tissues: 1) whole blood, 2) saliva, or 3) buccal cells. All genetic analyses for genetic determinants associated with asthma, respiratory symptoms, and lung function will be carried out in collaboration with study consultants Dr. Susanna Von Essen (University of Nebraska Medical Center), Dr. Tricia LeVan (University of Arizona Respiratory Center), Dr. Jeffrey Murray (University of Iowa Department of Pediatrics and Biological Sciences), and Dr. Joel Klein (University of Iowa Division of Pulmonary, Critical Care & Occupational Medicine, College of Medicine).

d. **Collection of lead samples from homes & analysis of blood lead levels.** Data collected in Rounds 1 and 2 indicated that many of the homes of our research subjects are very old. We therefore expect that many children in our study are being exposed to high levels of lead. We will collect samples of paint chips and wipe window sills for lead analyses. We will also analyze blood samples of adults and children for blood lead levels.

e. **Vision testing and use of stray light meter to investigate cataract formation.** We will study the prevalence of visual quality of life and retinal damage in all individuals in the KCHRS. Participants will answer a set of questions during a personal interview designed to elicit information describing the history of visual problems. Standardized visual acuity examinations will be

performed as well as an Early Treatment of Diabetic Retinopathy Study (ETDRS) chart under standardized light conditions. We will use questions from the National Eye Institute Visual Function Questionnaire (NEI-VFQ-25), a 25 question survey that has been validated and has been shown to be sensitive to changes in visual acuity, visual field and age related macular degeneration. The NEI-VFQ-25 has been shown to be not very sensitive to cataract formation. Therefore, after the visual acuity test has been performed, subjects will be tested with the stray light meter which has been validated and is very sensitive to cataract formation and also to corneal opacities that correlate with functional tests. The stray light meter is a relatively simple test. Subjects sit in front of a computer monitor which projects stray light in the form of a circle into the eye. Simultaneously, they are presented with two small half-circles that have a fluctuating intensity. By turning a knob subjects can change the amplitude of the fluctuating intensity, in the form of a two-alternatives forced choice. The amount of amplitude they require to match the other half-circle which is under the control of the stray light meter indicates the amount of glare they are experiencing. This study will be conducted in collaboration with Dr. Michael Abramoff, Department of Ophthalmology, University of Iowa.

9. Outputs/Activities/Service

a. Information dissemination.

i. Publications – see list below in Section g
ii. Databases – shared with researchers within and outside The University of Iowa
iii. Newsletters – mailed to research participants and Community Advisory Committee members twice a year
iv. Speaking to area community groups (Kiwanis, AARP, Farm Bureau, Farm Bureau Women, Lions, etc)
v. Website: www.kcrhs.org
vi. Newspaper articles in local communities
vii. Radio & TV spots in local communities
viii. Consultations with other researchers launching agricultural health-related studies

b. Training.

i. Occupational and Industrial Coding classes. The KCRHS has sponsored and coordinated two Occupational and Industrial Coding classes conducted by NIOSH staff and attended by persons from a variety of departments within The University of Iowa.

ii. Medical student training. The KCRHS has participated annually in the training of The University of Iowa College of Medicine students enrolled in a medical research classes.

iii. Fogarty scholars. Numerous scholars and physicians from Eastern European countries (Czech Republic, Slovakia, Romania) have worked with the KCRHS both to receive training and to work on their own projects using our data.

iv. Post-doctoral fellows. Several post-doctoral fellows, including a dermatologist from Finland, have spent a year working with our study data.

v. International visitors. The KCRHS has hosted numerous international visitors from countries around the world.

c. Collaborative studies. The KCRHS has conducted many studies in collaboration with investigators outside its own Department of Occupational & Environmental Health. The following are researchers outside The University of Iowa, and the projects are listed in Section 4f and described as part of Section 7.

i. Brian Curwin, NIOSH, Cincinnati, OH
ii. Susanna Von Essen, University of Nebraska Medical Center, Omaha, NE
iii. Tricia LeVan, University of Arizona College of Medicine, Tucson, AZ
iv. Patrick Lambert, Creighton University, Omaha, NE
v. Greg Flamme, Western Michigan University, Kalamazoo, MI

d. Service

i. Well-water testing with County Public Health Dept.
ii. County Fair – blood pressure testing, health & safety exhibits
iii. County Senior Citizens dinner – blood pressure testing
iv. State Fair - spirometry
v. Medical test results to research participants
vi. Environmental assessment results to research participants

e. Conferences. In the 16 years of the study, we have attended many, many conferences locally, regionally, nationally, and internationally.

f. Publications and references. Publications and references are listed below. KCRHS articles are starred (*). Non-starred articles include others cited in the narratives above.

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Great Plains Center for Agricultural Health

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1990-91 NonComp

Abstract: "Comparison of the Inflammatory Potency of Bacteria in Their Cell Wall Components in the Lung." JM Gassman, PS Thorne, M O'Neill, J Phipps, K Kulhankova, C Duchaine, Toxicological Sciences, The Toxicologist, March 2000, 39th Annual Meeting Society of Toxicology. March 2000.

Abstract: "A National Survey of Endotoxin in House Dust", PS Thorne, K Kulhankova, M. O'Neill, PJ Vojta, W Friedman, DC Feldin – Annual Meeting – American Thoracic Society, Toronto, Canada. May 2000.

Abstract: Application of a Subjective Health and Safety Rating System to Iowa Farm Operations, published in the ACGIH's journal: Applied Occupatoinal & Environmental Hygiene, vol. 14(12):852-867, 1999.

"A Systemic Review of Farm Safety Interventions", Lisa A. DeRoo, Risto H. Rautiainen. American Journal of Preventive Medicine, Vol 18 Number 4(Supplement), pgs 51-62, May 2000.

"Dust in Pig Buildings". Pedersen S, Nonnenmann M, Rautiainen R, Demmers, TGM, Banhaza T, Lyngbye M. Journal of Agricultural Safety and Health. Submitted.

"Behavioral and Demographic Risk Factors for Loaded Firearms", American Journal of Preventive Medicine.

"Ability to trace Migrant Farm Workers Ten Years after Initial Identification in a Northern State (Wisconsin)". American Journal of Industrial Medicine.

Abstract: Enhancing Bioaerosol Exposure Assessment: A Comparison of Three Commercially Available Impingers". Accepted for platform presentation, American Association of Aerosol Research Conference, St. Louis, MO, Nov. 2000.

Abstract: "Bioaerosols, Fungi and Mycotoxins: Health Effects Assessment, Prevention and Control", Eighth International Conference on Indoor Air Quality and Climate: Indoor Air 1999.

1990-95 Competitive

WORKSAFE IOWA
Ag Education Outreach Activities

Date Audience and/or Sponsor Activity/Title

Spring 88	PPE with Pesticides	Magazine article
7/88	RFD-TV	
7/88	News releases - Aflatoxin	(resulting media interviews)
11/88	Successful Farming	Magazine article - Child safety in Winter
10/88 5/89, 6/89	Iowa Farmer Today	Newspaper interviews
11/89	Hog Farm Management	Magazine interview
11/89	Pork 89	Magazine interview
89/90	Communicating for Agriculture	Furnished several articles
1/90	Wallace's Farmer	Magazine interview
1/90	Iowa Pork Congress	Media briefing (radio, magazines, papers)
3/90	Land-O-Lakes Cenex	Radio interview (no charge)
4/90	Dividends Magazine	Phone interview- respirators
5/90	Minnesota Public Radio	Interview
5/90	National Hog Farmer	Wrote 5 articles for blue print issue

1994-95 NonComp

Selim MI, El-Sharkawy SH, Padamilam BM. Supercritical fluid extraction of fumonisins from grain and contaminated dust. Midwest AOAC. Champaign, IL, June 8-11, 1992. Manuscript under publication in the Am Ind Hyg Jr (being revised for resubmission).

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Donham KJ, Venzke JK. Agricultural occupational health nurse training and certification program: Fulfilling the need for occupational health professionals in agricultural environments. J Agromedicine, 4(1/2):105-116, 1997.

Svendsen ER, Reynolds SJ, Zwerling C, Burmeister LF, Stromquist AM, Taylor CD, Merchant JA. Plotting rural households where map details are insufficient: The use of GPS in the Keokuk County Rural Health Study. Proceedings of the 3rd National GIS in Public Health Conference. San Diego, CA, ATSDR: 635-638, 2000.

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March 13, 2005	ATVs are Useful, Fun and Dangerous
April 10, 2005	Startled Horses can often Pose Danger to Rider
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Southeast Center for Agricultural Health and Injury Prevention

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Background

The Southeast Center for Agricultural Health and Injury Prevention was established in late September 1992. Now a mature Center with nine years' experience, we serve six states in the region (Kentucky, Tennessee, Virginia, North Carolina, South Carolina, and Georgia) through the multidisciplinary nature of the Center staff with faculty from the Colleges of Medicine, Nursing, Education, Agriculture, and Engineering at the University of Kentucky. The Southeast Center's mission focuses on three primary areas of endeavor: applied agricultural health research, education and training in agricultural health, and the design and conduct of prevention and intervention programs to address agricultural health and safety issues.

With the establishment of the Kentucky School of Public Health, the University of Kentucky College of Medicine is now one of only five Schools of Public Health located on land-grant campuses. Further, it is one of only 10 medical programs in the nation with all six divisions of medicine on one campus. The Southeast Center is the only Agricultural Health Center located on a land-grant campus with a School of Public Health. This unique combination of resources facilitates our research, education/outreach, and prevention/intervention capabilities.

The Center will continue to serve as a catalyst and resource for the initiation and support of applied preventive research into agricultural safety and health issues unique to the commodities and populations of the Southeast Region. The Center's research program will contribute resources for the support of investigators developing applied preventive research projects focused on issues of regional importance in agricultural health and safety. The primary role of the Center will be to act as a catalyst, providing funding and resources for primarily pilot projects and for applied research. This mission will be congruent with the agendas outlined in Healthy People 2010 and the National Institute of Occupational Safety and Health National Occupational Research Agenda (NORA). The Center is committed to supporting:

- Projects allowing investigators to collect pilot data, increasing the likelihood for competing successfully for an R01 or other independent sources of funding.
- Projects with a high likelihood of producing publishable quality results in the peer reviewed literature and advancing the state of the science.

Themes

Thematically, through the past several years, the Center has focused on:

- **Special populations**. Agricultural populations who are unique to the Southeast region with respect to their commodities or exposures or for which health-related research is under-represented in the scientific literature. With this application, we continue to focus our research and service efforts on women, children, migrant and seasonal farmers, and older working farmers.
- **Community-based interventions.** The Center provides an academic home for several projects funded through both the Center grant and other external funding that have used surveillance data in the development of innovative community-based intervention projects.

- **Engineering, Ergonomics, and Environmental Health Research.**

The Center will provide new support for research addressing the psychological effects on tobacco farmers of the shrinking demand for their product, health care for migrant workers, and an examination of musculoskeletal disorders among farmworkers.

Given its location within the Department of Preventive Medicine in the College of Medicine, the Center can expand its educational mission to provide greater visibility in the University and within the region. Center faculty and staff will take lead roles in curriculum development for the newly formed School of Public Health, and will be able to further integrate the field of agricultural safety and health and injury control into an agricultural health and safety track within the School. The unique status of the School of Public Health within a land grant University, rich in the tradition of agricultural research and with a strong network of agricultural extension services, allows for development of an interdisciplinary program to integrate the field of public health and preventive medicine with agricultural engineering and the service-oriented resources of Cooperative Extension. This will be accomplished through:

- The development of an agricultural health track in the School of Public Health.
- A sustained commitment to support the development of multi-disciplinary trained students in the Department of Biosystems and Agricultural Engineering.
- Integration of Agricultural Safety and Health in the Nursing Curriculum.

In fulfilling the service mission of the Center, the faculty and staff will provide support to organizations in the field of agricultural safety and health with a service orientation. It will support programs that provide direct care services to workers in agriculture, and continue to provide technical support to organizations and institutions with regard to safety and health. This will be accomplished through:

- A new stakeholder partnership project that incorporates a planned response to community intervention.
- Continued work on the development of multimedia projects for agricultural health and safety and development of new methods of dissemination of agricultural health and safety information.

The Southeast Center for Agricultural Health and Injury Prevention remains committed to continue to develop and sustain an innovative program of research, education, prevention programs, and health services to prevent work-related illness, injury, and death and improve the safety and health of agricultural workers and their families in the Southeastern United States.

Characteristics of the Six-State Region

The average annual rate of agricultural fatalities is greatest in the Southeast – 24 per 100,000 (Meyers and Hard, 1995, Am J Ind Med 27:51). In the Southeast, agricultural workers and their families face a matrix of health and safety hazards different from that of their counterparts elsewhere in the nation. Topography, crops, machinery, and livestock that are common to Wisconsin, Iowa, New York, or California are not necessarily the same as those in the Southeast. Exposure patterns and their sequelae differ based on regional agricultural

production, heat, humidity, and agricultural markets. Agriculture in the Southeast is highly diversified, with multiple crops often growing year round. The differences are not merely climatic and agricultural, but sociocultural as well. The Southeast's strong sense of regional culture and community pride are potential barriers when prevention programs designed by "outsiders" are implemented without adaptation to the cultural and historical aspects of farming in the South. Implementation of preventive measures is also difficult because of the scattered, small-scale nature of the region's agriculture base: owners and operators in the Southeast tend to be small-acreage family farmers, often with off-farm employment.

Moreover, three factors set the Southeast apart from much of the nation: racial diversity, poverty, and illiteracy. The cycle of poverty found in Appalachia and the Mississippi Delta imposes severe restrictions upon society's ability to solve basic health problems, much less address agricultural health and safety concerns. Not only are many people in the Southeast poor, but tax bases are often inadequate to support strong public health infrastructures like those found in many other regions of the United States. Illiteracy and low education levels in the Southeast, among whites, African Americans, and migrant populations, are profound barriers to communication and effective delivery of prevention programs.

Another barrier to improving agricultural safety and health in the Southeast is the remnant of a dual system of higher education that separated agricultural programs at large land-grant colleges (historically white campuses) from the programs at the smaller Historically Black Colleges and Universities (HBCUs). This division, which extends even to Cooperative Extension Service activities, is a product of the Morrill land-grant acts of 1862 (white) and 1890 (African American).

In summary, the Southeast has substantial problems that create unique challenges to improving the health and safety of farmers, loggers, and other agricultural and seasonal workers. In spite of these barriers, however profound, the opportunities for progress are plentiful.

Accomplishments

The faculty and staff of the Southeast Center have sought to establish a strong, well-funded research enterprise. In addition to the core NIOSH dollars, the Southeast Center has attracted substantial extramural dollars. For year eight of the Center, the extramural funding, excluding the NIOSH core dollars, was approximately 1.4 million dollars. The total extramural funding has been documented in previous annual reports. The Center has been an academic home for Drs. Reed, Luchok, Cole, and Browning who have each obtained extramural dollars related to occupational health and safety, with most of these projects relevant to the agricultural health and safety mission of the Center.

Work from the early years of the Center made substantial contributions in the areas of investigation of the epidemiologic patterns of Green Tobacco Sickness (GTS) and the use of regional Poison Control Center records for occupational health surveillance (McKnight, Levine et al. 1994; McKnight, Rodgers, 1995; McKnight, Dawson et al. 1996; McKnight, Kryscio et al. 1996) . The Center's interest in examining the risk of agricultural injuries in children and

developing interventions for reducing children's agricultural injuries also began at this time (McKnight, Piercy, 1995) .

The Kentucky Farm Family Health and Hazard Surveillance Project was housed in the Center and represented a major surveillance initiative to assess the health and injury status of older farmers, women, children, and part-time farmers in the state. The study included 8,271 farms in Kentucky and more than 4,000 interviews with farm family members, and visits to 138 farming operations were conducted. More than nine peer-reviewed publications and technical reports were developed from this project, and this public use data continues to be used by NIOSH and other researchers (Browning et al. 1998; Browning et al. 1999; Browning et al 2001; Heath et al 1998; Reed et al 1999; Jajosky et al 1998; Zwerling et al 1998) .

Over the years, the work of the Center has become well known for its focus on underserved populations. The Migrant Network Coalition originated with the Southeast Center, and researchers and staff of the Center are sought as the regional resource regarding matters of occupational health and health care with respect to migrant and seasonal farmworker issues. Numerous health fairs over the years have been conducted and conferences developed. In the past year, the Kentucky Agricultural Women's Network planned and implemented their first conference entitled Kentucky Women in Agriculture: Breaking New Ground; attendance was capped at 314 people demonstrating the strong interest in these issues among women in the region. The Georgia Women in Agriculture Conference held April 28-29 in 2000 included a substantial number of health screening opportunities for the participants. The service commitment of the Center has been considered excellent in recent University reviews. The Medical Spanish for Health Professionals has been a very popular and much needed program to address the needs of the region.

The Center has received national attention for its support of applied research projects like AgDare (Agricultural Disability Awareness and Risk Education) and the Kentucky Rollover Protection Structure (ROPS) project. AgDare has focused on disability awareness and risk education related to agricultural work for high school vocational education students in three states across in the U.S. Focusing national attention on the issue of disability resulting from agricultural injuries is an important issue among faculty at the Center (Reed & Claunch, 2000) . The Center has also supported underserved populations through programs such as Farm Safety 4 Just Kids and the first Kentucky Women in Agriculture Conference, co-sponsored by the Center

The Kentucky ROPS project, a three-year project for evaluating the quality of community educational materials and activities on impacting farmer's attitudes and behaviors with respect to adopting ROPS and seatbelts for their tractors has received national attention (Cole, Westneat et al. 2000) . The 500-page Kentucky ROPS notebook and a plethora of materials including over 100 radio and public service announcements (PSAs), a series of 25 newspaper articles, and 15 different mass mailings were developed from this project. In addition, a random sample survey of 1,650 farmers in four counties were administered a pre- and post- intervention telephone survey. The recently completed results have important implications to the design of community intervention projects. The Center's expertise on tractor safety issues has contributed to the academic literature and been disseminated to the public at large (Struttmann, 1995, Zwerling 1998 (McKnight, Piercy, 1995; Myers, Synder, 1995; Pana-Cryan, Myers, 2000)

The well-known Kentucky Partnership for Farm Family Health and Safety, originally established with funds from the Kellogg Foundation, has continued to benefit from support from the Center over the past several years. This community-based program was designed to empower farmwomen to reduce hazards to their family's health and safety. The Center continues active collaboration with the Deep South Center and the Southwest Center in providing consultation and technical assistance in extending and replicating successful Center projects, which developed with support from the NIOSH core dollars.

The Center has housed and supported the Bluegrass Chapter of Farm Safety 4 Just Kids since its beginning in 1993. The Chapter serves the central portion of Kentucky by delivering agricultural health and safety messages to medical students, the communities, providing resources for community organizations to use in their health promotion and injury prevention activities, and collaborating to start new chapters of Farm Safety 4 Just Kids. As a result of these efforts Kentucky added the Mamouth Cave Chapter in southcentral Kentucky in 1995. The chapter won the North American FS4JK Outstanding Chapter Award two consecutive years (1999 and 2000). Last year a new chapter was charted in Adair County, Kentucky and in March, 2001 the eastern section of the state added a chapter in Ashland, Kentucky. In 1996 the Bluegrass Chapter received funds form the Kentucky Department of Health, Maternal Child Health Division, to conduct a pilot project on equestrian helmet use by 4-H club members (Reed, Novack, Heath, 1998). The Bluegrass Chapter reviewed and edited an educational video on helmet use (Every Ride, Every Time, Washington State 4-H Foundation) and received farm press coverage (Successful Farming Magazine, Mid-March, 1997; Cooperative Farming, June, 1997). This information is now distributed through the North American Farm Safety 4 Just Kids Organization.

Center projects have supported student research on the etiology of injuries among farm women (McCoy, 2000), the risk of respiratory disease among tobacco strippers (Clouse, 1999), occupational rehabilitation of older farmers (Reed, 1996), breast and ovarian cancer incidence associated with exposure to the herbicide atrazine (Kettles, Browning et al. 1997; Stump et al. 2001) , and the risk of skin cancer and exposure to pesticides among older farmers (Webber et al., 1999). Dr. Reed's study was awarded the International Dissertation award from the Sigma Theta Tau, International (Nursing Honor Society) in 1997.

Throughout the nine years of operation, Center presentations at state, regional, national, and international conferences have been numerous. During the most recent 12 months, 17 peer-reviewed articles or abstracts were submitted and/or published from the Center. The Center continues to be an active participant with NIOSH researchers supporting their research activities in the agricultural community.

The Center will continue to be guided in its mission with the assistance of the external advisory board. The role of this committee is to provide an independent assessment of the Center's progress in meeting short and long term objectives. Members of the committee are Joseph Gore, MPH, EdD, Brunswick Community College, Supply, North Carolina;William Sprague, farmer and president of the Kentucky Farm Bureau; Mattie Mack, farmer, Brandenburg, Kentucky; Sr. Gail Grimes, Farmer Association of Florida, Apopka, Florida; H.

Glenn Joiner, farmer and hospital administrator, Glascow, Kentucky; and Alice Baesler, Special Assistant to the Commissioner of Agriculture, State of Kentucky.

It is important to note that the core dollars provided by NIOSH for the Center represent only about one third of the total budget of the Southeast Center. Over the past eight years, we have leveraged funds from the NIOSH Center grant to develop projects which could not have occurred without the core support dollars. These project are included in the diagram below:

Our plan for the projects and activities for the next five years has been the objective of this grant submission. The Center will continue to build on its strengths and support projects which we consider to be making a difference in the region and contributing broadly to the scientific base for agricultural safety and health. With this renewal, we continue many of the themes and research areas for which the Center has developed a national reputation. As well, the plan reflects the necessity of extending our research, service, and educational mission into new areas. Projects with a focus on ergonomics, engineering controls, and mental health issues of farmers are among the new areas for which the needs of the region indicate our need for involvement. Our the past year and as we continue into the future, the Center will continue to engage in the strategic planning process outlined in the last renewal. This process, with its focus on stakeholder concerns and continual appraisal of the needs of the region's constituents, is intended to assist us in setting the research agenda for agricultural safety and health in our region.

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1. Project Title
Further Dissemination and Evaluation of the Kentucky ROPS Project – The KY ROPS 2 Project

2. Project ID #
U06/CCU417554, -01, -02, -03, -04

3. Center
Southeast Center for Agricultural Health and Injury Prevention, University of Kentucky, College of Public Health

4. Contact Person/PI
Henry P. Cole, Ed.D, Professor, Preventive Medicine & Environmental Health Emeritus Professor, Educational and Counseling Psychology

5. Contact email address
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6. Project Start Date – Project End Date
08/01/99 – 07/30/03

7. Project Status
Completed

8. NIOSH Core
Multi-disciplinary research
Education and Outreach
Prevention/Intervention

9. NORA Program Area

Disease and Injury:	Traumatic Injuries (prevention of tractor overturn injuries)
Work Environment and Work Force:	Emerging Technologies
	Special Populations at Risk (limited resource Kentucky farmers, farm women, farm youth, older farmers)
Research Tools and Approaches	Intervention Effectiveness Research
	Surveillance Research Methods
	Social and Economic Consequences of Workplace Illness and Injury
	Intervention Effectiveness Research

10. NIOSH Objectives (i.e., Strategies)
Research
Prevention
Evaluation
Dissemination

11. Type of Agriculture
Row/Field Crops

12. Target Group

Farmers

13. Special Populations at Risk

Low resource farmers, older farmers, farm women and children

14. Project Description

This project continued the evaluation of the massive amount of data collected in the CPHF ROPS 1 project, achieved the modification and improvement of the KY ROPS Notebook farm community education program materials, and made the materials available electronically on the NASD website. The updated program materials were then implemented by a variety of partners involved in farm safety education. These included agricultural extension programs for limited resource farmers in Kentucky and South Carolina, Farm Bureau safety programs in Virginia and other states, and bilingual outreach programs (which used Spanish language versions of selected materials) among Hispanic farm workers in Kentucky.

15. Introduction/History/Success of Project

Background

On September 30, 1996 a three-year, quasi-experimental, community trials study began with four randomly selected Kentucky farming counties. Two were randomly assigned to the intervention and two to the control condition. The CDC/NIOSH Community Partners for Healthy Farming (CPHF) initiative funded the project. The Partners in Prevention: Promoting ROPS and Seat Belts on Family Farm Tractors became known as the Kentucky ROPS 1 project (Cole & Westneat, 2001 February).

ROPS are roll-over protective structures. They protect tractor operators from crush injuries during tractor overturns. Kentucky farmers are particularly at risk of tractor overturn injuries. Kentucky farming deaths average about 80/100,000 workers/year — about three times the national average. Approximately 33% of these farming deaths are related to tractors. Tractor overturns account for nearly 20% of all farming-related deaths in Kentucky. Fewer than 30% of Kentucky farm tractors are equipped with ROPS compared to a national average of 50%. About half of Kentucky farmers work at off-farm jobs. Average farm income in Kentucky is about half of the national average. These factors, combined with difficult and dangerous topography including steep slopes in hilly areas, entrenched streams in flat lands, karsts (sink holes) topography, and narrow winding roads that split farm land, place Kentucky farmers at risk of overturns.

The KY ROPS 1 project had three primary goals. First, it produced a theoretically grounded and injury-surveillance based set of community education materials in partnership with farmers and community leaders in the two intervention counties. Second, it implemented, user tested, and evaluated these materials in the two intervention counties. Third, the community education intervention materials and methods were evaluated by an experimental design that involved repeated measures ANOVA on large random samples of farmers in the two intervention and two control counties. The four classes of dependent variables included (1) changes in farmers' knowledge and attitudes about the value of ROPS for preventing injury and economic loss, (2) changes in farmers' contemplation of obtaining ROPS-equipped tractors, (3) changes in efforts to acquire ROPS, and (4) changes in the number of ROPS-protected tractors farmers acquired, as determined from three independent data sources. Data for these variables were collected pre- and post intervention from a random sample of 1,227 farmers and by inspection of ROPS retrofit sales records. Significant differences in the expected direction were found for all four

variables for the two intervention counties compared to one control county. The ROPS 1 project also produced a wealth of data about the utility and effectiveness of the many multi-media, multi-method materials and activities that constitute the total program that has become known as the Kentucky ROPS Notebook (Cole, H.P., et al. (2002).

In August 1999 a second CPHF project was funded for a four-year period. This Further Dissemination and Evaluation of the Kentucky ROPS project became known as the KY ROPS 2 project. It provided the time and money needed to analyze the massive amount of data collected during the ROPS 1 project and to raise and answer additional research questions. A series of 10 studies concerned with the further dissemination and evaluation of the ROPS 1 project materials across an array of groups involved in farming contributed to improvements to the Notebook materials. The 10 project-specific aims and a summary of the 10 studies are described below.

Goals and Objectives

The specific aims listed below directed the ROPS 2 project activities. The aims and activities built upon and extended research begun during the ROPS 1 project.

1. Continue analysis of the ROPS 1 pre- and the ROPS 2 post intervention Kentucky Farm Tractor Survey data.
2. Continue field testing and refining the ROPS program materials and methods in cooperation with other groups in Kentucky, Virginia, South Carolina, and other states.
3. Evaluate the degree to which the community education campaign messages reached African American and limited resource farmers.
4. Conduct ROPS promotion outreach efforts targeted to Kentucky and North Carolina minority and limited resource farmers.
5. Evaluate the mass communication message portions of the ROPS Notebook materials and revise these materials based on the results.
6. Integrate the Kayles' Difficult Decisions simulation exercise and other ROPS Notebook public health materials into high school social studies classes and assess the impact on students and community members.
7. Update the electronic version of the ROPS Notebook materials for distribution on the National Agricultural Safety Database (NASD) website.
8. Translate into Spanish selected ROPS Notebook materials for use in high school English as a second language (ESL) and Spanish classes, as well as for use in the Hispanic community at large.
9. Continue preparation of presentations and papers for publication in professional journals.
10. Prepare new proposals to complete data analysis and to pursue additional research questions that arose from the earlier studies.

The Project Activities section of this report is organized around these specific aims.

Project Progress

The project was completed on July 30, 2003 and the final report submitted on June 11, 2004. The human subjects IRB protocol remained active until September 5, 2005 to allow continued data analysis.

The ROPS 2 project produced many paper presentations, technical reports, and journal articles based on the ROPS 1 project data and activities as ROPS 2 continued the evaluation and refinement of the program materials and their dissemination. Key documents cited in the Project Activities section of this report are referenced in the Outcomes/Products section of the ROPS 1 project report because that is where the research began.

Project Activities

Each major project activity is summarized below. Products and outcomes that resulted from these activities are noted. Documents are cited that list the details of the activities and outcomes. A much more detailed description of the activities and outcomes is found in the ROPS 2 Final Report (Cole, June 2004).

Effectiveness of the KY Community ROPS Program

A quasi-experimental design, community-trials intervention study found that compared to control counties the KY ROPS program was successful in promoting intervention county farmers' increased contemplation about equipping unguarded tractors with ROPS and farmers' increased efforts to do so. Significantly greater numbers of intervention farmers also obtained ROPS than did farmers in one control county. An equipment dealer in the second control county mounted his own ROPS promotion effort, which proved to be nearly as effective as the formal effort in one intervention county and more effective than the other intervention county. The success of the University program resulted from (1) the community partner–university collaboration, (2) the development of the intervention materials from case-based and rate-based injury surveillance data, (3) the iterative development, field testing, and revisions of the program materials in cooperation with farm community members, and (4) a conceptual framework for the development of the materials and methods grounded in a strong theoretical base (Cole, 1997, 2000, 2002,; Murphy, 2003, Chapter 6; Scharf, Vaught, Kidd, et al., 2001). These four distinctions led to selection of the KY ROPS project for inclusion as chapter 7 of *Prevention of Neurotrauma: A Casebook of Evidenced Based Practices* (Richardson, 2004). Richardson's chapter provides a detailed analysis and evaluation of the project. The success of the equipment dealer's ROPS promotion effort in one control county provided the opportunity for the study of a "natural" experiment (Myers, Cole, & Westneat, 2005).

Cost-Effectiveness of the KY ROPS Campaign

In January 1999 the Kentucky ROPS 1 pre-intervention Kentucky Farm Tractor Survey was administered to a random sample of 1,648 farms in the two intervention and two control counties to determine the prevalence of ROPS and tractor overturns. In January 2000 the survey was re-administered post intervention to 1,227 of these same farms to determine intervention and control county increases in farmers' acquisition of ROPS. The sample attrition was related to farmers who had died, retired, or gone out of business. Data from these two ROPS 1 surveys were combined with the data from other surveillance studies and a new ROPS 2 random sample survey of 6,063 Kentucky farmers. The third survey gathered information about the frequency of tractor overturns and operator injury outcomes for ROPS-equipped and unguarded tractors and the severity of overturn injuries. Data from all three surveys and Census of Agriculture data were used to calculate the cost-effectiveness of the KY ROPS 1 project retrofit effort. Cost was calculated in terms of fatalities and injuries averted over a 20-year horizon period with a 4% annual discount rate. The cost-effectiveness of the KY ROPS intervention with the two control counties pooled was found to be $172,657 per injury averted. This figure compared favorably with a previous national study that reported a cost of $489,373 per injury averted using the same 20-year horizon and the same 4% annual discount rate. One of the intervention counties that had a cohesive and very active community leadership team achieved an even lower cost of $112,535 per injury averted. An equipment dealer in one control county who mounted his own effective ROPS promotion campaign achieved an even lower cost of $36,372 per injury averted (Myers, Cole, & Westneat, 2004).

The results of these cost-effectiveness analyses are significant for three reasons. First, they demonstrate the effectiveness of the ROPS promotion campaign. Second, they provide another empirical methodology by which to evaluate community intervention programs. Third, these

recent cost analyses used updated and robust population-based data for estimating the probability of overturns and injury outcomes that result from these overturns.

Probability of Operator Injury during Tractor Overturns

A review of published literature found that estimates of death during tractor overturns ranged from .032 to .68 (Cole & Westneat, 2000; Cole, Westneat, & Myers, 2006). Calculating the probability of operator injury outcomes during overturns of unguarded tractors and ROPS-equipped tractors requires population-based estimates of the total number of tractor overturns. While a number of prior studies collected and reported fairly complete data for tractor overturn fatalities, no prior studies provided population-based estimates of the frequency of all tractor overturns, fatal and non-fatal combined. Without an accurate denominator, it is impossible to estimate the effectiveness of ROPS promotion campaigns in terms of the cost per operator of fatal and non-fatal injuries averted.

We became aware of this problem early in the ROPS 1 and 2 projects as we talked with scores of farmers, many of whom had survived tractor overturns, a point also confirmed by the data from a random sample survey of 998 farmers as part of the earlier Kentucky Farm Family Health and Hazard Surveillance Study (Browning et al, 1998). As a first step we used four independent data sources to estimate the probability of death during a tractor overturn. The results of that study were reported at a National Occupational Injury Symposium. The four estimates of the probability of death during an overturn (P_{dOT}) were .132, .136, .153, and .219, values much lower than the published CDC value of .40 (CDC 1993, 2000). Better estimates of the denominator of all tractor overturns, and the frequency of six categories of injury outcomes to tractor operators during overturns, were needed to complete accurate cost-effectiveness analyses of ROPS promotion efforts. Thus in May 2002 we developed the 40-item Kentucky Tractor Overturn Survey (KY T/O survey). During the March to August 2002 period we pilot tested and revised the survey. During October and November 2002, the Kentucky Agricultural Statistics Service administered the survey to a statewide random sample of 6,063 farmers. The response rate was 79%.

Analysis of the survey data found an uncorrected probability of .054 of operator death during an overturn of an unguarded tractor. The comparable value for a ROPS-equipped tractor was .011 and in that single case the operator was not wearing the seat belt. Kentucky FACE data were used to calculate a corrected probability of death estimate of .080. The correction accounted for those farms that went out of business because of a tractor overturn injury or death, and were therefore not included in the KASS farm sampling frame. The KY T/O survey also yielded estimates of the frequency of five other classes of injury outcomes including no or minor injury, injury requiring medical treatment, injury requiring hospital admission, injury that resulted in days of farm work lost, and permanently disabling injuries (Cole, Myers, & Westneat, 2006).

The data from the Kentucky T/O survey are important for four reasons. First, they provide accurate population-based estimates of the denominator of all tractor overturns, as well as estimates for six classes of operator injury outcomes that result from overturns. Second, when these new values are used in cost- analysis decision models it is possible to estimate the number and the costs of overturn injuries and fatalities averted by ROPS. Third, cost analyses also can be calculated for non-fatal injuries that result from overturns, including very costly severe injuries and permanently disabling injuries. The prevalence of these injury outcomes was unknown previously. Fourth, other researchers can use the survey items, methods, and results to design and conduct similar studies to determine the generalizability of the Kentucky data to other regions with varied farming characteristics and operations.

Integration of Farm Safety and Economics into High School Social Studies

A joint effort by University of Kentucky and NIOSH researchers resulted in the development of the Kayles' Difficult Decisions simulation exercise. The initial development and a small evaluation study were funded by an earlier NIOSH project directed by the late Pamela Kidd (Britt, Chrislip, Bayer, et al., 1999; Cole, Kidd, Isaacs, et al. 1977; Scharf, Kidd, Cole, et al., 1998). The Kayles' simulation was subsequently included in the KY ROPS Notebook materials.

In 1999 and 2000, supplemental funds from NIOSH were added to the ROPS 2 project budget to conduct a formal evaluation of the effectiveness of an enhanced paper and pencil version and a newly developed parallel CD-ROM version of the Kayles' Simulation Exercise. The resulting two-year project involved 377 high school juniors and seniors enrolled in social studies classes in six rural county high schools. Ten outcome measures were used in a randomized control trial experimental design that involved two control schools, two schools where the CD-ROM version was administered, and two additional schools where the paper version was administered. The paper and pencil versions were found to be equally effective in promoting students' knowledge of farm safety and economics relationships. Students in the two intervention schools scored significantly higher ($p < .001$) on the Farm Safety and Economics posttest than students in the two control schools. Both the paper and pencil and the CD versions of the simulation fully engaged the students' and teachers' attention and participation in the simulation activity. Teachers were easily able to integrate the simulation exercise into the economics and practical living core content standards for high school social studies.

As a class assignment, individual students in the two simulation conditions (paper and CD) discussed the Kayles' case with a farmer, specifically the relationship between farm safety and economics. UK researchers conducted follow-up telephone interviews of a sample of 55 of these farmers a month after the students had talked to them. Approximately 85% of these farmers reported that their discussion with a student caused them to think about the economic costs of an injury to themselves or other workers on their farm. Seventy percent reported considering hiring part-time help during peak work times to avoid increased risk of injury from being stressed and fatigued. Sixty percent reported that they had taken specific actions to remove or lessen an injury hazard on their farm following their discussion of the Kayles' case with a student. The most frequently reported hazard reduction action was replacing or repairing damaged shields on farm machinery. The students' written reports about the interview also suggested that their discussion of the Kayles' case with farmers favorably influenced farmers' attitudes and knowledge about the cost- effectiveness of safety practices.

The detailed results of the Kayles' Simulation Exercise study are presented in a final report to CDC/NIOSH (Cole, Westneat, & Phillips, 2001, January). A more recent study involving 10 high school social studies, economics, business, and vocational agriculture teachers and several hundred students in five rural Kentucky high schools was funded by CDC/NIOSH (5 U50 OHO7447) from 9/30/04 – 9/29/06 (Cole, 2004, October). This project also included an economic cost tool used to calculate a cost analysis of the injuries depicted in four simulation exercises. The tool also calculates a cost-effectiveness analysis of available safety practices known to prevent the injuries depicted in the simulation exercises. The results of that study are currently being analyzed, and a number of papers have already been presented at professional meetings.

The studies of the Kayles simulation exercise and three other simulation exercises that deal with high frequency, high-severity, farming-related injuries are important for five reasons. First, they demonstrate that the public health issues addressed in the Kayles' case and in similar materials

in the ROPS Notebook can be integrated easily and effectively into a high school curriculum and that doing so enriches a curriculum. Teachers and students involved in using these materials subsequently accessed and incorporated into their class work many other activities and materials from the ROPS Notebook and the CDC/NIOSH website. Second, nearly all students in all schools are enrolled in social studies classes and thus can be educated in community-relevant public health issues as part of their normal class work. Third, public and community health and practical living are included in both national and state high school social studies curriculum content standards. Thus, the issues addressed in the simulation exercises and the ROPS Notebook include curriculum content that is relevant to health, social studies, and economics instruction. The simulations are also relevant to and resonant with concerns of rural community members. Fourth, students who attend rural public schools are an important target audience because a large proportion of these youth are involved in farming and at risk of farm injuries. Fifth, these students are the next generation of farmers and leaders in their communities. The attitudes and knowledge they acquire in school through their formal instruction may have a lasting and positive effect on community health and safety.

Evaluation of the ROPS Project Mass Communication Messages

During the 1999 to 2001 period, the project team conducted studies of three sets of the mass communication materials included in the ROPS Notebook. The first study was a series of conceptual and theoretical analyses of the Notebook's 25 newspaper articles, 100 radio public service announcements (PSAs), and 15 graphic and short text messages. These short messages were distributed in mass mailings of billing statements and checks by scores of businesses and other groups in the ROPS 1 project intervention counties. The results of these conceptual analyses and empirical studies were used to rewrite and improve the Notebook PSAs and stuffer messages. During the same period, we completed a conceptual analysis of all the ROPS Notebook mass communication messages.

A second large empirical study of the effectiveness of the mailing, billing and check stuffers was completed with a large sample of Kentucky farmers. The farmers were asked to examine, respond to and evaluate individual text and graphic messages about tractor overturns and ROPS. Each message was designed consistent with narrative representation theory (Cole, 1997), Pavio's (1978) dual coding theory, and Bruner's (1986) conceptions of how narrative thinking and iconic representation are basic to making meaning. Message design also included Witte's (1992) parallel-distributed processing model and appropriately designed fear messages. Bandura's (1989) theory of self efficacy and Witte's (1992) theory of self efficacy and response efficacy were used to combine message content with enabling strategies to empower members of the target audience to contemplate and then act to obtain ROPS and seat belts. This study of the graphic and text stuffer messages indicated that narrative-based messages that incorporate fear appeals and enabling strategies are more favorably evaluated by farmers than text messages that simply inform farmers or messages that rely on statistics and graphs alone. Consistent with Pavio's theory, farmers judged short text narratives accompanied by simple line diagram illustrations of the same message content to be effective. (Morgan, Cole, Struttmann, & Piercy, 2002). Pavio's dual coding theory is based on evidence that the human brain has two separate pathways for processing text and visual-spatial stimuli. When a message's affective and cognitive content are simultaneously presented in a short text passage and an accompanying graphic illustration, the message is more easily and fully comprehended.

These ROPS 2 mass communication studies are significant for four reasons. First, few empirical studies of farm safety mass media messages have been conducted. Second, most farm safety mass communication messages are developed without a theoretical basis. Third, most studies

of persuasive mass communication messages have focused on urban and suburban residents rather than on farm populations. Fourth, the mass communication messages in the ROPS Notebook comprise a large portion of the materials. They have been widely used by many groups as radio PSAs and as short print messages distributed through local newspapers, magazines, newsletters, mass mailings, and counter-top handouts.

Studies Related to African American and Limited Resource Farmers

Three studies were conducted concerning African American and limited resource farmers. The first study was a statewide telephone survey of the full sample of Kentucky's 450 Black principal farm operators listed in the 1997 Census of Agriculture. The survey measure was the same Kentucky Farm Tractor Survey that was used as a pre- and post measure in the ROPS 1 and ROPS 2 studies. The response rate was 51.2%. Of the 232 farmers who responded, only 6 (2.3%) reported having acquired a ROPS for their tractors within the last three years. Of these six ROPS, only one was a new ROPS purchased from an equipment dealer. One was a used ROPS and four were homemade ROPS. Three other farmers reported that they had acquired a newer tractor equipped with a ROPS primarily for the protection provided by the ROPS. The prevalence of ROPS-equipped tractors among African American farmers is much lower than among the larger farm population. Minority farmers also have fewer resources to equip their tractors with ROPS.

Following the initial survey of Kentucky Black farmers, two other studies were undertaken. The first study involved a two-year project with Black and limited resource farmers in South Carolina. UK project researchers demonstrated the KY ROPS project goals, materials and methods to South Carolina State University (SCSU) and Clemson University Agricultural Extension agents at a series of 2-day workshops. The meetings were held at the SCSU campus in Orangeburg. Clemson Extension safety specialist Charles Privette III, SCSU Extension specialist James Hill, and eight other Extension agents from the two schools selected materials from the KY ROPS Notebook for use with a ROPS promotion campaign in 14 South Carolina counties clustered in four regions of the state. The purpose of the project was to determine the utility of the KY ROPS Notebook materials for use in other states. Five sets of materials from the KY ROPS Notebook were selected. Four of the activities were modified slightly. Extension agents from both universities then delivered the SC ROPS Notebook program to approximately 500 people in these 14 counties. The KY ROPS Notebook was judged to be a valuable resource for safety extension outreach activities in South Carolina and in other states. The Extension agents found it easy to adapt the materials to regional farming practices. The two universities planned to distribute their South Carolina ROPS Notebook statewide as part of their Extension safety program efforts (Privette & Cole, 2003).

The second 2002 – 2003 study involved an onsite farm tractor safety survey interview of 77 Black and limited resource farmers followed by an inspection of their farm tractors. The farmers involved were from 18 Kentucky counties. Eight Kentucky State University (KSU) Extension agents conducted the farmer interviews and tractor inspections. The descriptive study design and farm safety survey and tractor inspections measures were developed jointly by the University of Kentucky and the KSU project team. The tractor safety inspection protocol was based on the Agricultural Safety and Health Best Management Practices manual developed by Dennis Murphy and his colleagues at Pennsylvania State University. The results of the KSU study have not yet been published. However, the study results are presented in a detailed unpublished technical report (Cole & Westneat, 2003, March).

The KSU study confirmed that minority farmers have a large proportion of old tractors. Most of the tractors have multiple safety problems (no ROPS, missing PTO master shields, damaged or missing lights, broken seats, poor brakes, badly worn tires, worn steering, and no SMV signs).

The farmers are aware of the injury and economic protection provided by ROPS and seat belts. Few have the financial resources to obtain ROPS retrofits for their older tractors or to replace these tractors with newer ROPS-equipped tractors. Few of these farmers have thought about or made efforts to obtain ROPS for their tractors. Sixty percent of the sample had seen or heard messages about ROPS and seat belts. Most of these farmers would install ROPS on their tractors if they received cash incentive awards for doing so and if ROPS for their older tractors were available at an affordable price.

Kentucky State University Agricultural Extension program officials subsequently wrote and submitted proposals for tobacco buy-out funds to obtain ROPS incentive awards in the amount of 50% of the price of a ROPS retrofit. If awarded, the plan is to make the incentive award program available to all farmers served by the KSU 1890 Extension program. The KSU University administration also spent $15,000 to update and revise its Extension farm safety and outreach pamphlets, videotapes, and posters. The funds were used to remove photographs of tractors without ROPS from outreach documents, fliers, posters, displays, and videotapes. The images of unguarded tractors were replaced with photographs of ROPS-equipped tractors.

During the two-year period of the project KSU Extension staff conducted ROPS and tractor safety outreach education activities with approximately 1,000 limited resource farmers. As a direct result of the project, KSU University administration and Extension leaders implemented a policy of promoting ROPS and seat belts on tractors as a priority topic in their outreach and service activities with farmers.

This work is significant because it documented limited resource farmers' interest in and limited access to ROPS-protected tractors. The study results provide background and baseline information that remains useful for planning and implementing future community-based ROPS promotion efforts with members of this population. In addition, both the South Carolina and the Kentucky projects involved collaborative efforts at ROPS promotion and farm safety outreach by two major land grant state universities and two historically Black universities. The four universities involved continue to sustain tractor safety education outreach efforts.

Placing the ROPS Notebook Materials on the NASD Website

During the 1999 to 2004 period, the ROPS Notebook materials were updated, revised and placed on the NIOSH Agricultural Safety Database (NASD, http://www.cdc.gov/nasd/docs/d000901-d001000/d000997/10.html). Prior to that time approximately 350 hard copies of the ROPS Notebook materials were distributed to many groups in Kentucky and elsewhere. An additional 500 copies of the CD-ROM containing the ROPS Notebook materials were also widely distributed, many as handouts at farm producer, FFA, and farm safety meetings and conventions.

Placing the Notebook on the NASD website was a significant accomplishment for several reasons. First, it became much easier for people to access and use the materials. Second, it made it much easier to update and add material to the collection. Third, it solved earlier problems of limited space and funds that prevented the University of Kentucky from maintaining adequate inventories of the hardcopy and CD-ROM versions of the Notebook and shipping these materials to individuals. (The hardcopy 3 D-ring Notebook is 3.5 inches thick and weighs six pounds.) Fourth, because the materials are available online from the Internet, Kentucky high school students and teachers involved in Kayles' Simulation Exercise study and a subsequent similar study frequently accessed and used other ROPS Notebook materials as part of their class work. Many Extension agents, health outreach workers, farm safety professionals, and other people also access and use the materials.

Target Community Involvement

The ROPS Notebook materials were developed, implemented, and evaluated with the cooperation of many community partners. The details of the collaborative effort and its outcomes are presented in Richardson's (2004) case study of the Kentucky ROPS project. Richardson reviewed the project proposals, documents, records, presentations, reports, and publications. In-kind contributions from the many community partners in the two intervention counties during the ROPS 1 project was estimated at $87,000 for a 17 month period and at twice that amount for the full project duration of three years. Many other details about community members' support of the project are described in Richardson's chapter.

Local employers in the two intervention counties actively promoted the KY ROPS project campaign messages. Fifty-nine percent of Kentucky farmers work at off-farm jobs, often for 40 hours per week. Many of these dual career farmers do so to earn additional income and to receive health insurance benefits for themselves and family members. Employers became involved in the ROPS promotion campaign because they recognized that a large proportion of their workers were farmers or farm family members at risk of tractor-related injuries. By becoming actively involved in promoting ROPS, seat belts, and tractor safety, these managers acknowledged that their companies benefit economically by helping to protect their workers from injury, lost work time, and increased health insurance costs. Company managers and human resource officers also recognized that company involvement in the program was a worthwhile public health and community-relations effort (Brandt, Struttmann, Cole, & Piercy, 2001).

Tractor equipment dealers in the two intervention counties also made major contributions to the ROPS 1 promotion campaign. In January 1997, they assisted in the design of the *How to Get a ROPS and Seat Belt on Your Tractor* pocket flier. This simple tri-fold document provided easy-to-read and specific directions for obtaining information about ROPS for any brand of tractor. In addition, it clearly identified the information about a tractor that a farmer would need prior to meeting with an equipment dealer. For each county in which the fliers were used, the local dealers' names, addresses, and telephone numbers were listed on the flier. In addition to helping design and distribute the fliers, the equipment dealers recorded their sales of ROPS to farmers throughout the project and allowed us access to this information. The equipment dealers also were instrumental in enlisting other community businesses in supporting the printing and distribution of the *How to Get a ROPS* tri-fold fliers. Local banks in each community agreed to have their names, addresses and telephone numbers listed in the fliers, along with a statement that they would provide low-interest loans for ROPS retrofits or replacement of older tractors with ROPS-equipped tractors. Dozens of other business paid for the printing and distribution of the fliers and listed their names after the statement, "This message brought to you by…."

At the end of the ROPS 1 project and the beginning of the ROPS 2 project, equipment dealers consented to a structured interview where they provided detailed information about their involvement in the ROPS project. This included their perceptions of the program methods and effectiveness, the barriers and frustrations they encountered while trying to promote and sell ROPS, how their attitudes and practices had changed as a result of the program, and their recommendations to improve the program and similar ROPS promotion efforts. (Struttmann, Brandt, Morgan, Piercy, & Cole, 2001).

These community involvement findings are significant for four reasons. First, they suggest that a wide variety of community agencies and employers can be effective partners in developing and

promoting health and safety community education campaigns. Second, they demonstrate that these types of community groups are willing to devote time and money to these efforts. Third, by promoting farm safety and public health, many individuals recognized they were protecting their own health and economic well-being, as well as that of their family, friends, and co-workers. Fourth, as Green and Kreuter (1991) pointed out, given the busy schedules of adults and children in today's society, one of the best ways to reach large numbers of individuals with health promotion information is through the workplace and public schools. Both are places where people gather regularly for extended periods of time and where they engage in sustained social interactions. Community social norms for appropriate health behaviors are strongly influenced by these social interactions and the knowledge, attitudes, and behaviors modeled within these groups (Brandt, Struttmann, Cole, & Piercy, 2001).

Farm Bureau Involvement

Early in the ROPS 1 project, Ms. Patti Blankenship, Director of Program Development for Kentucky Farm Bureau (KFB) became involved. She and others in the state office wrote letters of support for the original proposal and assisted Cole, Piercy, and Struttmann in planning the strategies and methods for the ROPS community education campaign. Ms. Blankenship reviewed early drafts of ROPS Notebook materials and made suggestions. Among other things, she advised us to use short text messages that told a story and simple graphics that engaged the viewer by communicating simple, clear, and powerful messages. She and others in Kentucky Farm Bureau continued to review the ROPS Notebook materials as they were developed and provided us with constructive criticisms and suggestions. KFB also awarded $500 to each of the two intervention county Farm Bureau offices. The funds were ROPS retrofit cash incentives of $100 each for five farmers in each county who won the awards in well-advertised public drawings.

At the beginning of the ROPS 2 project, Ms. Blankenship arranged for Dr. Cole to present the goals, key activities, and materials from the ROPS Notebook to annual meetings of the of the Kentucky County Farm Bureau's Presidents and Vice Presidents. Dr. Cole was also invited to make similar presentations to the annual Kentucky Farm Bureau Women's Leadership Conference. The men and women who attended these sessions are community leaders from among Kentucky's 120 Farm Bureau county chapters. During these meetings, the leaders learned about the ROPS project and provided invaluable feedback about the program materials and strategies. Subsequently, many of these individuals requested copies of the ROPS Notebook materials. Ms. Blankenship distributed more than 60 hardcopy versions of the Notebook materials to county chapters and later distributed many additional copies of the CD version of the Notebook.

Toward the end of the ROPS 1 project, Mr. Bruce Stone, Safety Director for Virginia Farm Bureau (VFB) heard a presentation about the Kentucky ROPS project at a National Institute for Farm Safety (NIFS) meeting. He and his deputy director, Mr. Ron Saacke, approached Drs. Cole and Piercy and asked if these scholars would share the Kentucky project materials and information with them for possible use in VFB's ROPS promotion efforts. At the beginning of the ROPS 2 project, Cole and Piercy shipped copies of the ROPS Notebook to VFB. Later Drs. Cole, Piercy, and Struttmann visited the VFB office in Richmond on multiple occasions. These experts demonstrated, displayed, and discussed various ROPS Notebook methods, strategies, activities, and materials. In turn, VFB shared with the presenters its ROPS promotion and other farm safety outreach materials, as well as records of the distribution of these materials. On a subsequent visit to Richmond, the ROPS 2 evaluation and dissemination project leaders met with Bruce Stone and with Farm Bureau leaders from three Virginia counties that had

experienced high rates of fatal tractor overturns. Following this meeting, VFB began adding to its existing tractor safety and ROPS promotion program materials adapted from the KY ROPS Notebook.

VFB's use of KY ROPS Notebook materials included adapting the Photos of Fatal and Non-fatal Tractor Overturn Injuries to Virginia overturn cases. Bruce Stone also made a physical model display of "What's the Problem," a ROPS Notebook chart that depicts the number of farmers in Kentucky who died in tractor overturns during a 6-year period. The VFB version consists of a series of plywood tombstones that are set up around an overturned tractor that is displayed at county fairs and farm safety day events. As in the original drawing in the KY ROPS Notebook, the plywood tombstones depict the number of tractor overturn deaths for a period of years, but in this case, for Virginia tractor overturn fatalities. The effect of the three-dimensional Virginia physical model is even more dramatic and compelling than the original Kentucky drawing. VFB likewise adapted many other KY ROPS Notebook materials and activities, including the Mr. Good Egg Farmer model tractor overturn demonstration, the radio PSAs, and the ROPS Retrofit Survey form used to interview Kentucky farmers who had retrofitted tractors with ROPS. The survey gathered information about what messages the farmers' had heard about ROPS, to what degree the messages influenced the farmers' decisions to install ROPS, their motivations for retrofitting a tractor with ROPS, and difficulties and barriers they may have encountered when doing so. The Virginia version included information about the cost of the ROPS to the farmers and how easy or difficult it was for them to locate, purchase, and have a ROPS installed on their unguarded tractors.

The interactions with VFB were mutually beneficial. The project team learned from VFB and, in turn, VFB also acquired and applied new ideas and methods that strengthened its program. Stone and Saacke stated that both the products produced by the KY ROPS project and the conceptual and research methods that underlay the project proved valuable to their VFB ROPS program. VFB continues to use, improve, and integrate KY ROPS Notebook materials and methods into its farm and community safety outreach program. It currently operates a statewide ROPS-retrofit incentive fund program and manages a similar program for the State of Iowa.

VFB made another major contribution to the dissemination of the KY ROPS Notebook materials and methods. In 1999 and 2000 under Bruce Stone's leadership a national group of state Farm Bureau Safety Coordinators was formed. Since 1999 the group has convened for 2.5 days each summer. The group was first called the Farm Bureau Safety Network. Later its annual meeting became known as the Farm Bureau Safety Coordinators' Conference. The 23 states and the national Farm Bureau Federation office listed in Table 1 are members of the group. Bruce Stone invited Dr. Cole's staff to share the UK ROPS program purpose, materials, and results with the group's first annual conference and two subsequent conferences. As a result, these state Farm Bureau leaders were equipped with the hardcopy and CD-ROM versions of the KY ROPS Notebook materials. At the August 8-10, 2002 annual meeting in Park City, Utah, members of this group reported using portions of the ROPS Notebook materials and methods in their states. In addition, state Farm Bureau contacts with local county chapters and other state and county organizations resulted in dissemination of the materials to many other agencies and groups including farm youth groups, farm women and leadership groups, Extension agents, EMS personnel, state police, and other public health and safety officials. For example, an Illinois State Police sergeant learned about the materials from the Illinois Farm Bureau office. He then contacted Cole at the University of Kentucky and learned about the NASD website. He began using selected topics and materials from the Notebook as part of the community and traffic safety programs he conducts throughout regions of his state.

The results of this activity are significant for three reasons. First, during their August 2002 Park City meeting the Farm Bureau Safety Coordinators conference participants discussed their goal of becoming the national group best able to promote and positively impact farm safety. The members of this group describe the ROPS Notebook as a "tool kit" appreciated for its utility as they implement their community-based health and safety programs. Second, farmers respect Farm Bureau as one of the oldest and most trusted farm community organizations. Third, Farm Bureau is a grassroots, bottom up organization. If county and state level Farm Bureaus get behind a program, the program is likely to be promoted and implemented.

Table 1: List of State Farm Bureaus whose safety directors and staff received an orientation to and a copy of the KY ROPS Notebook and CD-ROM

Arkansas	Louisiana	South Carolina
California	Maryland	Tennessee
Georgia	Minnesota	Utah
Illinois	Mississippi	Virginia
Indiana	Montana	Washington
Iowa	North Dakota	West Virginia
Kansas	Ohio	Wisconsin
Kentucky	Oklahoma	American FB Federation

Theoretical and Conceptual Contributions

The ROPS 1 and 2 projects also contributed to the further development of theories and concepts related to the design, implementation, and evaluation of community health promotion efforts. Much of the theory used in the KY ROPS project originated in many earlier studies that were influential in promoting health and safety in the mining industry (Cole, 1994; Cole, Lineberry, Wala et al., 1993; Cole, Vaught, Wiehagen, Haley, & Brnich, 1998). Applications of these theoretical principles to agricultural safety are described in the article Cognitive-Behavioral Approaches to Farm Community Safety Education: A Conceptual Analysis (Cole, 2002).

In chapter 7 of *Looking Beneath the Surface of Agricultural Safety and Health,* Murphy (2003) discusses how these conceptual and theoretical principles apply to farm safety programs. Richardson (2004) also discusses how these theories and methods generalize to other community safety and health promotion efforts. Both Murphy and Richardson note that the conceptual models that underlie the KY ROPS project provide robust ways to think about why farmers and farm family members engage in risky work practices as well as provide new conceptual tools for planning and conducting farm safety education programs. These issues are also addressed in two other articles.

Resources Used/Available

The resources included the following organizations and individuals.

- Funds from CDC/NIOSH
- University of Kentucky College of Public Health and the Southeast Center for Agricultural Health and Injury Prevention
- University of Kentucky faculty and staff Henry Cole (Preventive Medicine & Educational Psychology), Larry Piercy (Agricultural Engineering), Steve Isaacs (Agricultural

Economics), Joan Mazur (Instructional Technology), Melvin Myers (Agricultural and Cost Engineer), Susan Westneat (College of Nursing, Epidemiologist), Susan Morgan (College of Communications)

- NIOSH research collaborators Ted Scharf, Janet Ehlers, Teri Palermo, John Myers and John Etherton
- Clemson University, Charles Privette (Agricultural Engineer)
- South Carolina State University, James Hill (Agricultural Extension)
- Kentucky State University, Marion Simon and Louie Rivers (Agricultural Extension and Small and Limited Resource Farmer Outreach and Service Program)
- Kentucky Farm Bureau, Patti Blankenship (Health and Safety Coordinator)
- Virginia Farm Bureau Federation and Virginia Farm Bureau Insurance (Bruce Stone, Ron Saake, Glen Hetzel, Kim O'Connel)
- National Farm Bureau Safety Coordinators organization (representatives from 23 states)
- Kentucky Agricultural Statistics Service (Leland Brown and Bill Brannen)
- Kentucky high school teachers from Barren, Shelby, Marion, Washington, Mercer, Woodford, and Taylor Counties

16. Budget

ROPS 2 Budget: Further Dissemination and Evaluation of the KY ROPS Project

Acct #	Dates	Direct $	Indirect $	Total $
4-63228	8/1/99-7/31/00	125,114	56,926	182,040
4-64040	8/1/00-7/31/01	125,545	56,495	182,040
4-65038	8/1/01-7/31/02	148,795	56,322	205,117*
4-66099	8/1/02-7/31/03	140,136	62,780	202,916*
Totals:		539,590	232,523	**772,113**

* Includes carry forward funds from the previous year.

17. Stakeholders

Stakeholders for this project include farmers and farm community members at risk for tractor-related injuries. Other stakeholders include public school educators, employers, businesses, and community service agencies that serve farmers and have a moral and economic interest in preventing costly farming-related injuries. A third group of stakeholders includes researchers, educators, and policy makers who have an interest in designing, implementing, and evaluating community-based injury prevention and health promotion efforts.

18. Collaborators

Henry Cole, Professor of Preventive Medicine and Environmental Health, University of Kentucky, and Emeritus Professor of Educational Psychology, University of Kentucky

Melvin Myers, Associate Professor of Preventive Medicine and Environmental Health, University of Kentucky, Adjunct Professor, Occupational and Environmental Health, Emory University, Cost Engineer, and retired CDC/NIOSH commissioned officer

Susan Westneat, Epidemiologist and data analyst, University of Kentucky, College of Nursing

John Myers, senior statistician, CDC/NIOSH, Morgantown

John Etherton, agricultural engineer, CDC/NIOSH Morgantown
Leland Brown and Bill Brennan, Kentucky Agricultural Statistics Service

19. Intermediate Outcomes

See Outputs/Products section of the Intro/History/Success Stories narrative

20. End Outcomes

- The 10 ROPS 2 project activities advance three priority areas identified in the *National Agricultural Tractor Safety Initiative* (2004), specifically leadership, partnerships and promotion, and research.
- The 10 ROPS 2 project activities yielded a series of studies, methods, and materials that may prove useful as guidelines and models for similar community-based programs and their evaluation.

21. Significant Findings

- Research to practice (R2P) efforts require a program of related research studies and intervention activities that involve from the beginning partnerships with those at risk for injuries, community groups and organizations that provide services to those at risk, and interventionists and researchers supported by state and federal agencies and funds.
- Each of the 10 ROPS 2 project activities/studies resulted in multiple significant findings. These findings are reported at the end of each activity listed in the Project Activities section of this report.
- The materials produced and perfected by the ROPS 1 and 2 projects are useful across the U.S. for addressing issues of tractor and farm safety.
- The methods of the ROPS 1 and 2 projects were derived from many earlier injury epidemiology and prevention efforts. The methods are generalizable to many other efforts concerned with health promotion and injury and illness prevention.
- Multidisciplinary and transdisciplinary teams provide copious and diverse insights, skills, and knowledge needed to study complex social health and safety issues and to design preventive interventions.

22. Future Directions

- A new proposal based on the work of this project was prepared, submitted, and funded for the 09/01/2005 to 08/29/07 period as part of a priority area set forth in the Agricultural Centers, *National Agricultural Safety Initiative.* That project involves researchers from five of the Ag Centers in an interdisciplinary effort to continue researching the problems related to retrofitting the nations' tractors with ROPS.
- Researchers at the Southeast Center submitted a second five-year proposal to CDC/NIOSH earlier this year. That proposed project combines engineering, economic, policy, and public health intervention methods to develop low-cost ROPS. The goal is to make ROPS a much less expensive and a much more available commodity.
- A third four-year proposal was submitted earlier this year. It involves teaching future high school social studies and vocational agriculture teachers how to incorporate into high school core content the simulation exercises and cost tool developed in the ROPS 2 and later projects. Two outcomes will result. First, the economics of farming-related injuries and the cost-effectiveness of their prevention will be included in university upper division and graduate level courses in colleges of education and agriculture in two states (KY and FL). Second, the college students who graduate from these universities will in turn teach hundreds of rural high school students about the cost of farming community injuries that result from farm tractor overturns, roadway collisions, accidents among un-helmeted horseback and ATV riders, and exposure to loud farm machinery (i.e., cumulative noise-induced hearing loss). High school students will learn to use a cost tool to calculate the cost-

effectiveness of preventing these injury events. This information and these skill sets will be included in core economic content required in high school social studies, business, and vocational classes. Students in these classes will learn to use sophisticated economic cost-analysis tools programmed in Excel spreadsheets. These are the same tools used by professional cost engineers and health economists.

- An end result is that the next generation of rural and farm community adults and leaders will be much better educated in the personal and societal costs of these types of injuries and more aware of and committed to reaping the cost-effectiveness of preventing injuries.

References

The reference list includes the documents cited in the body of this report. Some of the references are documents and publications by other researchers that provided conceptions, methods, and data relevant to the ROPS 2 intervention research project. Many other references cited are documents that emerged from the various activities of the ROPS 2 project; however, this list does not include all of the papers, journal articles, and technical papers produced by the project team members.

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1. Center

Southeast Center for Agricultural Health and Injury Prevention, University of Kentucky, College of Public Health

2. Project Title

Partners in Prevention: Promoting ROPS and Seatbelts on Family Farm Tractors – The Kentucky ROPS Project

3. Project ID #

U06/CCU412900-01 – 04

4. Contact Person/PI

Henry P. Cole, Ed.D, Professor, Preventive Medicine & Environmental Health Emeritus Professor, Educational and Counseling Psychology

5. Contact Email Address

hcole@uky.edu

6. Project Start Date – Project End Date

Main study 09/30/96 – 9/29/99
Supplemental award 10/01/99 – 12/06/02

7. Project Status

Completed

8. NIOSH Core

Prevention/Intervention
Multi-disciplinary research
Education and outreach

9. NORA Program Area

Disease and Injury:	Traumatic Injuries (prevention of tractor overturn injuries)
Work Environment and Work Force:	Special Populations at Risk (limited resource Kentucky farmers, farm women, farm youth, older farmers)
Research Tools and Approaches	Intervention Effectiveness Research Social and Economic Consequences of Workplace Illness and Injury

10. NIOSH Objectives (i.e., Strategies)

Research
Outreach
Prevention
Evaluation
Dissemination

11. Type of Agriculture

Row Crops/Field

12. Target Group

Farmers

13. Special Populations at Risk

Low resources farmers, older farmers, farm women and children

14. Project Description

Main Project – This community-trials intervention developed, implemented, and evaluated a program of materials that encouraged Kentucky farmers to equip their tractors with ROPS and seatbelts in order to prevent crush injuries to tractor operators during overturns. Comparison of intervention and control counties outcomes revealed that the program materials were effective in changing farmers' knowledge, attitudes and behaviors with respect to retrofitting older tractors with ROPS or replacing them with newer ROPS-equipped tractors.

Supplemental Project – This project implemented and compared the effectiveness of paper and CD versions of the "Kayles' Difficult Decisions" simulation exercise, which illustrates the huge social and economic costs that resulted when a 14-year old boy was injured during a non-ROPS tractor overturn. The simulation was designed to increase awareness of farming community high school students to their risks of tractor overturn injuries, the personal and social costs of these injuries, and the prevention of overturn injuries and the associated costs by installation of ROPS and seatbelts on farm tractors. High school students were targeted because they are (a) the age group at greatest risk of farm machinery injury, and (b) the next generation of farmers and farm community leaders who will make decisions about purchase and use of ROPS and seatbelts. Social studies classes were targeted because all students are enrolled in these classes, whereas only about 10% of students enroll in vocational agriculture classes. In addition, social studies core curriculum content includes civics, economics, and practical living units that deal with public health and safety issues and their impact on community well-being. Social studies teachers in four rural Kentucky high schools implemented the program as part of their required economics and practical living units. The paper and pencil and CD versions were equally effective in engaging students and teaching the economics of injury prevention.

15. Introduction/History/Success of Project

Background

According to the 1997 Census of Agriculture, Kentucky's 82,273 farms averaged 162 acres with a mean income of $11,909 compared to 487 acres and $22,260 nationally. A large random sample survey by the University of Kentucky in October 1996 found that half of the tractors on Kentucky's farms were manufactured prior to 1970. Only 29% were equipped with rollover protective structures (ROPS) that prevent crush injuries during overturns. In 1994 the fatality rate for Kentucky's agricultural/forestry/fishing industry was 85/100,000 workers/year, a rate three times higher than the national average. During 1994 tractor overturns and runovers accounted for 62% of Kentucky's agricultural fatalities (MMWR, 1995 / Vol. 44 / No. 26, p. 482). According to Kentucky FACE reports during the 1994 – 99 period, 78 Kentucky farmers died in overturns. Another 32 farmers died when they fell from moving tractors. ROPS and seatbelts could have prevented 108 of these 110 deaths.

Goals and Objectives

- Translate injury surveillance data from the Kentucky Farm Family Health and Hazard Surveillance Project, the Kentucky Occupational Health Nurses in Agricultural

Communities Project, the Kentucky Community Partners for Healthy Farming Surveillance Project, and the Kentucky FACE project in order to develop a community education program to promote farmers' retrofitting their tractors with ROPS and seat belts (R2P).

- Develop, implement, and evaluate a program of community education materials that promote farmers' use of ROPS and seatbelts on their tractors.
- Use the Kayles' Difficult Decisions simulation exercise and selected other ROPS project materials in rural Kentucky high schools to evaluate their utility for inclusion in core curriculum content that deals with the social and economic costs of workplace injury.

Project Progress

The main KY project was completed in 2000. The final report was submitted February 15, 2001. The project also resulted in a CDC/NIOSH supplemental project award of $46,000 received on May 10, 1999 with the final report for that project completed on January 17, 2001. The supplemental study was titled "Evaluation of Two Delivery Formats of a Farm Safety Simulation Exercise (also called "The Kayles' Difficult Decisions Evaluation Study"), UK IRB number 99-10018. The project resulted in numerous presentations, publications, and the Kentucky ROPS Project Notebook, which was made available first in hard copy and then, after further evaluation, online through the National Agricultural Safety Database.

Project Activities

Partners from two intervention counties and the UK research team used injury surveillance data from the four recent surveillance studies to develop a program of community education messages and materials including hands-on demonstrations, group activities, short stories, public service announcements and simulation exercises dealing with farm tractor-related injuries. The quasi-experimental community trials design included two intervention and two control counties. The materials were user tested, evaluated, and compiled into the 450-page KY ROPS Notebook. In the intervention counties, local news media and businesses, employers, farm service agencies, extension agents, equipment dealers, nurses, public schools, and others disseminated many components of the community education materials to groups with whom they interacted in their farming communities.

Five rural county high school teachers in two counties incorporated the Kayles' simulation exercise and related simulations and activities from the KY ROPS Notebook into their social studies, American studies, and law and justice classes. The teachers used the Kayles' simulation exercise as part of their instruction of required economics, civics, and practical living core content. The Kayles' simulation presents a case involving a severe tractor overturn injury to a 14 year-old boy and the social and economic impact on his family and community.

Project Outcomes for the Community Partners Kentucky ROPS Project Main Study

The impact and outcomes were evaluated through a series of studies. These included (1) ethnographic studies of key community players concerning their views of the impact of the KY ROPS Project and their recommendations for its improvement; (2) monitoring equipment dealers' sales of ROPS in the two intervention counties and then interviewing the farmers who purchased the ROPS; (3) collecting data from SAF-T-CAB (a major supplier of retrofit kits) concerning its sales of ROPS to equipment dealers in the intervention and control counties; and (4) repeated measures analysis of variance (ANOVA) on four dependent variables obtained from pre- and post-intervention telephone survey data gathered from random samples of 26% of 584 intervention county and 29.1% of 643 control county farmers. The ANOVA hypotheses were

that compared to control county farmers, a statistically significantly greater proportion of intervention county farmers would:

- Perceive a higher protective value for ROPS and seatbelts
- Contemplate obtaining ROPS and seatbelt protected tractors
- Make efforts to acquire ROPS and seatbelts for unguarded tractors
- Retrofit or replace unguarded tractors with ROPS-equipped tractors

The project goals and activities were implemented as planned, the program materials widely disseminated, evaluated, and found to stimulate interest in the issue of tractor overturns and the role of ROPS and seatbelts for reducing risk of injury and economic loss. Tractor equipment dealer records revealed a total of four ROPS sales across all four counties in the year prior to the intervention. Three years and five months from program implementation, dealers in the two intervention counties had sold 81 ROPS to 79 farmers. For approximately the same period, SAF-T-CAB records showed 50 ROPS sales to equipment dealers in the two intervention counties and 10 to dealers in the two control counties.

Repeated measures ANOVA of the pre- and post-intervention survey data confirmed the first three hypotheses. Intervention county farmers rated the injury protection value of ROPS higher, exhibited greater contemplation about acquiring ROPS, and made a greater effort to obtain ROPS than did control farmers. However, no significant overall difference in the percent of ROPS-equipped tractors acquired was found for intervention and control county farms. Intervention and control counties were then individually examined for percent of ROPS retrofits acquired (see Table 1). The 95% confidence intervals revealed that intervention county 02 and control county 04 acquired significantly more ROPS-equipped tractors than did control county 03. Subsequent investigation revealed that an equipment dealer in control county 04 implemented a successful ROPS-retrofit effort after one of his customers was killed in a tractor overturn. Intervention county 02 was organized better and was more effective in program implementation than Intervention county 01.

Four important findings emerged.

1. Community educational interventions are likely to be more effective to the degree that community members are involved in developing and implementing a program.

2. Multiple evaluation methods are necessary to assess the degree to which a program is implemented and with what degree of impact.

3. Replications of both intervention and control groups is desirable. If only one control and one intervention county had been used in this study, the effective intervention activities mounted by intervention county 02 and by the control county 04 equipment dealer could have obscured the effectiveness of the planned project intervention and/or the equipment dealer's unanticipated yet effective effort to promote ROPS among his customer base. Even though his customers were only a small fraction of the total county farmer population, his effort to promote ROPS made a statistically significant difference in countywide ROPS sales compared to the one true control county.

4. There are many more farm equipment dealers in the United States than there are groups of researchers or community service agencies who are able to advocate effectively for farmers use of ROPS and seatbelts. Farmers seek advice about their tractors from the equipment dealers who sell and service these machines. Other community agencies and

groups are less credible with farmers on such matters. The efforts of the equipment dealer in county 04 were motivated by the death of a friend and a desire to prevent similar deaths in his community. His intervention was much more cost-effective than the University of Kentucky ROPS Project intervention even when discounting the KY ROPS project costs related to developing the intervention materials and conducting the project research and evaluation studies. This suggests that future efforts to promote farmers' equipping their tractors with ROPS and seatbelts may be more effective if tractor manufacturers support and assist equipment dealers in promoting ROPS among the farmers they serve in local communities.

Table 1: Pre- to post-intervention percent increase in ROPS retrofits and ROPS-equipped replacement tractors for samples of farmers across intervention and control counties, by county

	Intervention Counties			Control Counties		
County	Barren	Fleming	Combined	Hardin	Nelson	Combined
Farmers (n)	301	283	584	322	321	643
Retrofits	15 (5.0%)	27 (9.5%)	42 (7.2%)	8 (2.5%)	33 (10.3%)	41 (6.4%)
Replacement tractors with ROPS	10 (3.3%)	15 (5.3%)	25 (4.3%)	8 (2.5%)	7 (2.2%)	15 (2.3%)
Total	25 (8.3%)	42 **(14.8%) ***	67 (11.5%)	16 **(5.0%) ***	40 **(12.5)**	56 (8.7%)
95% CI	5.6-12.2	**11.0-19.6**	9.1-14.4	**3.0-8.1**	**9.2-16.7**	6.7-11.2

Significant difference ($p < .05$) in farmers' intentional acquisition of ROPS-protected tractors.
Note: ROPS replacement tractors included only those cases where farmers purchased a newer tractor with a ROPS for the ROPS and not for other reasons. The results in this table are based on the random sample post-intervention telephone interview of the 1,227 farmers in the four counties.

Project Outcomes for the Supplemental Kayles' Difficult Decisions Simulation Exercise Study
An interdisciplinary team of University of Kentucky and NIOSH researchers completed the "Evaluation of Two Delivery Formats for a Farm Simulation Exercise" (the Kayles' Simulation Exercise study) with supplemental funding to the larger three-year KY ROPS project. The parent KY ROPS project involved the development and evaluation of a community education program to promote farmers' use of ROPS and seat belts on tractors. As part of the parent project and another earlier NIOSH project, an initial paper and pencil version of the Kayles' Difficult Decisions simulation exercise was developed and evaluated. The simulation illustrates how good farm planning, management and safe work practices prevent injury, illness and economic loss. For this supplemental project, the team continued the development of the Kayles' simulation in both an enhanced paper version and a new parallel CD-ROM version.

The primary goal of the project was to evaluate the effectiveness and impact of the two delivery formats on a target audience of high school social studies students. Data were collected from a total of 377 students (90 pilot study, 131 control, 74 paper, and 82 CD). Learning outcomes were assessed by 10 measures developed by the research team. Overall there was little difference in the effectiveness of the two versions of the simulation. The only difference between the paper and the CD groups was the students' evaluation of the simulation, and even here the

differences were small though statistically significant at alpha .05 (paper M = 82.1%, CD M = 78.4%). The equal effectiveness of the paper and the CD versions is related to two factors. First, the paper version of the exercise was carefully developed, fully field tested, and perfected prior to the main study. This made it relatively easy to program the CD version to include the same information and the same interactive structure within the same story line. Second, as the materials were revised, efforts were taken to make both versions as parallel, authentic, and attractive as possible. Teachers and students liked and became fully engaged in both versions of the simulation. Schools involved in the study continued to use the materials as part of their social studies curricula and two counties continued to use the materials in their American Studies curricula as well.

As one part of the activity 119 students contacted farmers and discussed the Kayles' simulation exercise, specifically the injuries depicted and their economic costs. The students also interviewed farmers about their farm safety practices and the degree to which the farmers thought about and invested in safety equipment and safe work practices to prevent tractor and machinery-related injuries and the associated economic loss. One month following the students' discussions with the farmers UK researchers Henry Cole, Joan Mazur, and Pamela Kidd called and interviewed a sample of 55 of the farmers. Approximately 85% reported that their discussions with the students caused them to think more about how injuries hurt farm production, the economic cost of the injuries, and the cost effectiveness of investing in safety equipment and safe work practices. Seventy percent of the farmers reported that their interaction with a student caused them to think more about having enough help at peak harvest time to avoid being overworked, fatigued, and at increased risk of injury. Sixty percent reported that after their interview by a student they took specific actions to prevent injuries. Examples included two farmers who after being interviewed by their granddaughters made arrangements to have ROPS and seatbelts installed on non-ROPS tractors. Another farmer replaced damaged shields on power take off (PTO) drivelines.

Resources Used/Available

The resources included the following partial list. (See the project Final Report for the complete listing and the methods by which these data were calculated.)

- Funds from CDC/NIOSH.
- An estimated $87,000 in-kind contributions from the two intervention counties during the first 17 months of the main study and a similar dollar amount for the next 18 months (e.g. local printing and distribution of ROPS safety messages; PSAs, graphic mailing stuffers; newspaper stories about tractor overturns and injury outcomes for operators on ROPS and non-ROPS tractors and why people bought ROPS; free broadcasting of 100 PSAs on local radio stations in conjunction with farm and weather reports multiple times per day for 3 years; producer groups, farm services businesses, and local farm community agencies' raising of incentive funds for ROPS retrofits as well as arranging for ROPS promotion efforts at annual meetings; duplication and dissemination of ROPS Notebook materials by local manufacturing plants to their workers and developing and distributing these messages in paper and multimedia TV formats to workers in factories.
- Skills and resources from the project team members whose academic affiliations included the UK Colleges of Medicine, Education, Agriculture, Nursing, Engineering, Communications, and Arts and Sciences.
- Dr. Carol Lehtola, University of Florida, an expert on farm tractor safety and the primary author of the *TRAC-SAFE Community-Based Program for Reducing Injuries and Deaths Due to Tractor Overturns Facilitators Manual* (DHHS [NIOSH] Publication No. 96 – 108, 1996), which was a beginning point for our community education and outreach planning.

- Four high school administrators, the Kentucky Council of Social Studies, a Kentucky Department of Education administrator who advocated for the project, and high school teachers in four Kentucky counties who implemented the Kayles' simulation in social studies classes.
- NIOSH research and surveillance collaborators, including Ted Scharf, Janet Ehlers, Teri Palermo, Mike Colligan, David Chrislip, Steve Bayer, Pauline Elliot, and Marsha Britt.
- The USDA Kentucky Agricultural Statistics Service (KASS), which assisted in planning and developing the KY ROPS Project pre-intervention Kentucky Farm Tractor Survey and that also administered the survey to a random sample of 1,648 principal farm operators. KASS also assisted in the design of the post-intervention survey and administered that survey to the 1,227 farms that were still in operation and available for interview post intervention.
- Bruce Stone and Ron Saake of Virginia Farm Bureau, who first learned of the Kentucky ROPS project materials at an NIFS meeting and immediately provided valuable suggestions and feedback as they incorporated selected materials from the ROPS Notebook into their state-wide ROPS promotion effort.
- Patti Blankenship of Kentucky Farm Bureau, who read and critiqued the ROPS Project methods and community education materials and assisted access to Farm Bureau leaders, services, meeting spaces, and ROPS-retrofit incentive funds for the two intervention counties.
- Nine tractor and Farm Equipment Dealers in the two intervention counties who provided us with lists of ROPS sales in the year prior to the intervention and for 3 years and five months following the intervention.
- SAF-T-CAB, a ROPS retrofit kit supplier, provided us with the number of its ROPS sales to equipment dealers in the intervention and control counties during the project intervention years.

Outputs/Products (for both the main study and the supplemental Kayles' study)
Products that emerged from the project include refereed journal articles, book chapters, professional paper presentations, technical reports, instructional materials, and data files. Representative examples from each category are listed below

Journal Articles

Cole, H.P., Kidd, P.S., Isaacs, S.G., Parshall, M., & Scharf, T. (1997). Difficult decisions: A simulation that illustrates cost effectiveness of farm safety behaviors. *J of Agromed, 4(1&2),* 117-124.

Scharf, T., Kidd, P., Cole, H., Bean, T., Chapman, L., Donham, K., & Baker, D. (1998). Intervention tools for farmers – Safe and productive work practices in a safer work environment. *JASH, 4*, 193-203.

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Cole, H.P., Westneat, S.C., Browning, S.R., Piercy, L.R., & Struttmann, T.W. (2000). Sex differences in principal farm operators' tractor driving safety beliefs and behaviors. *JAMWA, 55(2)*, 93-95.

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Morgan, S.E. & Cole, H.P. (2002). Stories or statistics? Farmers' attitudes toward messages in an agricultural safety campaign*. JASH, 8*, 225-239.

Cole H., Mazur J, Kidd. P., Scharf, T., Westneat, S., Phillips, S., Bayer, S., Colligan, M., Chrislip, D., & Elliott P. (2004). Promoting tractor and farm safety practices among high school social studies students and adult farmers in rural communities. *J of Rural Comm Health 24(2),* 35-42.

Professional Meeting Presentations/Proceedings

Cole, H., Piercy, L., Brandt, V., Muehlbauer, J., Westneat, S., Morgan, S., & Mazur, J. (2001). *Translating injury surveillance data into a community-based program to reduce farm tractor overturn injuries.* Paper presented at the National Occupational Research Agenda Symposium 2001: Leading Research in Occupational Safety and Health, Washington, DC, June 27.

Lin, B. (2002). *A hypermedia simulation that teaches defensive driving skills.* Invited paper presented at the Third Annual Pilot Research Project Symposium sponsored by the University of Cincinnati NIOSH supported Education and Research Center, University of Cincinnati, Cincinnati, OH, October 10 – 11.

Cole, H., Piercy, L. Struttmann, T., Westneat, S., Brandt, V., Muehlbauer, J., & Morgan, S. (2002). *Improving farmers' self-protective behavior with a narrative-based tractor safety community education program.* Paper presented at the 6th International Commission on Occupational Health (ICOH) Scientific Committee on Education and Training in Occupational Health, Baltimore, MD, October 28 – 30.

Mazur J. & Cole H. (2002). *Integrating farm safety information into social studies classrooms in rural public schools: A report from the field: 1998-2002.* Paper presented at the 6th ICOH Scientific Committee on Education and Training in Occupational Health, Baltimore, MD, October 28 – 30.

Scharf, T., Kidd, P., Cole, H., Mazur, J., et al. (2002). *Evaluating a farm safety training program with rural high school students.* Paper presented at the 6th ICOH Scientific Committee on Education and Training in Occupational Health: Best Practices in Occupational Safety and Health, Education, Training, and Communication, Baltimore, MD, October 28 – 30.

Mazur, J. (2002). *Narrative forms of Instruction: Implications for researching and designing the use of story in multiple learning contexts.* Paper presented at the Association for Educational Communications & Technology Annual Meeting, Dallas, TX, November 12 – 16.

Cole, H.P. (2002). *Theory and methods of using interactive narratives to teach and assess critical health and safety skills.* Paper presented at the Association for Educational Communications & Technology Annual Meeting, Dallas, TX, November 12 – 16.

Cole, H., Mazur, J., Kidd. P., Scharf, T., Westneat, S., Phillips, S., Bayer, S., Colligan, M., Chrislip, D. &, Elliot, P. (2003). *High school social studies students as farm safety advocates.* Paper presented at the Fifth Interdisciplinary Conference on Occupational Safety and Health, Work Stress and Health: New Challenges in a Changing Workplace. Toronto, Canada, March 19-21.

Cole, H.P. (2003). *Narrative approaches to health behavior research and injury prevention.* Invited research paper presented at the NIOSH Seminar Envision Series. Alice Hamilton Laboratory, Cincinnati, OH, January 29.

Cole, H.P. (2003). *The Kentucky ROPS Project: A community trials tractor safety intervention.* Invited research paper presented at the NIOSH Seminar Envision Series. Alice Hamilton Laboratory, Cincinnati, OH, January 29.

Mazur, J. (2003). *Integration of community-relevant public health materials into required public school curricula.* Invited research paper presented at the NIOSH Seminar Envision Series. Alice Hamilton Laboratory, Cincinnati, OH, January 29.

Cole, H.P. (2003). *Farmers' perceptions of ROPS and tractor safety: Studies, stories, and statistics.* Invited paper presented at the NIOSH Agricultural Centers Tractor-related Injury and Death Workshop, Station Square, Pittsburgh, PA, February 13 – 14. (Published in the meeting proceedings.)

Cole, H., Mazur, J., Kidd, P., Scharf, T., Westneat, S., Phillips, S., Bayer, S., Colligan, M., Chrislip, S. & Elliot, P. (2003). *High school social studies students as farm safety advocates.* Paper presented at the Fifth Interdisciplinary Conference on Occupational Safety and Health, Work Stress and Health: New Challenges in a Changing Workplace. Toronto, Canada, March 20 –22. (Sponsored by APA, NIOSH and Queen's University School of Business).

Cole, H.P. (2003). *Integration of behavioral science and epidemiology to improve farm safety instruction: Theory, methods, examples, and outcomes.* Paper presented at the 2003 Summer Meeting of the National Institute for Farm Safety, Windsor, Ontario, Canada, June 22 – 26.

Cole, H.P. (2003). *Applications of narrative psychology and injury epidemiology to prevent occupational injuries.* Invited keynote address to the Fifth International Symposium, Future of Rural Peoples, sponsored by the Institute of Agricultural Rural and Environmental Health, Saksatoon, Saskatchewan, Canada, October 19 – 23.

Cole, H.P. (2003). *Across industry narrative approaches to occupational injury prevention research.* Invited paper present to the 3rd National Occupational Injury Research Symposium, Sheraton Station Square, Pittsbugh, PA, October 28 – 30.

Cole, H.P. (2004). *Epidemiology, embedded testing and multi-method approaches to measuring outcomes and impact of community safety education materials and programs.* Invited paper presented at the NIOSH Great Lakes Center for Agricultural Safety and Health, Improving Agricultural Health and Safety Programs Through Evaluation: Rigorous and Practical Strategies. The Ohio State University, Columbus, OH, March 15 – 16.

Myers, M.L. (2004). *The evaluation of tractor safety interventions.* Invited paper presented at the NIOSH Great Lakes Center for Agricultural Safety and Health, Improving Agricultural Health and Safety Programs through Evaluation: Rigorous and Practical Strategies. The Ohio State University, Columbus, OH, March 15 – 16.

Proceedings and Technical Reports

Cole, H., Lindberg, J., Struttmann, T., Brandt, V., Muehlbauer, J., Piercy, L., Perera, R.,& Scheerer, A. (1999). How and why Kentucky farmers retrofit their tractors with ROPS. *Proceedings of the National Institute for Farm Safety,* Paper No. 99-17.

Cole, H.P., Westneat, S.C., & Phillips, S. (2001, January 17). Evaluation of two delivery formats for a farm safety simulation exercise. (Completed under supplemental funds awarded to CDC/NIOSH Cooperative Agreements U07/CCU408035 and U06/CCU412900), Lexington: University of Kentucky, Southeast Center for Agricultural Health and Injury Prevention.

Cole, H.P. & Westneat, S.C. (2001, February 15). The Kentucky ROPS Project – Final technical report for the Partners in Prevention: Promoting ROPS and seat belts on family farm

tractors (CDC/NIOSH Cooperative Agreement Number U06/CCU412900), Lexington: University of Kentucky, Southeast Center for Agricultural Health and Injury Prevention.

Cole, H.P. (2003). Integration of psychology and injury epidemiology to improve farm safety instruction: Theory, methods, examples and outcomes. *Proceedings of the National Institute for Farm Safety*, Paper No. 03-T1.

Book Chapter

Richardson, C. (2004). Community Partners for Healthy Farming (CPHF) Project/The Kentucky ROPS Project. In R. Volpe & J. Lewko (Eds.), *Preventing neurotrauma: A casebook of evidence based practices*; Toronto, Canada: University of Toronto, Life Span Adaptations Project.

Instructional Materials

Cole, et al. (2002). The *Kentucky Community Partners for Healthy Farming ROPS Project Notebook*: A program of materials and activities to preserve farmers' health, way of life, and money. The Notebook was developed by the University of Kentucky, Southeast Center for Agricultural Health and Injury Prevention with support from CDC/NIOSH Cooperative agreements U06/CCU412900 and U07/CCU406035. The materials in the 450-page notebook were initially developed, user tested, and evaluated in collaboration with farming community partners in the two intervention counties in the ROPS 1 project. Then, after editing, they were compiled into the hard copy Notebook. Approximately 400 hard copies of the Notebook were duplicated and distributed. Later, under the ROPS 2 project, the materials were updated, placed on CDs, and then uploaded to the National Agricultural Safety Database where they are currently available and accessed nationally and internationally at http://www.cdc.gov/nasd/, under *The Kentucky Community Partners for Healthy Farming ROPS Project.*

Cole, et al. (2002) *Farm Safety and Economics*. A CD-ROM that includes two programs:

- *The Kayles' Difficult Decisions Simulation Exercise* and all its support materials (lesson plans, pre- and posttests, etc.)
- *Preventing Tractor Overturn Injuries*, a series of photographs of overturned tractors with and without ROPS, accompanied by human interest stories about the injury or non-injury outcomes; video clips of full-size tractor overturns; the "Mr. Good Egg" tractor overturn demonstration with a raw hen's egg as a simulated tractor driver and model ROPS and non-ROPS tractors that overturn, crushing Mr. Good Egg on the non-ROPS tractors but not damaging the Mr. Good Egg on the non-ROPS tractors; interactive quizzes about tractors and ROPS; etc.

International Recognition and Testimonials

The Community Partners for Healthy Farming (CPHF) Kentucky ROPS Project was selected as one of seven projects for inclusion in the *Preventing Neurotrauma: A Casebook of Evidence Based Practices* (2004) published by the University of Toronto. In his letter announcing the inclusion of the KY ROPS project in the casebook, Dr. Richard Volpe stated:

> *The programs reviewed in the Casebook are among the best in the world, and are offered as opportunities for adaptation and improvement in the field of injury prevention. Already the material has made a global impact – with project expansion and implementation in many urban and rural communities.* (See the attached copy of Dr. Volpe's letter dated March 22, 2004).

The KY ROPS Project case study is reported in chapter 7 of the Casebook. The chapter, authored by University of Toronto researcher Cynthia Richardson, is titled *Community Partners for Healthy Farming (CPHF) Project/The Kentucky ROPS Project*. Ms. Richardson's chapter is the most complete report of the project goals, design, activities, and accomplishments. In the chapter conclusion Richardson states (p. 214):

> *The design of the program and its educational materials involved a hands-on, iterative process with community partner participation and a shared learning process. This iterative process encompassed the modification of the program by successive consultations and feedback with community groups and stakeholders. The process facilitated the integration of contextual and cultural knowledge into creation of the "voice" of the educational materials making them relevant to and resonant with the target population.*
>
> *This rigorous field testing of the injury prevention educational materials establishes the evidence-based effectiveness of the specific educational practices in terms of both content and design. This type of rigorous evaluation and research and the continued refinement of such interventions can assist the field of injury prevention education in general, and the field of neuro trauma prevention specifically, by addressing the multi-factorial and multi-dimensional sociocultural nature of health and safety behavior and injury prevention.*

16. Budget

ROPS 1 Budget: Partners in Prevention: Promoting ROPS and Seat Belts on Family Farm Tractors, plus the Kayles' supplemental study

Acct #	Dates	Direct $	Indirect $	Total $
4-60384	9/30/96-9/29/97	125,458	49,542	175,000
4-61332	9/30/97-9/29/98	117,040	47,494	164,534
4-62351	9/30/98-9/29/00	140,792	63,011	203,803
4-70732 (Kayles supplement)	9/30/98-9/29/00	32,707	13,293	46,000
Totals		415,997	173,340	**589,337**

17. Stakeholders

Stakeholders for this project included the farmers, farm community members, and the farm business and service agencies who serve these farmers (farm equipment dealers, insurance companies, banks and lenders, health services and hospitals, local factory and other employers were farmers and farm family members hold off-farm jobs, farm supply businesses, farm producer groups, and public schools. All of these groups are deleteriously affected when farm family members and farm workers are injured. All have a stake in lowering and preventing farming-related injuries

18. Collaborators

Many collaborators were involved throughout the project. Tables 2 at the end of this document name the collaborating organizations for each of the two intervention counties and describe the type of organization and the nature of the collaboration.

19. Intermediate Outcomes

See Outputs/Products section of the Intro/History/Success Stories portion

20. End Outcomes

- Demonstrated hazard reduction for overturn injuries as a result of statistically significant increases in the proportion of tractors retrofitted with ROPS or replaced with ROPS-equipped tractors.
- A set of multi-method, interactive instructional materials that promote thinking about and adoption of behaviors to recognize and control hazards and thereby prevent costly injuries. The thought-provoking messages, innovative methods, and engaging activities in the KY ROPS Notebook have been and continue to be widely accessed and used by many individuals and organizations.

21. Emerging Problems

- Printing, duplicating, and dissemination of the KY ROPS Notebook materials proved costly and cumbersome. Designing the interface and placing the materials on the NASD website was a major step forward in making them widely available at no cost or low cost associated with local selection and duplication.
- At present, the interactive simulation exercises and other similar materials are available only in PDF, Word or Excel files from the NASD website. There is a strong need for and a current effort underway to prepare these materials for interactive online delivery with no need for paper copies. This method of delivery appeals to students, teachers, farmers and many others who can access and complete an online activity, obtain immediate feedback and desired information without ever having to handle paper.

22. Future Directions

- The initial project efforts to teach the economics of investing in safety practices and the cost-effectiveness of doing so were restricted to basic concepts. As we worked with adult farmers and high school teachers and students, we became aware that the economic analysis of the cost of the injuries depicted and the cost-effectiveness of the preventive measures could be much more fully developed. Moreover, doing so would ready the materials for use in high school and college business and economics courses. Subsequently we planned, submitted, and had projects funded that have moved us ahead in this direction.
- The KY ROPS Project was a research to practice (R2P) effort that built on many years of farming- related injury surveillance and epidemiology, as well as many years of applied human learning and instructional systems design directed at the prevention of occupational injury. We now have a number of new projects underway and/or planned that will continue this inter- and trans-disciplinary approach to the development of educational and intervention programs aimed at reducing occupational illness and injury.

Table 2

Primary Barren County Collaborators by Agency and Sector with Description of Collaborative Activity

Barren County Major Collaborators	No.*	Sector	Primary Collaborative Activity
FS4JK	4 p	Local farm safety group	Assisted with development and dissemination of messages and materials. Arranged, planned, and conducted displays, presentations. Collected data from selected activities.
Glasgow Daily Times	1 b	Press	Attended community meetings. Wrote news stories about CPHF ROPS project goals, meetings, KY tractor overturn statistics, FACE tractor overturn fatalities. Published these as an ongoing series for county residents.
Farm Equipment Dealers	3 b	Business - Tractor & ROPS Sales	Assisted in development and dissemination of "How to Get a ROPS" flyer. Provided records of ROPS retrofits. Advised project staff about barriers farmers and dealers face in retrofitting ROPS. Sponsored, participated in, and conducted community presentations and displays about ROPS.
Banks	2 b	Lending agency	Assisted in the development and distribution of "How to Get a ROPS" flyer. Offered low-interest loans to farmers for ROPS purchases.
Printer	1 b	Local printing company	Printed several hundred copies of "How to Get a ROPS" flyer at no cost to the project or to other community groups and agencies.
Barren County High School	5 p	Vocational Ag. Teachers, Extension, & FFA	Made possible classroom presentations by core staff. Used project messages and materials at Farm Safety Day Camps and meetings and in vocational agriculture classes and discussed plans to involve FFA students in farm safety & ROPS project promotion and evaluation activities.
Austin Tracy Elementary School	1 a	Elementary school admin. & teachers	Hosted FS4JK meetings. Hosted Austin Tracy Young and Adult Farming Meetings. ROPS project overview, goals, materials and activities were presented at three meetings.
Park City Elementary School	1 a	Elementary school admin. & teachers	Hosted FS4JK and community meetings where ROPS project overview and materials were presented.
Hiseville Elementary School	1 a	Elementary school admin. & teachers	Hosted Hiseville Community Health Fair (attendance 144) including farmers, farm safety groups, teachers, general public. Presented ROPS project display and materials.

* p = people, b = business, a = agency

Table 2: Primary Barren County Collaborators (continued)

Barren County Major Collaborators	No.	Sector	Primary Collaborative Activity
North Metcalfe Elementary School	1 a	Elementary school teachers & children	Hosted a presentation of a tractor safety and ROPS promotion program to 175 preschool - fifth grade students using FS4JK coloring books and model tractors with and without ROPS.
WCLU Radio	2 p	Local commercial radio station	Broadcast short interviews with core staff about ROPS project. Ran ROPS and tractor safety PSAs from March 1 to September 30, 11 times daily at peak times when farmers listen to radio (morning farm report, news, and commuting times). Aired 1,708 PSAs during this period, sampled from approximately 36 PSA messages.
Mammoth Cave RC&D	1 a	Resource Conservation & Development District Office	Reviewed project goals and materials. Planned and collaborated in the development of proposals to state and federal agencies and to foundations for incentive fund grants to assist local farmers' ROPS purchase, and to involve FFA students in farm safety & ROPS promotion and evaluation.
T.J. Sampson Hospital	1 b	Local health care agency	Invited project staff to make ROPS project presentations to hospital nursing and education staff. Displayed project posters for hospital staff and patients. Duplicated and distributed 4 sets of ROPS message stuffers and 3 sets of FACE storied to 900 employees. Assisted local ROPS project coordinator V. Brandt in making contacts with and presentations to other community groups.
SKF	1 b	Mfg. of roller bearings	Displayed project posters for employees. Duplicated and distributed 4 sets of ROPS message stuffers and 3 sets of FACE storied to 430 employees.
Span Tech	1 b	Mfg. electronic components	Displayed project posters for employees. Duplicated and distributed 4 sets of ROPS message stuffers and 3 sets of FACE stories to 65 employees.
Farmers Rural Electric Cooperative	1 b	Local power company & comm. leader	Worked with K. Button and V. Brandt and planned and conducted two community meetings attended by 140 FREC employees, EMS/DES personnel, electricians, and farmers. Presented ROPS project overview and materials. Sponsored essay contest about tractor overturn stories in *Kentucky Living,* Barren County insert.
Southern States	1 b	Farm supply business	Provided leadership in planning, reviewing, presenting, and distributing ROPS project materials and messages. Included ROPS project materials, presentations, demonstrations, and tractor overturn survivor stories at two annual meetings: SS Pancake Fry, March (240 attended) & SS Annual Meeting, September (90 attended). Provided meals and refreshments at both meetings, both of which were > 5 hours.

Table 2: Primary Barren County Collaborators (continued)

Barren County Major Collaborators	No.	Sector	Primary Collaborative Activity
Barren County YMCA	1 a	YMCA Health & Fitness Program	Sponsored farm safety program for Barren and Hart County FS4JK members. Presented FS4JK walkabout and tractor safety books. Showed actual tractors with ROPS and seat belts, and model tractors with and without ROPS.
Progressive Farmer	1 a	Magazine, Farm Bureau, FFA instructors & volunteers, children age 8-13 (4H)	Presented Mr. Good Egg Farmer model tractor overturn activity in 10 sessions to 176 children to demonstrate the effects of an overturn with and without a ROPS. Conducted a child extra rider survey. Provided each child with a "Goody Bag" containing tractor safety information to be taken home.
Farm Bureau	1 a	County organization	Community leaders attended planning meetings. Assisted by reviewing project goals and materials, and by assisting in arranging and hosting local community meetings. Provided information about key groups, agencies, and community leaders and facilitated their involvement in the project activities.
RC&D	1 a	Resource Conservation & Development District Office	Reviewed project goals and materials. Planned and collaborated in the development of proposals to state and federal agencies and to foundations for incentive fund grants to assist local farmers' ROPS purchase, and to involve FFA students in farm safety & ROPS promotion and evaluation.
Victims & Survivors of Tractor O/Ts	5 p	Individual farm family members	Two of these persons told the stories of how they overturned a tractor without a ROPS. They described their serious injuries; the long, difficult, and costly recovery period; and the ways in which the injury changed their lives. Three family members told the stories of the death of a family member, and how this death proved to be tragic and costly to the family. The stories are being used as part of the community education program materials and messages.
Farmers who have Retrofitted ROPS	13 p	Individual farmers	Midway through Year 2, 13 farmers had each retrofitted a tractor with a ROPS. By the end of the project, 79 farmers in Barren and Fleming Counties had acquired 81 ROPS-equipped tractors. A sample of 59 of these farmers were contacted and interviewed about why they wanted a ROPS, how they learned about ROPS, and what convinced them to spend the time and money to get a ROPS. The information from these interviews is being used to develop program materials, messages, and activities.

Table 3

Primary Fleming County Collaborators by Agency and Sector with Description of Collaborative Activity

Fleming County Major Collaborators	No.*	Sector	Primary Collaborative Activity
Flemingsburg Gazette	1 b	Weekly county newspaper	Attended community meetings. Wrote 2 news stories about CPHF ROPS project goals, meetings, and KY tractor overturn statistics. Published 2 articles about tractor overturn injuries and ROPS.
Fleming Shopper	1 b	Weekly news and shopping paper	Published a series of short articles about the ROPS project, the value of ROPS and seat belts and 7 FACE stories about tractor overturn fatalities.
The Ledger Independent	1 b	Daily, multiple county newspaper, Maysville, KY	Published 2 articles, one about the ROPS project goals and activities, and one about a tractor fatality involving a Lewis County farmer.
The Fleming Farmer	1 a	Quarterly Farm Service Administration & Extension newspaper (5,000 circulation)	Published 2 articles about the ROPS project goals and activities and 3 FACE stories about tractor overturn fatalities and the value of ROPS and seat belts.
Farm Equipment Dealers	7 b	Business - Tractor & ROPS Sales	Assisted in development and dissemination of "How to Get a ROPS" flyer. Provided records of ROPS retrofits. Advised project staff about barriers farmers and dealers face in retrofitting ROPS. Sponsored, participated in, and conducted community presentations and displays about ROPS.
Banks	2 b	Lending agency	Assisted in the development and distribution of "How to Get a ROPS" flyer. Offered low-interest loans to farmers for ROPS purchases.
Printer	1 b	Local printing company	Printed several hundred copies of "How to Get a ROPS" flyer at cost.
Fleming County High School	6 p	Vocational Ag. Teachers, Extension, & FFA, FHA, adm.	Made classroom presentations available by core staff. Used project messages and materials at community meetings and in vocational agriculture classes. 109 students completed "My Experiences," "My Story," TRAC-SAFE, TRIF, skits, and other activities presented by Cole, Piercy, Muehlbauer, Struttmann.
Fleming County Middle School	1 a	Flem. Co. "Back to School Gala"	Hosted ROPS project poster display, FS4JK video on farm and tractor safety, "How to Get a ROPS" flyers and FS4JK materials on chore task expectations for farm children ages 2-18 as part of an all-day event with 300 people attending.

* p = people, b = business, a = agency

Table 3: Primary Fleming County Collaborators (continued)

Fleming County Major Collaborators	No.	Sector	Primary Collaborative Activity
WFLE Radio	2 p	Local commercial radio station	Ran ROPS and tractor safety PSAs from June 20 to September 30, three times daily, 7 days a week at news time (7-8 am, 12-1 pm, & 5-6 pm, peak times when farmers listen to radio). Aired 315 PSAs during this period, using 30 PSA messages randomly distributed.
Fleming County Hospital	1 a	Local health care agency	Displayed 4 project posters for hospital staff and patients. Duplicated and distributed 4 sets of ROPS message stuffers to 160 employees. Sponsored Fleming County Health Fair and arranged to have the ROPS project exhibit materials and handouts, along with Case I-H, John Deere, and Massey Ferguson brochures on how and why to have a ROPS.
Green Tree Forest Products	1 b	Mfg. of wood products (pallets, lumber, etc.)	Displayed project posters for employees. Duplicated and distributed 4 sets of ROPS message stuffers and 3 sets of FACE stories to 50 employees.
Fleming County Dairy Supplies	1 b	Provides dairy supplies & service to farmers	Sent out to > 200 farmers ROPS project check stuffers enclosed with bills for Fleming County Dairy Supply services and goods. These stuffers were taken from the project overview transparencies and included information about (1) the percentage of ROPS and non-ROPS tractors in FC, (2) the percentage of FC farmers who thought about getting a ROPS within the past year, and (3) the percentage of FC farmers who had made some effort to get a ROPS within the past year.
Textron Fastening Company	1 b	Mfg. automotive & appliance trim parts	Displayed 4 ROPS project posters for 119 employees.
Farmers Rural Electric Cooperative Corp.	1 a	Local power company & comm. leader M.B. Nance	Facilitated and advised the development and dissemination of ROPS project materials and activities. Distributed > 200 stuffers to farmers attending the RECC annual meeting. These stuffers were taken from the project overview transparencies and included information about (1) the percentage of ROPS and non-ROPS tractors in FC, (2) the percentage of FC farmers who thought about getting a ROPS within the last year, and (3) the percentage of FC farmers who had made some effort to get a ROPS within the last year.
RC&D	1 a	Resource Conservation & Development District Office	Reviewed project goals and materials. Planned and collaborated in the development of proposals to state and federal agencies and to foundations for incentive fund grants to assist local farmers' ROPS purchase, and to involve FFA students in farm safety & ROPS promotion and evaluation.

* p = people, b = business, a = agency

1. Center

Southeast Center for Agricultural Health and Injury Prevention, University of Kentucky, College of Public Health

2. Project Title

Children's Injuries on Kentucky's Beef Cattle Farms

3. Project ID #

1R01 OHO3924-01

4. Contact Person/PI

Steve Browning, Ph.D. c/o Susan Westneat, MS

5. Contact email

Swest1@email.uky.edu

6. Project Start Date—Project End Date

9/30/97 – 9/29/01

7. Project Status

Completed

8. NIOSH Core

Multi-disciplinary Research

9. NORA Program Area

Disease and Injury:	Traumatic Injuries, Hearing Loss, Asthma and Chronic Obstructive Pulmonary Disease
Work Environment and Work Force:	Special Populations at Risk (youth)

10. NIOSH Objectives (i.e., strategies)

Research
Outreach
Evaluation

11. Type of Agriculture

Livestock

12. Target Population

Beef Cattle Farmers

13. Special Populations at Risk

Youth

14. Project Description

The Children's Injuries on Kentucky's Beef Cattle Farms was a three-year, longitudinal cohort study of children between ages 15-18 years working on family farms in Kentucky. The project sought to assess if children who perform chores on beef cattle farms are at a

higher risk for injury and whether or not farm management practices are associated with an increased risk of injury among children living and working on family farms.

15. Introduction/History/Success of Project

Background

In 1996, the National Committee for Childhood Agricultural Injury Prevention (NCCAIP) published a National Action Plan written to address the hazards associated with children's work in agriculture and to maximize the health and safety of all children who may be exposed to agricultural production hazards (Prevention, 1996). Among the recommendations was a call for research that would delineate the specific risk factors associated with agricultural work in children. Further, the report emphasized the necessity for research that would aid the formulation of age- and developmentally appropriate guidelines for children's work in a variety of agricultural settings. An important and useful result of this work was the development of the North American Guidelines for Children's Agricultural Tasks (Lee and Marlenga, 1999).

Recent national initiatives in the United States have encouraged research into the etiology and design of interventions for childhood agricultural injuries (Castillo, Hard, et al., 1998). It is estimated and widely cited that about 1,298,000 children and adolescents aged 19 years and younger live on farms in the United States (Rivara 1996). While agricultural injury data have been limited for most of the family-operated farms, there has been an increased national interest in obtaining data on children's agricultural injuries (Myers and Hendricks, 2001). However, there are no legal reporting requirements of injuries for farms with fewer than 11 employees, and the extent to which self-reported voluntary approaches to collecting farm injury data are accurate is subject to debate. Indeed, an estimated 95% of U.S. farms are exempt from the Occupational Safety and Health Administration (OSHA) reporting standards. Consequently, researchers are required to rely on voluntary reporting through studies and surveys (Purschwitz & Field, 1990; Murphy, 1992).

Despite the magnitude of this public health issue, limited analytic epidemiologic research has been directed specifically toward children's agricultural injuries beyond population-based surveillance efforts and hospital-based, case-control studies (Scheidt, Harrel, et al. 1995; Myers and Hendricks, 2001). This report documents the first multi-year, longitudinal study of agricultural injuries focused on children living and working on family-owned farms. The characteristics of farming operations with livestock, identified from surveillance efforts as high-risk farms for injury, have received limited attention from the research community with respect to children's agricultural injuries.

With 71,000 family-owned and operated farms in the state, many Kentucky children are active participants in farm labor operations. Research has suggested that children residing on farms with livestock may be at an increased risk for work-related injuries compared to children who work on other commodity farms, such as those growing tobacco or grain. The primary purpose of the study was to characterize children's work tasks on beef cattle farms, to identify the characteristics that predict the time children work at these tasks, to determine whether beef cattle farms are more labor intensive for child workers, and to assess whether children who work on these farms are at increased risk for farm work injuries. In addition, research on current farm management practices was undertaken to better understand animal handling procedures and work practices on Kentucky beef cattle farms. Examining the risks of farm-related injuries and work practices among children working on family-operated farms is an important occupational health issue, since children have traditionally provided a substantial portion of the

labor, especially during school breaks and peak harvest seasons. The federal Fair Labor Standards Act (FLSA) does not apply to children working on their family farm, and minors of any age may be employed by their parents to assist with farm work.

We conducted a three-year longitudinal study of children living and working on family farms in Kentucky. The study built upon baseline data collected in 1994/1995 on a cohort of children (N=999) living on family farms from 60 counties across a geographically diverse region of the state. The baseline data were collected as part of the NIOSH Kentucky Farm Family Health and Hazard Surveillance Project (FFHHSP), a multi-mode effort to determine agricultural risks and injuries among farm families in Kentucky (Browning, Truszczynska, et al., 1998). The current study extended data collection on this established cohort of children, with an in-depth focus on the children undertaking chores in beef cattle operations. Since an estimated 41% of the children in the cohort resided on farms with beef cattle, the study was designed to focus on this particular commodity group. Previous research in this cohort indicated that animal care chores were one of the principal tasks engaged in by children of all ages and both genders living on farms and animals are one of the primary external causes of injury to these children.

Project Goals & Objectives (Specific Aims)

The primary intent of the study was to characterize the work tasks and exposures of children living on beef cattle farms and to determine the risk factors that were predictive of the types of tasks children do and the amount of time they are engaged in farm work. Further, the study was undertaken to explore a diverse set of potential risk factors, including farm management practices and developmental characteristics of the individual child, which may be associated with an increased risk of injury to children residing on these farms.

This study was designed to consider the specific exposures related to beef cattle operations for an established cohort of children aged 5-18 years of age. The results are intended to aid the formulation of age- and developmentally appropriate guidelines for a broad age span of children working on farms with cattle and to provide specific recommendations for interventions targeted to reducing injuries among youth on beef cattle farms. One of the major objectives was to undertake an interdisciplinary approach to considering the farm management practices of beef cattle operations as they pertain to animal husbandry, confinement, and handling procedures that may be modified to reduce the potential for human injury.

The specific aims of the study were as follows:

1 Develop an exposure profile for farm tasks related to beef cattle activities (e.g., feeding, treating, transporting, etc.), and especially the exposed time in those tasks (hours per week over an assigned exposure period) for a cohort of children performing farm work on family-operated, beef cattle farms in Kentucky.

2 Identify the developmental characteristics of the child, parental influences, and farm management practices most strongly associated with a child's performance of farm chores related to beef cattle operations and the amount of time in these tasks.

3 Determine whether children on farms with beef cattle devote significantly more time to farm chores in comparison to children on other farms. Compare the time involved in chores and specific tasks by sociodemographic characteristics of the farm, such as farm income, farm size, number of workers, and commodity diversity.

4 Assess whether children who perform farm chores on farms with beef cattle are at an increased risk for farm-related injuries in comparison to children living on farms without cattle.

5 Determine whether current farm management practices on Kentucky beef cattle farms, including the design of confinement facilities and animal handling procedures, are associated with an increased risk of injury to children living and working on the family farm.

Project Progress (Methods)

For this research project, entitled Children's Injuries on Kentucky Beef Cattle Farms, there were two primary study designs used to address the specific aims. The first component of the research was a longitudinal study of a fixed cohort of children age 5 to 18 years who were first enumerated at baseline (1994/95) as part of the Kentucky Farm Family Health and Hazard Surveillance study. This component of the study was known as the Farm Child Health Study and consisted primarily of two longitudinal telephone surveys. The first follow-up telephone survey (Follow-up 1) was conducted from June-August in 2000 with 299 completed interviews, and the second telephone survey (Follow-up 2) was conducted from July-August 2001 with 242 completed interviews.

The second major component of the research was the development, pilot testing, and data collection of the Farm Management Survey. This survey was pilot tested (N=112) among the beef farms from the cohort in the Farm Child Health Study and followed by a full-scale data collection effort from a cohort of members of the Kentucky Cattleman's Association (KCA Survey) for a cross-sectional study focusing on the specific farm management practices used on Kentucky beef cattle farms. Rates of injuries related to the beef cattle operation were calculated from this survey. The survey of the KCA membership yielded 1,226 completed questionnaires. This component of the research was not part of the original proposal but developed over the course of the study and provided a valuable addition to the data collected from the longitudinal cohort portion of the research.

Baseline data were obtained by telephone interview from parents or guardian proxies from a two-stage cluster sample of 999 children living on Kentucky farms in 1995 (86% response) with follow-up telephone interviews in 2000 (N=299) and 2001(N=242). The 30-minute telephone surveys included questions regarding work patterns and exposures (e.g. days performed farm work, days driven a tractor), participation in farm tasks emphasizing cattle-related chores, injuries sustained by the child in the past 12 months, and selected health conditions of the child. We estimated the prevalence of youth participation in various farm chores, especially those related to tobacco and cattle production on farms. The incidence of nonfatal farm-work injuries from the baseline and the first and second follow-up surveys for the farm injury rates were analyzed using a repeated measures, generalized estimating equation (GEE) analysis strategy. In addition, we conducted a mail survey of a random sample of 2,500 members of the Kentucky Cattleman's Association (KCA) in October 2001 regarding their farm management practices and injuries among workers on these beef cattle farms.

Project Outcomes (Results)

The care and feeding of animals on beef cattle farms is one of the primary farm tasks undertaken by children. An estimated 70-80% of children (depending on the age and gender group considered) are involved in animal-related chores (see Appendix A for a distribution of the tasks by age and gender). Beef cattle farms in Kentucky are more labor intensive with respect to

the number of hours per week that children devote to the operation than other commodity farms (tobacco, crops, etc) in the state. Across all age groups, children on beef cattle farms devote a greater number of hours per week to farm work compared to children living on other commodity farms, especially during the school year. Children who worked on farms with greater than 40 head of beef cattle performed more hours of farm work per week (adjusted difference = 2.3 hours per week; SE=1.4) compared to children living on farms with less than 40 cattle (adjusted difference = 1.8; SE=1.3) or other commodity farms (referent). These children also participate in tasks that place them in direct contact with cattle, which accounts for the contribution of animal-related injuries to their total injury burden. Among children living on beef cattle farms who did farm work, 51% (95% CI: 0.43-0.58) participated in loading and unloading cattle, 40% (95% CI: 0.32-0.48) treated cattle with medications or secured ear tags, and 23% (95% CI: 0.16-0.29) worked in a yard with a bull.

There were 46 farm work injuries reported in the cohort of children over the time period of the study. The leading external cause of injury was contact with a foreign object (e.g. injuries to the eyes from rocks, sticks, and hay; and injuries to the extremities from hand tools and barbed wire). Machinery-related injuries were the second most frequent cause of injury; i.e., fractures and contusions from all terrain vehicles (ATVs) and tractor crashes, and cuts from using hitching equipment and hand tools. The upper extremities (arms and hands) were the body part most commonly injured during farm work.

A repeated measures cohort analysis (N=1028 observations) based on 39 farm work injury events for which we had complete data over the period of the study was performed. The cumulative incidence of farm work injuries on beef cattle farms was 3.4 injured children per 100 children per year. In the analysis of all children, male gender was the only significant factor for the risk of farm work injury. Boys were nearly four times (OR= 3.8; 95% CI: 1.63-8.75) more likely to sustain a farm work injury than girls, after adjustment for age, days of farm work per year, level of supervision, type of farm, and the year of the survey. In the analysis of all children, working more than 180 days per year, performing farm work independently, and working on a beef cattle farm (compared to other commodity farm) increased the risk for a farm work injury, although none of these associations were statistically significant. Boys who performed their farm tasks independently were at an increased risk for a farm work injury (OR=2.41; 95% CI: 1.15-5.06) in the analysis of the farm work injuries among males only. Working on a beef cattle farm increased the risk of a farm work injury 40% in all children, after controlling for days worked and other covariates in the model.

Of the 1205 farms surveyed from the KCA sampling frame, the farm management practices survey obtained data on 170 cattle-related injuries in the past year which occurred among the principal operator or a family member, yielding a cattle-related injury rate of 14.1 injured persons per farm per year. The majority of the injuries were associated with transporting cattle, using cattle-related equipment (e.g. headgates, chutes), and performing medical and herd health tasks on the animals. Of the injuries reported on this survey, only 5% of all the cattle-related injuries occurred in children (< 18 years) on the farm.

Beef cattle farms in Kentucky are more labor intensive with respect to the number of hours per week that children devote to the operation than other commodity farms (tobacco, crops, etc). Across all age groups, children on beef cattle farms devote a greater number of hours per week to farm work compared to children living on other commodity farms, especially during the school year. Assisting with dehorning, castration, working in a yard with a bull, and loading cattle are common tasks, especially for older male children. Farms with beef cattle may increase the risk of work-related injury to children, although the increased risk observed in this study was not

statistically significant. Pasturing cattle over the year and using professional veterinarians for the performance of selected tasks may be an approach for reducing cattle-related injuries on the farm.

Outputs/Products (Intermediate Outcomes)

Recommended Policy/Engineering/Public Health Program Changes

Our data confirm the importance of designing and evaluating injury control programs targeted toward the high risk group of adolescent males age 15-18 years of age who are most involved in farm work and most likely to participate in hazardous tasks. A large proportion of children (70-80%) in this study reported involvement with animal-related chores. The prevention of animal-related injuries is one area where there have been limited efforts to develop appropriate injury prevention interventions. Intervention research on the prevention of animal-related injuries would be appropriate for children of all ages that reside on the farm. The results of this study suggest the following recommendations for changes in policy, engineering, and other public health approaches:

1. The formulation of specific, age- and developmentally appropriate guidelines for children who work on beef cattle and livestock farms would complement the useful guidelines that have been developed as the *North American Guidelines for Children's Agricultural Tasks* (Lee and Marlenga, 1999).

2. There are many farm tasks that place children in direct contact with cattle, including feeding, castration, dehorning, administering medications, etc. Research focused specifically on merits of alternative approaches for performing these tasks that remove children from the immediate "zone of contact" with these animals, particularly when the animals may be in an agitated state, would be useful.

3. Guidance for when a veterinarian or other professional may be needed with some cattle maintenance tasks would be valuable as well as financial and other support for having professional assistance from a qualified veterinarian may reduce the risk of injury to children and other farm workers.

Continued support and encouragement of the importance of adult supervision of children while they conduct farm tasks, particularly around large animals, needs to be part of farm safety educational messages, programs, and campaigns.

Published Manuscripts

Browning SR, Westneat SC, Donnelly C, and Reed DB. Agricultural Tasks and Injuries among Kentucky Farm Children: Results of the Farm Family Health and Hazard Surveillance Project. Southern Medicine, Volume 96, Number 12, December 2003.

SR Browning, Westneat SC, Szeluga R. Final Report for the Children's Injuries on Kentucky Beef Cattle Farms grant. Submitted to the National Institute for Occupational Safety and Health.

Abstracts

Browning SR, Westneat SC, Szeluga R. Work Exposure and risk of cattle-related injuries on Kentucky Beef Cattle Farms. Submitted to 2004 Canadian Agricultural Association Annual Conference, December 2-4, 2004. Quebec, Canada.

Browning SR, Westneat SC, Szeluga R. Farm Work and Agricultural Exposures Among Children on Kentucky Beef Cattle Farms. (Abstract published in Epidemiology, July 2002, Volume 13, Number 4, Supplement). Presented at the ISEA/ISEE International meeting. International Society for Environmental Epidemiology. Vancouver, British Columbia, Canada. August 2002.

Szeluga R, Browning S. Westneat S. Farm management practices, work exposures and risk of cattle-related injuries on Kentucky beef cattle farms. Agromedicine Conference. San Diego, California. November 2002.

Browning S, Westneat SC, Szeluga R. Farm work injuries to children on Kentucky beef cattle farms. Presentation at the National Occupational Injury Research Symposium. Pittsburgh, PA. October 17-19, 2000.

Resources Used/Available

- Funds from CDC/NIOSH
- Skills and experience from project team members whose academic affiliations included the University of Kentucky Colleges of Medicine, Nursing and Public Health
- Kentucky Cattleman's Association members
- Participants of the Farm Child Health Study
- Farm Bureau and Individual Farmers

16. Budget

- CDC/NIOSH $492,686

17. Stakeholders

Stakeholders in this project included children, parents, farm community members, and the farm businesses and rural service agencies who serve these individuals and families (equipment dealers, insurance companies, emergency workers, and health care providers). All of these stakeholders are impacted when a child is injured while performing beef cattle tasks on the family farm.

18. Collaborators

- Steve Browning, Ph.D.
- Susan Westneat, MS
- RaeAnn Szeluga, MSPH
- Kentucky Cattleman's Association
- Farm Bureau

19. Intermediate Outcomes

See Outputs/Products section of Intro/History/Success narrative

20. End outcomes

- The results of this study indicate that beef cattle farms in Kentucky are more labor intensive with respect to the number of hours per week that children devote to the operation than other commodity farms (tobacco, crops, etc). Farms with beef cattle may increase the risk of work-related injury to children, although the increased risk was not statistically significant.

- Information from this study would be useful in the creation of animal-related child task guidelines that are developmentally and age appropriate for children living and working on cattle beef farms.

21. Significant Findings

- The results of this study indicate that beef cattle farms in Kentucky are more labor intensive with respect to the number of hours per week that children devote to the operation than other commodity farms (tobacco, crops, etc). Farms with beef cattle may increase the risk of work-related injury to children, although the increased risk was not statistically significant.
- Information from this study would be useful in the creation of animal-related child task guidelines that are developmentally and age appropriate for children living and working on cattle beef farms.

22. Emerging problems

- The study did allow for the control of exposure time (days of work in the past year) in the repeated measures of farm work injuries among the children. The study was targeted toward the assessment of the work practices of a specific farm commodity — the raising of beef cattle — based on prior research and other studies in the field that suggested an increased risk of injury among farm workers on livestock operations. The cohort entry criteria are focused on children aged 5 to 18 years, the ages at which they are most intensely involved in farm work and chores.
- The focus of the second aim of this study on examining the predictors of exposure time (hours performed farm chores in the past week) may prove to be a useful technique for examining the factors that determine what influences children's farm labor participation. From this work, it is evident that the greater labor demands of livestock operations influence children's risk of injury. From an ecologic perspective, one may conclude that as demand for beef increases on a global level, children who work in these operations may be at an increased risk for work related injury.
- While the longitudinal cohort design is potentially a powerful one with respect to the assessment of "causality" of the relevant risk factors, the relatively small number of farm work injury events in the children's cohort (N=46; 39 with complete vector of data) limits the number of potential risk factors that can be examined in the multivariable analysis.
- The limitations in using self-reported farm injury data for children have been well documented in several studies. The loss to follow-up was a concern of this longitudinal design; the largest component of this loss in a cohort study of children was due to "aging out of the cohort given the eligibility criteria" as opposed to a lack of participation in the data collection efforts. The GEE method used assumed that the missing variables are distributed completely at random (MCAR).

23. Future Directions

- The focus of the study on the collection of detailed data on the animal-related tasks being performed by children and the farm management practices which may be related to the risk of cattle-related injuries offers ideas for the design of commodity appropriate interventions in childhood agricultural safety research. The identification of "high risk" tasks among children who work on farms appears a more useful approach than limiting work hours or prohibiting farm work, especially if these tasks can be performed by others or modified/redesigned to reduce the risk of injury.
- The results of the analyses provide suggestions for consideration of cattle handling procedures that may increase the risk for injury. For example, herding techniques that used horses or dogs to move cattle appeared to increase the risk of injury. As a general

approach to raising cattle, having the animals in pasture year round reduces the hours required to feed the herd and attendant risk of injury. Certain breeds of cattle may pose a greater risk of injury by virtue of their size and temperament. While definitive conclusions regarding breed could not be drawn from this investigation, the data suggest a slightly increased risk of injury on farms with Charolais or Limousin cattle. The use of ATVs for performing herding tasks may also increase risk of injury for children. This approach may "upset" the cattle to a greater degree than approaches that do not employ machines to move the animals. An incorporation of these issues in an expanded version of the *North American Guidelines for Children's Agricultural Tasks* (Lee and Marlenga 1999) may be useful.

- Research in the field of the design of animal handling facilities offers ideas that may have an impact on human safety as well. Interdisciplinary collaborations on designing evaluations of alternative animal handling facilities and procedures may benefit both animal husbandry and public health.

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Appendix A: Distribution of farm tasks for Kentucky farm children by age and gender (all farms)

	Age 5-9		Age 10-14		Age 15-18	
	Boys (n=28)	Girls (n=14)	Boys (n=41)	Girls (n=41)	Boys (n=29)	Girls (n=24)
Task	% Yes (95% C.I.)	% Yes (95% C.I.)	% Yes (95% C.I.)	% Yes (95% C.I.)	% Yes (95% C.I.)	% Yes (95% C.I.)
Cleaned pens with animals	7.1 (0.9-23.5)		9.8 (2.7-23.1)	17.1 (7.2-32.1)	17.2 (5.8-35.8)	8.3 (1.0-27.0)
Fed cattle with shovel	21.4 (8.3-41.0)	14.3 (1.8-42.8)	14.6 (5.6-29.2)	9.8 (2.7-23.1)	34.5 (17.9-54.3)	12.5 (2.7-32.4)
Fed cattle by tractor	17.9 (6.1-36.9)	21.4 (4.7-50.8)	36.6 (22.1-53.1)	17.1 (7.2-32.1)	58.6 (38.9-7.5)	29.2 (12.6-51.1)
Lifted hay bales by hand	25.0 (10.7-44.9)	7.1 (0.2-33.9)	61.0 (44.5-75.8)	29.3 (16.1-45.5)	72.4 (52.8-87.3)	33.3 (15.6-55.3)
Assisted with cattle loading	28.6 (13.2-48.7)	14.3 (1.8-42.8)	51.2 (35.1-7.1)	29.3 (16.1-45.5)	79.3 (60.3-92.0)	37.5 (18.8-59.4)
Helped treat cattle with medications	32.1 (15.9-52.4)	14.3 (1.8-42.8)	39.0 (24.2-55.5)	29.3 (16.1-45.5)	65.5 (45.7-82.1)	29.2 (12.6-51.1)
Helped deliver calf	7.1 (0.9-23.5)		26.8 (14.2-42.9)	9.8 (2.7-23.1)	20.7 (8.0-39.7)	4.2 (0.1-21.1)
Worked in yard with bull	10.7 (2.3-28.2)	7.1 (0.2-33.9)	22.0 (10.6-37.6)	12.2 (4.1-26.2)	37.9 (20.7-57.7)	20.8 (7.1-42.2)
Moved cattle with prod, stick	14.3 (4.0-32.7)		17.1 (7.2-32.1)	14.6 (5.6-29.2)	51.7 (32.5-70.6)	25.0 (9.8-46.7)
Moved cattle with ATV	7.1 (0.9-23.5)	14.3 (1.8-42.8)	22.0 (10.6-37.6)	7.3 (1.5-19.9)	24.1 (10.3-45.5)	12.5 (2.7-32.4)
Helped with dehorning	14.3 (4.0-32.7)		12.2 (4.1-26.2)	12.2 (4.1-26.2)	31.0 (15.3-50.8)	4.2 (0.1-21.1)
Assisted with cattle castration	14.3 (4.0-32.7)		24.4 (12.4-40.3)	9.8 (2.7-23.1)	48.3 (29.4-67.5)	4.2 (0.1-21.1)
Raised calf for project	3.6 (0.1-18.3)		7.3 (1.5-19.9)	12.2 (4.1-26.2)	31.0 (15.3-50.8)	8.3 (1.0-27.0)
Operated tractor alone	14.3 (4.0-32.7)		51.2 (35.1-7.1)	14.6 (5.6-29.2)	82.8 (64.2-94.2)	37.5 (18.8-59.4)

1. Center

Southeast Center for Agricultural Health and Injury Prevention, University of Kentucky, College of Public Health

2. Project Title

Agricultural Disability Awareness and Risk Education: AgDARE

3. Project ID #

R01 CCR414307

4. Contact Person/PI

Deborah B. Reed, PhD, RN, C, MSPH, Associate Professor, University of Kentucky College of Nursing.

5. Contact Email Address

3. Project Start Date – Project End Date

09/30/97-9/29/01

4. Project Status

Completed

5. NIOSH Core

Education and Outreach

6. NORA Program Area

Disease and Injury:	Traumatic Injuries, Hearing Loss, Asthma and Chronic Obstructive Pulmonary Disease
Work Environment and Work Force:	Special Populations at Risk (youth)
Research Tools and Approaches	Intervention Effectiveness Research Social and Economic Consequences of Workplace Illness and Injury

7. NIOSH Objectives (i.e., strategies)

Research
Outreach
Prevention
Evaluation
Dissemination

8. Type of Agriculture

Multiple

9. Target Group

Youth

10. Special Populations at Risk

Youth

11. Project Description

This four-year intervention developed, implemented, and evaluated a novel farm injury prevention program for high school agriculture students emphasizing disability awareness and utilizing both narrative and physical simulation exercises. Reaching more than 1,100 students in three states (Kentucky, Iowa, and Mississippi), the project aimed to (1) increase students' knowledge of the long-term consequences of cumulative and catastrophic injury, (2) enrich students' understanding of the economic and personal costs of permanent disability, and (3) encourage and empower students to make specific injury-reduction and behavioral changes. Recognizing that the emotional and cognitive development of adolescents often hinders their responsiveness to information on mortality risk, the AgDARE curriculum uses the concept of disability to teach farm safety. Studies suggest that teens are less likely to react to a threat of injury or death but are more inclined to avoid disability, disfigurement, and a change in body image.

12. Introduction/History/Success of Project

Background

NIOSH has estimated that more than 70 Americans younger than age 18 die on the job each year (NIOSH, on-line 12/17/01). Thousands more are injured. The magnitude of agriculture work-related injury for adolescents is unknown, since 95% of U.S. farms are exempt from OSHA reporting standards; however, the estimate for agricultural injury deaths for children is 104 annually (Rivara, 1997). This project focused on the 346,000 farm adolescents aged 14 and over, the group at highest risk for agricultural work injury. Although death rates from child and adolescent agricultural injuries have fallen between 39% and 43% in the past ten years, injury rates have risen 10.7% (Rivara, 1997; USDHHS/NIOSH, 2001). Survival after injury is not synonymous with recovery; injured youth may suffer life-long consequences in the form of permanent disability (Reed & Claunch, 2000).

Rural adolescents frequently take agriculture classes in their schools. The role of agriculture education in public schools across the United States has been to equip young persons for employment in production agriculture. While instructions regarding safety rules are in place in the classroom, there is no structured agricultural safety education in the agriculture curriculum. Instead, each agricultural education teacher may choose how safety messages are delivered. This approach severely limits effective evaluation of safety instruction. The AgDARE project thus provided a field evaluation of a novel instructional method to deliver safety instruction for adolescents.

Prevention programs often ignore the acquisition of permanent disabilities among farm youth. Rather, mortality prevention is usually emphasized, even though this concept is incongruent with the developmental capacity of many youth (i.e., concrete operators versus abstract thinkers)**.** The goal of the AgDARE project was to develop and test the effectiveness of a novel farm injury prevention program for high school agriculture students. The objectives were for students to increase their knowledge of the long-term consequences of cumulative and catastrophic injury, to better understand the personal and economic costs of permanent disability, and to make specific injury-reduction and behavioral changes.

From its inception, the project involved students and high school agriculture teachers in Kentucky, Iowa, and Mississippi. The project was implemented in two phases over a four-year

period. Phase I consisted of instrument and intervention development. The intervention consisted of four reality-based, latent-image (narrative) simulation exercises that focused on prevention of amputations, spinal cord injuries, noise-induced hearing loss, and hypersensitivity pneumonitis (Farmer's lung). Four simulated work exercises (physical simulations) that focused on the same prevention strategies were also developed and tested. The simulations were designed to emphasize the life-long occupational consequences of permanent disabling conditions. The simulation topics were selected based on the existing literature, case-based data from AgrAbility, and focus groups held with agriculture teachers and students. Phase II consisted of intervention dissemination and evaluation.

Goals and Objectives

The primary objectives of the project were to:

- Increase agricultural education students' knowledge of the long-term consequences of cumulative and catastrophic agriculture-related injury;
- Increase agricultural education students' knowledge of the personal and economic costs resulting from permanent disabilities;
- Increase the students' use of specific injury prevention strategies while performing farm tasks.

Consistent with these three key objectives, the project also aimed to

- Foster attitudes in agricultural education students that support safety behaviors;
- Examine the generalizability of simulations across culturally diverse communities in different geographical regions with different types of agricultural production;
- Increase agricultural education teachers' resources for providing agricultural safety education.

Project Progress

The project resulted in numerous professional presentations and published articles, as well as the AgDARE curriculum, which was field tested, revised, and retested; translated into Spanish; placed on CDs; and made available online through the National Agricultural Safety Database (http://www.cdc.gov/nasd/docs/d000101-d000200/d000153/d000153.html).

The narrative and physical simulations were developed in Phase I of the project, with focus groups of farm youth participating in the process. A quasi-experimental cross-over design was used to test the intervention in Phase II. Schools were selected based on location, commodity, and regional similarities. Schools within each geographic region were then randomly assigned to one of two intervention groups or to the control group. Students in the intervention groups completed a demographic survey, Farm Safety Attitude (FSA) Instrument and Stages of Change (SOC) Instrument immediately before the intervention. Each student completed an evaluation of the individual simulation unit immediately following the unit. At the end of the semester or at the end of the academic year (depending on the school year structure), students were given the second intervention and they completed post FSA and post SOC tests. Students in the control group completed demographic surveys, pre FSA and pre SOC tests, and post FSA and SOC tests within the same time-frame as students in the treatment groups. No other activities were conducted with control schools. One year after the intervention, farm visits were made to 29 students who completed the AgDARE intervention and currently did farm work to assess their work behavior.

Project Outcomes

The AgDARE intervention tested the following hypotheses:

1) Students who complete AgDARE would demonstrate greater knowledge of long-term consequences of agricultural-related injury compared with students in the control group.

2) Students who complete AgDARE would demonstrate greater knowledge of personal and economic costs resulting from permanent disabilities compared with students in the control group.

3) Students who complete AgDARE would demonstrate greater use of injury prevention strategies while performing farm tasks compared with students in the control group.

A cohort of 1,138 high school agriculture students in Kentucky, Iowa and Mississippi participated in the study. The treatment groups consisted of 591 students in 14 schools. Of these students, 373 completed at least two narrative and two physical simulations that focused on the same disabilities. Students in the control group (N=547) were enrolled in 7 schools. 417 control students had complete data sets. Seventy-five percent (N= 590) of the full sample with complete data sets reported they had farm work experience. Twenty-nine students who completed at least two matched units of AgDARE (physical and narrative simulations focused on the same disabilities) and who reported they lived and worked on farms participated in farm visits approximately one year after their AgDARE class instruction.

Data were coded and entered into a SAS program. Descriptive statistics, such as means and standard deviations or frequency distributions, were run on the groups. Comparisons between the intervention and control schools at baseline were performed using two-sample t-tests or chi-square tests of association, as appropriate to the level of measurement. Pre- and post-intervention and follow-up measures were analyzed using repeated measures Analysis of Covariance models. Outcome evaluation was based on post-intervention surveys and direct observations of hazard reduction behaviors.

Numerous important findings emerged:

1. Students and teachers were highly receptive to the AgDARE curriculum. Students in the control group were more likely to be male, be slightly older and have more farm work experience than intervention students.

2. Seventy-eight percent of all students reported ever working in any agricultural production activities and 69% reported currently working on farms. Students who completed at least two matched units of AgDARE demonstrated significant positive changes ($p<.01$) in both FSA and SOC scores compared to control students. Students reported that the simulations were both realistic and applicable to their farm work.

3. Of the 29 students who completed AgDARE and received farm visits one year later, 25 (86%) had made safety related changes in their farm work. Eighty-seven percent of these changes related directly to injury prevention strategies taught through AgDARE. Students reported that the other changes were made because they now thought more about safety while doing farm work.

4. The curricula performed equally well across all three states in the study. High school agriculture teachers' reception to the curriculum was positive.

Resources Used/Available

The resources included the following partial list.

- Funds from CDC/NIOSH
- Skills and experience of the project team members, whose academic affiliations included the University of Kentucky Colleges of Nursing, Agriculture, Medicine, and Public Health, as well as the Arizona State University College of Nursing
- Teachers and principals from 21 high schools in Kentucky, Iowa, and Mississippi
- NIOSH researchers and technical experts, including Dr. Ted Scharf and Dr. Brian Day
- Dr. Henry Cole, Professor of Medicine and Environmental Health, and Emeritus Professor of Educational Counseling and Psychology, University of Kentucky
- Dr. Joan Mazur, Associate Professor, Instructional Systems Design and Technology, Department of Curriculum and Instruction, University of Kentucky
- Staff members of the UK College of Communication, who, together with technical experts from NIOSH, assisted in the creation of the 7-minute hearing loss video, "Sound Advice through the Years"
- Kentucky Migrant Education Program and Migrant Coalition Network, as well as several church groups affiliated with the Network, which helped facilitate access to adolescent migrant farm workers
- Staff members of Kentucky AgrAbility, Tennessee AgrAbility, and Farm Safety 4 Just Kids, who assisted in refining the various physical simulation exercises
- A graduate student in agricultural education who has a lifelong background in farming and who provided many valuable insights during development and implementation of the AgDARE curriculum
- Shari Burgess of FS4JK and John Hancock of Kentucky AgrAbility, who provided ongoing insights and support based on their respective fields of expertise
- Staff members of the NIOSH Science and Human Factors Branch, Work Organization and Stress Research Organizational Section, who assisted in refining the physical simulation exercises
- Farm Bureau and individual farmers

Outputs/Products (for both Phase 1 and Phase II)

Products that emerged from the project include the AgDARE curriculum notebook and supporting classroom materials, online instructional materials (including Spanish translations of several narrative simulations), refereed journal articles, professional paper presentations at regional and national conferences, and data files.

Instructional Materials

Reed, D.B., et al (2000). The *AgDare Curriculum Notebook.* The notebook is a 3-inch binder with detailed instructions on how to implement the safety curriculum, references and resource listings, and evaluation materials. Each section includes lesson plans and specific objectives. The 7-minute hearing loss video accompanies the binder. Copies of the curriculum and notebook have been duplicated and distributed in more than 25 states.

Cole, H.P. & Mazur, J. (2001). *The AgDare Curriculum Guide*. A web-based version of the narrative and physical simulations that includes teacher guidelines, supplemental activities,

posters, fact sheets, and references. The web-based versions include sound and illustrations and may be toggled between English and Spanish.

- *Jim in a Jam (Artruro en Apuros)*
  - Lesson plan and teacher's guide
  - Narrative simulation
    - "Jim In a Jam" Problem Booklet
    - "Jim In a Jam" Answer Key
    - "Jim In a Jam" Answer Sheet/Questionnaire
  - Physical Simulation
    - Supplemental Activity 1: Case Report
      - "Case Report: 13-Year-Old Caught in Silo Sweep Auger"
    - Supplemental Activity 2: Group Role Play
    - Supplemental Activity 3: Guest Speaker
  - Posters:
    - "How will you spend $20,000?"
    - "Still running after your dreams?"
    - "Smart Work Choices Help You Reach Your Goal"
    - "If It Dangles, It Tangles"
  - Student Reference Sheet
  - Teacher Fact Sheet
- *Ben Can't Breathe (Pulmòn del Granjero)*
  - Lesson Plan
  - Narrative Simulation
    - Guide
    - "Ben Can't Breathe" Problem Booklet **Spanish Version**
    - "Ben Can't Breathe" Answer Key **Spanish Version**
    - "Ben Can't Breathe" Answer Sheet/Questionnaire **Spanish Version**
  - Physical Simulation
    - Supplemental Activity 1: Case Report
      - "Case Report: Dairy Farmer Diagnosed with Farmer's Lung"
    - Supplemental Activity 2: Guest Speaker
    - Supplemental Activity 3: Personal Protective Equipment (PPE)
    - Supplemental Activity 4: Mask Comparison
    - Supplemental Activity 5: Study Sheet
  - Teacher's Guide
  - Student's Study Sheet
  - "Respiratory Protection" - Respirator Comparisons
  - Farmer's Lung Illustration (pdf)
  - Student Reference Sheet
  - Teacher Fact Sheet

- *What Happened to Bob*
  - Lesson Plan
  - Narrative Simulation
    - Guide
    - "What Happened to Bob?" Problem Booklet
    - "What Happened to Bob?" Answer Key
    - "What Happened to Bob?" Answer Sheet/Questionnaire
  - Physical Simulation
    - Supplemental Activity 1: Case Report

"Case Report: Spinal Cord Injury from Tobacco Barn Fall"
Supplemental Activity 2: Guest Speaker
Supplemental Activity 3: Group Field Trip Activity
Supplemental Activity 4: Study Sheet
Teacher's Guide
Student's Study Sheet
Student Reference Sheet
Teacher Fact Sheet

- *Sound Advice throughout the Years (Pérdida De Oído)*
  - Lesson Plan
  - Narrative Simulation
    - Guide
    - "Sound Advice throughout the Years" Problem Booklet **Spanish Version**
    - "Sound Advice throughout the Years" Answer Key **Spanish Version**
    - "Sound Advice" Answer Sheet/Questionnaire **Spanish Version**
  - Physical Simulation
    - Supplemental Activity 1: Noise Level Recognition
    - Teacher's Guide
    - Student's Worksheet
    - Supplemental Activity 2: Field Trip
    - Supplemental Activity 3: Guest Speaker
    - Supplemental Activity 4: Personal Protective Equipment (PPE)
  - Sound Levels Thermometer (pdf)
  - Student Reference Sheet
  - Teacher Fact Sheet
  - Hearing Loss Video
  - References

Professional Meeting Presentations/Proceedings

Reed, D.B., (2000, October). Invited presentation to the National FFA Convention. Louisville, KY. This event is the largest annual convention of agricultural educators and students, drawing more than 50,000 participants. In less than one-half day, all print copies of the curriculum were distributed at this event and a waiting list for reprints was generated.

Reed, D., (2001, October). Invited presentation to National FFA Convention. Louisville, KY.

Published Articles

Reed, D.B. & Kidd P.S. (2004). Collaboration between nurses and agricultural teachers to prevent adolescent agricultural injuries: The agricultural disability awareness and risk education model. *Public Health Nurs 21,4,* 323-330.

Reed, D.B., Kidd, P.S., Westneat, S., & Rayens, M.K. (2001). Agricultural disability awareness and risk education (AgDARE) for high school students. *Inj Prev 7* (Suppl 1)*,* i59-63.

Reed, D.B. & Claunch D.T. (2000). Nonfatal farm injury incidence and disability to children. *Am J Prev Med 18(4 Suppl),* 70-79. Review.

Recognition and Testimonials

In June 2000, AgDARE was presented to approximately 200 Kentucky agricultural education teachers at the request of the president of Kentucky Agriculture Teachers. A standing-room-only crowd attended the session and requests for the final curriculum were received.

Copies of the AgDARE curriculum and supporting materials have been distributed in more than 25 states.

A radio interview featuring AgDARE was conducted with the Kentucky Farm Bureau in September 2000.

Two schools in the project constructed simulation work boards for use in their classes and community farm safety education programs. The work boards used in AgDARE were used by Kentucky AgrAbility for community education with farmers with disabilities. The AgDARE project staff has continued to work with AgrAbility and other groups, such as Farm Safety 4 Just Kids, in developing new safety educational materials based on the AgDARE model.

Under the direction of Dr. Brian Day of NIOSH, the "Ben Can't Breathe" narrative was adapted and used as a template for development of a similar simulation for construction workers.

Agricultural Disability and Awareness and Risk Education (AgDARE) for High School Students (Reed, Kidd, Westneat & Rayens, 2001) was selected by NIOSH for a special issue of *Injury Prevention.*

13. Budget:

$588,830

14. Stakeholders:

Stakeholders for this project included high school students, agricultural education teachers, parents, farm community members, and the farm business and rural service agencies who these individuals and families (farm equipment dealers, insurance companies, banks and lenders, emergency workers, health care providers, factories and other employment facilities where rural youth hold off-farm jobs). All of these groups are adversely affected when young persons incur injury and/or disability. All have a stake in lowering and preventing farming-related injuries among adolescents.

15. Collaborators:

Many collaborators were involved throughout the project. Table 1 on page 9 lists the collaborating individuals and organizations in each of the three states and nationally.

16. Intermediate Outcomes

See Outputs/Products in narrative section

17. End Outcomes:

- The AgDARE curriculum demonstrated a positive and statistically significant influence on safety attitudes and safety behaviors among high school agricultural education students who completed at least two narrative and two physical simulation exercises. These changes lasted after the actual intervention ended.

- The AgDARE project led to the development of a comprehensive yet flexible package of multi-media educational materials that can readily fit into existing curriculum, time, and budget constraints.

18. Significant Findings:

- The involvement of teachers, youth, and disability experts in the design, delivery, and evaluation of the project was helpful in fostering community buy-in and the quality and utility of the AgDARE curriculum.
- The intervention study design produced statistically significant increases in students' disability awareness, their contemplation of occupational hazards and safe work behaviors, and their adoption of specific injury-prevention actions when doing farm work.
- The AgDARE curriculum and/or supporting materials began to be utilized by a variety of stakeholders, including job trainers and AgrAbility staff members, as well as high school teachers in more than two dozen states.
- The AgDARE curriculum and collateral materials have been distributed in hard copy, CD-ROM, and online through the NASD website. Many presentations and publications resulted from the project and continue to do so.

19. Emerging Problems:

- One limitation of this design was the inability to evaluate the relative strength of the individual components of the intervention. This, however, is not a major concern since the primary goal of the study was to evaluate the intervention as a total package. The administration of the narrative and physical simulations was randomized to help control for bias. Evaluation of whether an intervention effect is due to the study-specific intervention and not to an external intervention or other confounding factor was enhanced in this study by using control schools that were comparable to the treatment schools, by collecting data in the survey regarding the children's exposure to other farm safety programs, and by conducting multiple replications of the intervention.
- Another bias in a repeated measures design is the potential loss to follow-up of students who participate early but leave the school or become unavailable to participate at the time of follow-up. This bias was minimized by collecting data over a relatively short time period (one year). The primary analyses for this study were done at the individual level using a mixed design ANOVA with repeated measures.
- The Co-Investigators delivered both the narrative and physical simulations. This reduced the potential of bias being introduced by style of presentation.
- One of the criticisms of previous safety education is the reliance on self-reported behavior to evaluate change (Murphy et al., 1996). This study incorporated both self-reported and observed behaviors. Agreement between self-reported and observed behaviors was measured, and supported training effectiveness.
- Participants who received the intervention in Year 3 were a year older than those who receive the intervention in Year 2. Although an individual's physical, cognitive, and psychosocial development proceeds in a predictable fashion, it does not always adhere to a particular chronological pace. Therefore, it is possible that some of the participants were at a different developmental level than they would have been if they had been measured at an earlier time period.

20. Future Directions:

- A formal evaluation of the performance of the curriculum in a regular classroom setting is essential. The Project was a research to practice (R2P) effort that built on many years of farming-related injury surveillance and epidemiology, as well as many years of applied human learning and instructional systems design. Further evaluation of the curriculum in a regular classroom setting will assure more effective use of this multi-media, trans-disciplinary approach to youth injury and disability prevention.
- Students' enthusiasm for the hearing loss video and their ensuing questions about hearing loss in general suggest that that video may be very useful in health or science classes, where the etiology and physiology of hearing loss can be further explored. This may be especially valuable in the age of widespread use of sophisticated car stereos and iPODs, etc., among youth.
- The FSA instrument shows promise as a short, easily administered farm safety attitude scale for the classroom. More items intended to measure attitudes toward disability should be constructed and tested to improve the performance of this subscale. The SOC however, performed extremely well. This instrument should be used in future farm safety research targeting the adolescent.

Table 1: AgDare Collaborators

Individuals

Henry P. Cole, EdD
Susan Pollack, MD
Tim Struttmann, MSPH
Steven R. Browning, PhD
Larry Piercy, MS, CSP
Susan Westneat, MA
Shari Burgus, MA
Beverly Belcher, MA
Dorthi Bearden
Debbie Claunch, BBA
Lynne Miller, BS
Daniel Rosnik, BA
Katheryn Wilson, BA
Joan Mazur, MS, PhD
Ted Scharf, PhD
Brian Day PhD

Participating High Schools

Kentucky

Bath County High School
Hopkins County Central H.S.
Jackson County High School
Lincoln County High School
Logan County High School
Madison Central High School
Madisonville N. Hopkins H.S.
Mercer County High School
Scott County High School
Trigg County High School
Wolfe County High School

Iowa

Atlantic High School
Harlan Community H.S.
Maquoketa Community H.S.
Rockwell-Swaledale H.S.
St. Ansgar High School
Wapsie Valley High School

Mississippi

Coffeeville High School
Northeast Jones High School
South Panola High School
Weir Attendance Center

1. Center

Southeast Center for Agricultural Health and Injury Prevention, University of Kentucky, College of Public Health

2. Project Title

Cost-Effectiveness of Promoting Roll-Over Protective Structures (ROPS) and Seat Belts on Family Farm Tractors

3. Project ID #

U50/OHO7547, -01, -02, -03

4. Contact Person/PI

Henry P. Cole, Ed.D, Professor, Preventive Medicine & Environmental Health Emeritus Professor, Educational and Counseling Psychology

5. Contact email address

hcole@uky.edu

6. Project Start Date – Project End Date

09/30/01 – 09/29/04

7. Project Status

Completed

8. NIOSH Core

Prevention/Intervention
Multi-disciplinary Research

9. NORA Program Area

Disease and Injury:	Traumatic Injuries (prevention of tractor overturn injuries)
Work Environment and Work Force:	Special Populations at Risk (limited resource Kentucky farmers, farm women, farm youth, older farmers)
Research Tools and Approaches	Surveillance Research Methods
	Social and Economic Consequences of Workplace Illness and Injury
	Intervention Effectiveness Research

10. NIOSH Objectives

Research
Prevention
Evaluation
Dissemination

11. Type of Agriculture

Row Crops/Field

12. Target Group

Farmers

13. Special Populations at Risk

Low resource farmers, older farmers, farm women and children

14. Project Description

A statewide random sample of 6,063 Kentucky farmers were surveyed about their history of tractor overturns and operator injury outcomes for non-ROPS and ROPS equipped tractors. Key findings included the denominator of fatal plus non-fatal tractor overturns, the frequency and severity of six classes of operator injury outcomes (numerators), the associated costs of these injuries, and the probability of each fatal and non-fatal injury outcome for ROPS and non-ROPS tractors.

15. Introduction/History/Success of Project

Background

Tractors are the leading cause of fatal farm injuries. Most of these fatalities result from overturns. Roll-over protective structures (ROPS) in combination with seat belts are a cost-effective means for preventing overturn-related fatalities. In combination, these two simple devices keep tractor operators in a protected zone during overturns and collisions. When tractors without ROPS are involved in overturns or collisions, operators frequently are severely injured or killed from being crushed by the tractor or ejected from the tractor seat. Prior to this study no accurate estimate of the denominator of all fatal and non-fatal tractor overturns existed for tractors with or without ROPS. Thus, accurate calculations of the cost-effectiveness of equipping tractors with ROPS could not be completed.

Goals and Objectives

The five study objectives are listed below.

1. Conduct a cost-effectiveness analysis of the Kentucky "Promoting ROPS and Seat Belts on Family Farm Tractors" community intervention project by making use of existing data from that project (Cole & Westneat, 2001), by using a recently developed decision analysis tool (Pana-Cryan and Myers, 2000; Myers & Pana-Cryan, 2000), and by reviewing previous cost effectiveness studies (Year 1).
2. Design and administer a telephone survey to a statewide random sample of 6,063 Kentucky principal farm operators to provide population-based estimates of key parameters for the Myers and Pana-Cryan decision analysis tool and subsequent cost effectiveness evaluations of ROPS and seat belt promotion efforts (Year 2).
3. Calculate the cost analysis of retrofitting tractors with ROPS based upon the Year 2 telephone survey data and the more accurate estimates of the values used in the decision analysis tool (Year 3).
4. Determine the distribution of costs and benefits of the Kentucky ROPS Project retrofit program (and other ROPS promotion and intervention programs) from a societal perspective, an equipment dealer perspective, and a farmer perspective as compared to no intervention by conducting three separate decision and economic analyses (Year 3).
5. Apply the updated decision and cost-effectiveness model to other ROPS promotion projects and efforts. These include a study of the cost-effectiveness of (1) a Kentucky equipment dealer’s intervention, and (2) the Virginia Farm Bureau ROPS promotion program (Year 3).

Prior studies have not included robust estimates of the costs and benefits of programs that promote retrofitting tractors with ROPS. This is because prior to the present study, no

population-based census had been conducted on total tractor overturn events and the six categories of operator injury outcomes that result from overturns. The six classes of overturn injury outcomes include (1) no injury or minor injury that requires medical treatment, (2) injury that requires outpatient medical treatment but not hospitalization, (3) injury that requires hospital admission, (4) injury that results in temporary disability, (5) injury that results in permanent disability, and (6) injury that results in death. Thus, prior to this study, cost-effectiveness analyses of ROPS promotion efforts were deficient for the following reasons. First, the denominator of total tractor overturn events was underestimated. Second, without a population-based denominator of all tractor overturn events (non-fatal and fatal), estimates of the frequency and severity of overturn injuries of tractors without ROPS and those quipped with ROPS are inaccurate.

Most surveillance systems identify tractor overturn cases based on death certificates and newspaper articles. Newspapers typically report only "newsworthy" overturns that result in severe injury or death. Death certificates frequently do not provide sufficient detail about the circumstances of tractor-related deaths. As a result, many farm tractor overturns that result in non-fatal injury and many others that result in death are not included in surveillance data. Furthermore, farmers typically do not report tractor overturns that result in minor injuries or no injuries because they are embarrassed by these events. Even when overturns result in injuries that require visits to clinics and emergency departments, many of these cases are not reported for lack of a standard surveillance system. Thus, the denominator values used in previous analyses omit many non-injury events, many non-fatal injury overturn events, as well as fatal events.

Project Progress

The project was completed in September 2004 and the final report was submitted shortly thereafter. The human subjects IRB protocol remains active to allow continued analysis of the Kentucky Tractor Overturn Survey data. These data are essential to the ongoing Cost of Tractor Operator Injuries from Overturns and Highway Collisions that was funded from 06/24/05 – 06/23/07 as part of the Agricultural Centers' implementation of the *National Agricultural Tractor Safety Initiative*.

Project Activities

The Kentucky Tractor Overturn Survey was designed, pilot tested, and perfected during Year 1. It was then administered to a statewide random sample in Year 2. The survey interview collected data about (a) the frequency and severity of injury resulting from tractor overturns, (b) the probability of annual tractor overturns, (c) the probabilities of injury outcomes during tractor overturns, and (d) the effectiveness of ROPS and seat belts for preventing injuries and fatalities in situations other than overturns. The survey data were analyzed during the later part of Year 2 and throughout Year 3.

The Kentucky Tractor Overturn Survey was administered to a statewide random sample of 6,063 farms, 8% of the 76,017 principal farm operators in the state who collectively operate 150,268 wheel-type farm tractors. Principal operator is a Census of Agriculture category that refers to people who own and operate farms. Kentucky's principal operators have a mean age of 55 years, 92% are male, and typical farm size is about 200 acres (Census of Agriculture, 1997).

Prior to interviewing the statewide sample of farmers, the Kentucky Agricultural Statistics Service (KASS) prepared a 10,000 farm random sampling frame from its master list of farms. Principal operators were sampled proportional to the number of farms in each of Kentucky's six

agricultural districts and were stratified by annual farm income category. The intention was to oversample to ensure a sufficiently large number of completed survey forms. Following multiple revisions and user tests with small groups of farmers the Kentucky Tractor Overturn Survey was pilot tested with a random sample of 39 farmers. Minor adjustments to a few survey items were made. Then KASS enumerators called and interviewed farmers from this pool of 10,000 individuals until the target sample size of 6,000 completed surveys was achieved.

All participants interviewed were adults ranging from 18 to 85 years of age. The survey began with an explanation of the study purpose, who was doing the study, and why. It then solicited each participant's verbal informed consent to participate in the interview. The participant was told not to answer any questions he or she felt uncomfortable with, as well as to end the interview at any time he or she wished. Our earlier experience with similar telephone interviews suggested that the human subjects protection procedures built into the telephone survey would work well. The 6,063 completed farm surveys represented a 79% response rate. Farmers' primary reason for non-participation was lack of time. No complaints about the survey or the study were received.

The completed survey data received by the University of Kentucky researchers was stripped of all farmers' names, farm names, USDA farm ID numbers, and all other personal identifiers. Prior to releasing the data to the UK research team, KASS created and assigned a random number to each of the 6,063 completed survey forms.

Project Outcomes

Among the entire random sample of 6,063 farms, 5,512 (90.09%) reported having had no tractor overturns. A total of 551 farms reported having had at least one overturn (9.09%). The overturns spanned the period from 1925 to 2002. Of the total 551 overturns, 92 (16.70%) involved ROPS-equipped tractors and 445 (80.76%) involved tractors without ROPS. The overturns of the non-ROPS tractors were distributed as follows: 17 (3.82%) year unknown, 26 (5.84%) from 1925-1955, 55 (12.36%) from 1956-1965, with the remaining 346 (77.76%) distributed approximately equally within five-year intervals from 1966 to early 2002. Injury outcomes were known for 443 overturns of non-ROPS tractors and distributed as follows: No or minor injury 312 (70.43%), outpatient medical treatment 97 (21.89%), hospital admission 68 (15.35%), temporary disability 60 (13.54%), permanent disability 14 (3.16%), and death 24 (5.42%). Operator gender was distributed as male 433 (97.96%), female 9 (2.04%), and 3 unknown. The type of tractor stance reported for 400 overturns was distributed as follows: Narrow front end 166 (41.5%), wide front end 234 (58.50%), and 45 unknown. The types of overturns reported for 419 events were distributed as follows: On side 90-degree roll 217 (51.79%), sideways upside down 180 degree roll 121 (28.88%), sideways roll ≥ 360 degrees 37 (8.83%), backward 180 degree flip 44 (10.50%), and 16 unknown.

This study provided population-based estimates of the frequencies for six classes of operator injury outcomes resulting from overturns of farm tractors without ROPS as well as the types of overturns. The unadjusted probability of death during overturns of unguarded tractors was calculated at 24/443 events or .054. This observed value was adjusted for farms not included in the sampling frame because they had ceased operation as a result of a tractor overturn injury or death. The adjusted probability of death during an overturn of a non-ROPS tractor is .080, a value approximately 5 times smaller that the current commonly accepted value of .44 (CDC, 1993). Accurate estimates of the frequency of overturns and their injury outcomes are needed to calculate the cost-effectiveness of ROPS promotion programs. Previous estimates of the probability of death during overturns of unguarded tractors may be too high. Population-based

estimates of the probabilities of non-fatal outcomes of overturn events have not been available previously.

The frequency and severity of overturn injuries for tractors equipped with ROPS was calculated for the 89 cases in which the injury outcomes were known. Table 1 presents the frequency of the six classes of overturn injury outcomes for tractors without ROPS. Table 2 presents the same data for overturns of tractors equipped with ROPS. Comparing the values in the two tables clearly demonstrates the injury protection provided by ROPS.

Table 3 presents the nearly identical frequency of operators' temporary disability that results from overturn injuries for tractors without ROPS compared to ROPS-equipped tractors. Temporary disability was recorded as the number of days the tractor operator could not engage in his or her regular farm work after an overturn. Permanent disabling injury cases and deaths were excluded from the category of temporary disability. Inspection of Tables 1 and 2 reveals that the frequency of operator temporary disability is about the same for ROPS-protected as for unprotected tractors. However, as can be see from Table 3, the duration of temporary disability is much smaller for operators of ROPS-equipped tractors than for unguarded tractors. This suggests that ROPS dramatically reduce operator injury severity during overturns.

Table 1. Frequency of injury outcomes from overturns of 443 tractors without ROPS*

Overturn injury outcomes for non-ROPS Tractors	Frequency *	Frequency%
No injury or minor injury – no treatment required	312	70.43
Required treatment by doctor/clinic/hospital	97	21.89
Required hospital admission	68	15.35
Resulted in > 1 day to < 365 days of lost work**	60	13.54
Injury resulted in permanent disability	14	3.16
Injury resulted in death	24	5.42

* Frequency values sum to more than the 443 overturn cases because many individuals who were injured and required treatment also required hospital admission, were temporarily or permanently disabled, or died. Conversely, some who died were never treated or admitted to a hospital. The values in the last column are the fraction of persons in each category divided by the total 443 overturn events.

** Days of work lost: M = 97.8, SD = 122.6, Median = 36 (range 364), Mode =365 (8)

Table 2. Frequency of operator injury outcomes from overturns of 89 ROPS-equipped tractors*

Overturn injury outcomes for tractors with ROPS	Frequency*	Frequency%
No injury or minor injury – no treatment required	73	82.02
Required treatment by doctor/clinic/hospital	8	9.00
Required admission to hospital	3	3.37
Resulted in > 1 day to < 93 days of lost work*	13	14.61
Injury resulted in permanent disability	0	0.00
Injury resulted in death**	1	1.12

* Frequency of treatment events sum to more than the 89 overturn cases because individuals who were injured and required treatment also sometimes required hospital admission, were temporarily disabled, or died. The one death was to a 19-year old involved in a roadway

collision overturn. He was admitted to a hospital and died a few days later. The values in the last column are the fraction of persons in each category divided by the total 89 overturn events for which injury outcomes were known

** Days of work lost: M = 21.9, SD = 28.5, Median = 7 (range 92), Mode = 1 (3)

Table 3. Days farm work lost from overturn injuries by tractor ROPS status

Tractor ROPS Status	Mean	SD	Median	Range	Mode
No ROPS (n = 60)	97.8	122.6	36	364	365 (8)
With ROPS (n = 13)	21.9	28.5	7	92	1 (3)

Outputs/Products

This study involved much more than designing and conducting the Kentucky Farm Tractor Overturn Survey. The survey was one of three major activities. The survey data were needed to more precisely define values for "gaps" in an existing ROPS cost-analysis decision-tree model developed by Myers and Pana-Cryan (2000) and Pana-Cryan (2000). Key among these missing values were the frequency and severity of non-fatal injuries that result from tractor overturns and their associated costs. Other key variables included the probability of annual tractor overturns, and the probability of nonfatal and fatal injury in the event of an overturn.

The second major activity involved cost analysis and cost-effectiveness studies of three intervention programs that successfully promoted farmers' acquiring ROPS-protected tractors. All three analyses used the Myers and Pana-Cryan model. The first analysis was of the University of Kentucky community-trials ROPS promotion program conducted during the January 1997 to January 2000 period with two intervention and two control counties. The KY program was found to be cost effective (Myers, et al., 2004). The second analysis was conducted on a natural experiment that occurred during the 1997 – 2000 Kentucky ROPS intervention project. In one control county, an equipment dealer undertook his own ROPS promotion effort after a customer and friend died in an overturn of a tractor without a ROPS. The analysis revealed that the dealers' effort did not have as wide an impact on community attitudes about ROPS but was more cost- effective for promoting ROPS than the larger University directed community intervention project (Myers, et al., in press). Both the equipment dealer's effort and the University's project resulted in significantly more ROPS-equipped tractors than the other control county. The third analysis was conducted using data from the Virginia Farm Bureau statewide ROPS promotion program. That program also was found to be cost effective.

The third major activity followed the analysis and collection of the survey data. This activity involved updating the Myers and Pana-Cryan analytical model with more precise estimates of values for key variables. The revised model was then used to recalculate more accurate cost-effectiveness analyses for the various ROPS promotion programs.

Continued decision and cost-effectiveness analyses are currently underway in order to better understand the distribution of the ROPS-promotion program costs of these three intervention programs and other similar programs. These include the costs to farmers, equipment dealers, and societal costs. The improved precision of the cost-analysis analytic model will be useful for similar cost-effectiveness analyses in other states as policy makers promote retrofitting unguarded tractors with ROPS or their replacement with ROPS-equipped tractors.

Journal articles, professional presentations, proceedings and the one technical report about the project work are listed below.

<u>Journal Articles</u>

Myers, M.L., Cole, H.P., & Westneat, S.C. (2004). Cost-effectiveness of a ROPS retrofit education campaign. *JASH*,*10*, 77-90.
Myers, M.L., Cole, H.P., & Westneat, S.C. (2005). Cost-effectiveness of a dealer's intervention for retrofitting rollover protective structures. *Injury Prevention 11*, 169-173.
Myers, M.L., Cole, H.P., & Westneat, S.C. (2006). Seatbelt use during tractor overturns. *JASH 12*, 43-49.
Cole, H.P., Westneat, S.C., & Myers, M.L. (2006). Frequency and severity of injuries to operators during overturns of farm tractors. *JASH,12*, 127-138.

Professional Meeting Presentations/Proceedings

Myers, M.L., Cole, H.P., & Westneat, S.C. (2003). *Cost-effectiveness of a dealer's ROPS retrofit program.* Paper presented at the National Occupational Injury Research Symposium, October 28. Pittsburgh, PA.
Cole, H.P. (2003). *Farmers' perceptions of ROPS and tractor safety: Studies, stories, and statistics.* Presented at the NIOSH Tractor-Related Injury and Death Meeting, February 13-14. Pittsburgh, PA. (Available in the meeting *Record*, pp. 221-228). Morgantown, WV: NIOSH.
Myers, M.L. (2004). *The evaluation of tractor safety interventions.* Invited paper presented at the NIOSH Great Lakes Center for Agricultural Safety and Health, Improving Agricultural Health and Safety Programs Through Evaluation: Rigorous and Practical Strategies, March 15-16. Columbus: Ohio State University.
Myers, M.L. (2004). *Cost-effectiveness of public health interventions.* Health and Safety Summit, March 23. Jackson: Mississippi State University and the Mississippi Farm Bureau.
Cole, H.P., Westneat, S.C., & Myers, M.L. (2004). Frequency and severity of operator injuries during overturns of tractors without ROPS. *Proceedings of the National Institute for Farm Safety 2004 Summer Conference*. (Technical Paper No. 04-02). Madison WI: National Institute for Farm Safety.
Myers, M.L., Cole, H.P., Stone, E.B., Saacke, R.J., & O'Connell, K. (2004). *Cost-effectiveness of the Virginia Farm Bureau's ROPS incentive campaign.* Paper presented at the Summer NIFS Conference, June 20-24. Keystone, CO.
Cole, H.P., Westneat, S.C., & Myers, M.L. (2006). Ratio of non-fatal to fatal operator injuries for overturns of farm tractors without ROPS. *Proceedings of the National Institute for Farm Safety 2006 Summer Conference*. (Technical Paper No. 04-02). Madison WI: National Institute for Farm Safety.

Technical Reports

Cole, H.P. (2004). *Cost effectiveness of promoting roll-over protective structures (ROPS) and seat belts on family farm tractors.* Final Report, November 29, 2004.

Resources Used/Available

The resources included the following:

- Funds from CDC/NIOSH.
- NIOSH research collaborators John Myers and John Etherton.
- The USDA Kentucky Agricultural Statistics Service (KASS), which assisted in developing the Kentucky Tractor Overturn (KT T/O) Survey, administered the pilot test of the survey, and conducted the statewide survey.

16. Budget

Cost-Effectiveness of Promoting Roll-over Protective Structures (ROPS) and Seat Belts on Family Farm Tractors				
Acct #	Dates	Direct $	Indirect $	Total $
4-71604	9/30/01-9/29/02	44,686	20,000	64,686
4-71872	9/30/02-9/29/03	42,347	18,971	61,318
4-72168	9/30/03-9/29/04	47,591	21,321	68,912*
Totals:		134,624	60,292	**194,916**

* includes carry forward from previous year

17. Stakeholders

Stakeholders for this project include health economists and policy makers interested in cost-effective methods for preventing tractor overturn and roadway collisions through the application of ROPS technology, its promotion and adoption by farmers, equipment dealers, tractor manufacturers, and others. Additional stakeholders include farm community members and the farm business and service agencies that serve these farmers (farm equipment dealers, insurance companies, banks and lenders, health services and hospitals, local factory and other employers were farmers and farm family members hold off-farm jobs, farm supply businesses, farm producer groups, and public schools). All of these groups are deleteriously affected when farm family members and farm workers are injured. All have a stake in lowering and preventing farming-related injuries.

18. Collaborators

Henry Cole, Professor of Preventive Medicine and Environmental Health, University of Kentucky, and Emeritus Professor of Educational Psychology, University of Kentucky.

Melvin Myers, Associate Professor of Preventive Medicine and Environmental Health, University of Kentucky, Adjunct Professor, Occupational and Environmental Health, Emory University, Cost Engineer, and retired CDC/NIOSH commissioned officer.

Susan Westneat, epidemiologist and data analyst, University of Kentucky, College of Nursing

John Myers, senior statistician, CDC/NIOSH, Morgantown

John Etherton, agricultural engineer, CDC/NIOSH, Morgantown

Leland Brown and Bill Brennan, Kentucky Agricultural Statistics Service

19. Intermediate Outcomes

See Outputs/Products section of the Intro/History/Project Success narrative

20. End Outcomes

- Improved tractor overturn injury cost-analysis models and cost-effectiveness models for the role of ROPS and seat belts in preventing overturn injuries.
- Advancing one of the priority areas, the economics of preventing tractor-related injuries, listed as a research and policy objective in the *National Agricultural Tractor Safety Initiative*.

21. Significant Findings

- The frequency and severity of injuries to operators who overturn ROPS and non-ROPS tractors was empirically determined — the first such population-based study results reported in the world's literature.
- The data obtained from the KY Tractor Overturn Survey were used to update parameters in the existing Myers and Pana-Cryan cost-analysis model for tractor overturn injury events making the model more valid.
- In the future, the data provided by the KY Tractor Overturn Survey can continue to be mined and analyzed to help raise and answer additional important research questions.
- Existing values for the probability of operator death during overturns of non-ROPS tractors were shown to be much higher than the values that were empirically determined with this study's population-based survey.
- A more accurate denominator that includes all tractor overturns was calculated. When used with the numerators for six classes of non-fatal injury outcomes, much more accurate cost estimates are possible for each type of injury outcome.
- The net result is a more precise cost-analysis model for tractor overturn injuries and more robust cost effectiveness analyses of ROPS and ROPS promotion campaigns.

22. Emerging Problems

- High costs, few producers, and limited availability of ROPS retrofit kits prevent many farmers with older tractors from acquiring rollover protection.
- An influx of foreign manufactured non-ROPS tractors not marketed by tractor manufacturers or equipment dealers is occurring. The result is increased use of relatively newer tractors for which there are no ROPS suppliers.
- Multiple sets of ROPS engineering design specifications discourage after-market manufacturers from producing and marketing ROPS.

23. Future Directions

- A new proposal based on the success of this project was prepared, submitted, and funded for the 09/01/2005 to 08/29/07 period as part of a priority area set forth in the Agricultural Centers' *National Agricultural Safety Initiative.* That project involves researchers from five of the Ag Centers in an interdisciplinary effort to continue researching the problems related to retrofitting the nations' tractors with ROPS.
- Researchers at the Southeast Center submitted a second five-year proposal to CDC/NIOSH earlier this year. That proposed project combines engineering, economic, policy, and public health intervention methods to develop low-cost ROPS. The goal is to make ROPS a much less expensive and a much more available commodity.

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NIOSH Agricultural Safety and Health Centers. (2004). *National Agricultural Tractor Safety Initiative.* Seattle: University of Washington, School of Public Health and Community Medicine, Pacific Northwest Agricultural Safety and Health Center.

Pana-Cryan, R. and Myers, M.L. (2002). Cost-effectiveness of Roll-over Protection Structures. *Am Journal Ind Med, Suppl 3,* 1-4.

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Southern Coastal Agromedicine Center

Table of Contents

Introduction

The Southern Coastal Agromedicine Center has been very active during the past grant period in promoting the safety and health of our region's agricultural workers. Projects span the range from basic and applied research, e.g., pesticide metabolism studies (Rose), to a variety of prevention, outreach & educational activities, e.g., outreach to prevent pesticide poisoning among tree farm workers (Hamilton). Table A lists all the projects funded by the Center both current and past. There are 11 R01 type projects and 19 R21/Discretionary type projects.

We have used the Center's discretionary funds to explore a number of promising new activity areas. Discretionary projects were selected through a competitive process involving a call for project ideas followed by merit review by the Director and the internal advisory board of the SCAC. Discretionary projects received between $10,000 to 20,000 per project. As expected, there were varying levels of success among the exploratory projects. A number of these, however, were instrumental in the developing our current Center theme; reducing health disparities among migrant, Latino, and minority agricultural workers (Hamilton, Griffith-El Peunte, Ibrahim/Thompson); and initiating a collaboration with the 1890 Alliance of Southeastern HBCUs (Ibrahim/Thompson).

Individual progress reports for our projects appear below organized by the calendar year of first funding. The products of our projects include:

- 25 peer reviewed publications (journal articles),
- 20 other publications (e.g., book chapters),
- many newspaper and electronic media articles,
- 78 formal presentations to scholarly, trade, extension, and community groups,
- 52 outreach/education programs serving 2200 farm workers and those who medically serve them.

Projects begun in 2001

Human Metabolism of New and Emerging Pesticides
PI: Randy Rose PhD, North Carolina State University,
Type: R01 Research

Description:
Specific Aims: To examine the role of specific human xenobiotic metabolizing enzymes in the metabolism of selected pesticides important to agriculture.

1. Establish methods for analytical identification of all test compounds and their metabolites.
2. Determine metabolic pathways and rates of metabolism in human liver microsomes.
3. Determine substrate specificity of recombinant CYP or FMO isoforms relative to the test compounds.
4. Determine the importance of human polymorphisms in identifying populations and/or individuals at increased risk.
5. Examine potential for adverse pesticide interactions by induction of metabolizing enzymes in human hepatocytes using branched DNA signal amplification technology.

Activities/Accomplishments:
Comparative tests for cytotoxicity and apoptosis in the HepG2 cell line and human hepatocytes have been conducted with several pesticides including fipronil, fipronil sulfone, endosulfan, deltamethrin, chlorpyrifos, cypermethrin, fenvalerate and permethrin. Fipronil and its primary metabolite, fipronil sulfone, have the greatest potential for cytotoxicity in human hepatocytes. A preliminary draft of a manuscript, delineating cytotoxicity and human hepatocyte induction studies using bDNA technology in combination with western blotting to document CYP induction by fipronil has been prepared for publication. A second manuscript delineating the results of bDNA and cytotoxicity screening for the other pesticides is under development.

Studies on the metabolism of endosulfan using human liver microsomes demonstrated that endosulfan is metabolized in humans to endosulfan sulfate. A screen of 19 CYP isoforms demonstrated that CYP2B6 is almost exclusively responsible for the formation of this metabolite. Collaborative studies with Andrew Wallace demonstrated that both endosulfan and endosulfan sulfate induce CYP3A4 and 2B6 in human hepatocytes via the pregnane X receptor. Because there are few specific probes for CYP2B6 activity, it is anticipated that endosulfan may be a good probe substrate for 2B6 activity in human samples; therefore additional studies are underway to document this possibility.

Our previous studies indicated that CYP2B6 and 2C19 are important in the intoxication and detoxication of organophosphorus pesticides, respectively. We previously demonstrated that polymorphisms of CYP2C19 abolish detoxication of chlorpyrifos. A literature survey identified several polymorphisms of CYP2B6, several of which affect catalytic activity towards other xenobiotics. Three protocols have been tested to assay for these polymorphisms in CYP2B6 and 2C19. Preliminary tests with human liver samples have identified two polymorphisms found in the CYP CYP2B6*6 allele. This allele has been linked to reduced metabolism of other CYP2B6 substrates such as efavirenz and cyclophosphamide. Since CYP2B6 primarily activates chlorpyrifos to the more toxic oxon, the presence of this allele could be protective. In contrast the presence of the wild-type CYP2B6 allele could result in increased activation. After polymorphisms from liver samples have been identified we plan to prepare microsomes and test their ability to metabolize chlorpyrifos based on genotype. Several liver samples have been recently acquired from the National Disease Research Interchange to be utilized in these studies.

We have also acquired the A549 human lung adenocarcinoma cell line to test its cytotoxic and metabolic response to chlorpyrifos. The MTT [3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide] assay was used to test exposure to chlorpyrifos and two metabolites, chlorpyrifos oxon and 3,5,6 trichloro-2-pyridinol. Only chlorpyrifos was found to have a significant effect. It is postulated that the cytotoxicity of chlorpyrifos in the A549 cell line is due in part to the metabolic production of the reactive sulfur during metabolism to chlorpyrifos oxon. The addition of nicotine was found to be protective against the cytotoxicity of chlorpyrifos. This protective effect was also found in the HepG2 cell line. We have prepared microsomes from the A549 cell line and will test their ability to metabolize chlorpyrifos.

Products:

1) Presentations:

- In vitro metabolism of carbofuran by human, mouse, and rat liver microsomes, and human cytochrome P450 isoforms. K.A. Usmani, E. Hodgson, R.L. Rose. 43rd Annual Meeting of the Society of Toxicology, Baltimore, MD, March 21-25, 2004.
- Study of metabolic interactions of fipronil and some CYP3A4 substrates. J. Tang, A. Usmani, E. Hodgson, R.L. Rose. 43rd Annual Meeting of the Society of Toxicology, Baltimore, MD, March 21-25, 2004.
- Pesticide Metabolism in Humans and the Potential for Metabolic Interactions. R.L. Rose, K.A. Usmani, E.D. Karoly, Y. Cao, N. Cherrington, E. Hodgson. Agricultural Health and Safety Symposium. Keystone, CO, June 21-24, 2004
- Sulfoxidation of thioethers by human cytochrome P450 and FMO isoforms with particular reference to the CYP2C subfamily. K.A. Usmani, E.D. Karoly, R.L. Rose, and E. Hodgson. Advancing the Science of Toxicology and Entomology, Symposium Honoring the Distinguished Career of Dr. Ernest Hodgson, RTP, NC Sept 19, 2003
- In vitro study of fipronil metabolism and its metabolic interaction with testosterone. J. Tang, K.A. Usmani, E. Hodgson and R.L. Rose. Advancing the Science of Toxicology and Entomology, Symposium Honoring the Distinguished Career of Dr. Ernest Hodgson, RTP, NC Sept 19, 2003
- Sulfoxidation of thioethers by human cytochrome P450 and FMO isoforms with particular reference to the CYP2C subfamily. K.A. Usmani, E.D. Karoly, R.L. Rose, and E. Hodgson. ISSX Meeting. Providence, NH Oct 12-16, 2003
- In vitro study of fipronil metabolism and its metabolic interaction with testosterone. J. Tang, K.A. Usmani, E. Hodgson and R.L. Rose. ISSX Meeting. Providence, NH Oct 12-16, 2003

Poster Presentations:

- In vitro sulfoxidation of phorate and methiocarb by human P450 and FMO isoforms. Edward Karoly, Ernest Hodgson, Randy L. Rose. Poster presentation for ISSX meeting, Orlando, FL Oct. 2002.
- In vitro sulfoxidation of phorate and methiocarb by human P450 and FMO isoforms. Edward Karoly, Ernest Hodgson, Randy L. Rose. Pesticides in the Molecular Age, Orlando, FL, Oct 2002.

Invited Presentations:

- Human metabolism of pesticides, Randy L. Rose. Pesticides in the Molecular Age, Orlando, FL. Oct 2002
- Pesticide Metabolisms in Humans. RL Rose. Toxicology Seminar, North Carolina State University, Raleigh, NC, November 2002
- Human metabolism of xenobiotics: Implications for risk analysis. Ernest Hodgson. Pesticides in the Molecular Age, Orlando, FL, Oct 2002
- Pesticide Metabolism in Humans, Including Polymorphisms. International Symposium on Agricultural Exposures and Cancer. Green College, Oxford, England. November 2002.
- Pesticide Metabolizing Enzymes: From Insects to Mice to Humans. RL Rose. Advancing the Science of Toxicology and Entomology, Symposium Honoring the Distinguished Career of Dr. Ernest Hodgson. Raleigh NC September, 2003.

- Pesticide metabolism and potential for metabolic interactions. RL Rose. The Agricultural Health Study Biomarker Workshop on Cancer Biology. Research Triangle Park, NC 2004.
- Usmani, K.A., R.L. Rose and E. Hodgson. Inhibition of the human liver microsomal and human cytochrome P450 1A2 and 3A4 metabolism of estradiol by deployment-related chemicals. Society of Toxicology, 44th Annual Meeting, New Orleans, LA. March 6-10, 2005.
- E. Hodgson and R.L. Rose. 2005. Toxicology of AHS important chemicals. The Agricultural Health Study Biomarker Workshop on Cancer Etiology. Research Triangle Park, NC.
- R.L. Rose and E. Hodgson. 2005. Pesticide metabolism and potential for metabolic interactions. The Agricultural Health Study Biomarker Workshop on Cancer Etiology. Research Triangle Park, NC.

2) Publications:

a) Peer Reviewed Journals:

R.L. Rose, J. Tang, J. Choi, Y. Cao, A. Usmani, N. Cherrington, and E. Hodgson. 2005. Pesticide Metabolism in Humans, Including Polymorphisms. Scand. Journal of Work, Environment and Health 31:suppl 1:156-163.

E. Hodgson and R.L. Rose. 2005. Human metabolism and metabolic interactions of deployment-related chemicals. Drug Metabol. Rev. 1:1-39.

Rose, R.L., J. Tang, J. Choi, Y. Cao, A. Usmani, N. Cherrington and E. Hodgson. 2005. Pesticide metabolism in humans, including polymorphisms. Scandinavian Journal of Work, Environment and Health 31 Suppl 1:156-163.

KA Usmani, ED Karoly, E Hodgson, RL Rose. 2004. In vitro sulfoxidation of thioether compounds by human cytochrome P450 and flavin-containing monooxygenase isoform with particular reference to the CYP2C subfamily. Drug Metab. Dispos. 32:333-339.

J Tang, KA Usmani, E Hodgson, RL Rose. 2004 Invitro metabolism of fiptonil by human and rat cytochrome P450 and its interactions with testosterone and diazepam. Chemico-Biol. Interact. 147:319-329.

KA Usmani, E Hodgson, and RL Rose. 2004. Invitro metabolism of carbofuran by human, mouse and rat cytochhrome P450 and interactions with chlorpyrifos, testosterone, and estradiol. Chemico-Biol. Inter. 150:221-232.

J Choi, E Hodgson, RL Rose 2004. Inhibition of trans-permethrin hydrolysis in human liver fractions by chlorpyrifos oxon and carbaryl. Drug Interact. 20:233-246

RCT Casabar, RL Rose, AD Wallace. Endosulfan induction of CYP3A4 and 2B6 promoter activity via the pregname X receptor (PXR). In preparation.

RCT Casabar, AD Wallace, RL Rose. Indosulfan as a potential substrate for CYP2B6 catalytic activity in human liver microsomes. In preparation.

DC Das Y Cao, N Cherrington, E Hodgson and RL Rose. Fipronil mediates CYP3A4, CYP2B6 and CYP1A1 gene induction and apoptotic cell death in human hepatic cells. In preparation.

PC Das, Y Cao, N Cherrington, E Hodgson and RL Rose. Pesticide induction of CYP isoforms in human hepatocytes. In preparation.

b) Other Publications

E. Hodgson and R.L. Rose. 2005. Toxicology of AHS important chemicals. J. Biochem. Molec. Toxicol. 19:180-181.

R.L. Rose and E. Hodgson. 2005. Pesticide metabolism and potential for metabolic interactions. J. Biochem. Molec. Toxicol. 20:276-277.

3) Short Courses:

Human metabolism of public health-related, deployment-related, industrial and agricultural chemicals. Organizers: Randy Rose and Ernest Hodgson. Jan 10-12, 2005, NCSU, Raleigh, NC (not supported by NIOSH funds).

General Toxicology Short Course. Organizer: Ernest Hodgson. April, 2005. NCSU, Raleigh, NC (not supported by NIOSH funds)

Ergonomic Interventions In The Agriculture Industry
PI: Gary Allen Mirka PhD. Dept Industrial Engineering, NCSU.
Type: R01 Prevention/Interventions

Description:
The specific aim of this project is to develop and test ergonomic interventions for the reduction of the incidence and severity of musculoskeletal disorders among people working in the agriculture industry. The overall process involves 1) identification of high risk jobs/tasks, 2) ergonomic task analysis of these high risk jobs/tasks to identify the specific ergonomic risk factors seen in these jobs/tasks (this includes some basic biomechanical research to better understand the underlying mechanism of injury), 3) prototyping of ergonomic interventions for the reduction of exposure to these ergonomic risk factors, 4) laboratory assessment of the effectiveness of these solutions, 5) fabrication of field-ready ergonomic interventions, and 6) field evaluation of these solutions.

Activities/Accomplishments :
(1) Published a manuscript that evaluates the slip potential risk as farm workers perform repetitive lifting tasks on slippery ground surfaces.
(2) Published a manuscript and conference proceedings that document the lifting technique employed by farm workers when lifting on laterally slanted ground surfaces (side to side slanted surfaces).
(3) Published a study that documents the biomechanical risk assessment of commercial crab-pot fishing operations.
(4) Revised a manuscript that documents the results of a laboratory study focused on strategies to increase likelihood of worker acceptance of ergonomic solutions.
(5) Prepared and revised a manuscript and conference proceedings that documents a laboratory and field evaluation of two prototypes for the process of lifting a newborn calf for weighting and developed two preliminary intervention designs.
(6) On-going development of worker musculoskeletal surveillance systems. Developing a manuscript that describes this work.

(7) On-going evaluation of ergonomic and productivity data collected during field testing of two different systems for improving the ergonomics of pepper harvesting (both cart-based systems).
(8) Collected laboratory data documenting the impact of the tobacco table lift assist device on the postures of the lumbar spine during the sorting and packing operation on a tobacco farm.
(9) Completed data collection/analysis and biomechanical modeling of the viscoelastic properties of the lumbar spine during prolonged stooped postures. Conference proceedings generated and journal articles in development
(10) Began data collection on the biomechanics of front load carriage.

Products:

1. Presentations
(1) Costello and Mirka, (2003) "A Multi-method Approach to Agricultural Occupational Injury and Illness Surveillance and High Risk Job Task Identification for Ergonomic Challenge and Danger/Hazard Characteristics", 2003 ASAE ANNUAL INTERNATIONAL MEETING - July 27 - July 30 2003 - Las Vegas, NV
(Paper # 038023)
(2) Mirka, Shin, Haithcock, and Jiang, (2003) "Ergonomics of Harvesting from Ground Level", 2003 ASAE ANNUAL INTERNATIONAL MEETING - July 27 - July 30 2003 - Las Vegas, NV (Paper # 038021)
(3) Mirka, Shin, Haithcock, and Costello, (2003) "Ergonomics of Harvesting Ground-Level Crops", 2003 International Ergonomics Association Meeting - Seoul, South Korea.
(4) Mirka, Shin, Kucera, and Loomis, (2003) "Assessing Back Stress in Commercial Crab Fishermen", 2003 International Ergonomics Association Meeting - Seoul, South Korea.
(5) Shin and Mirka, (2003) "The effects of sloped standing surface on the hip, knee, and ankle joint kinetics and kinematics during manual lifting tasks", 2003 International Ergonomics Association Meeting - Seoul, South Korea.
(6) Costello, T Floyd, H and Sabella, J, (2004) “Clinic-level Occupational Injury and Illness Surveillance Pilot project” National Symposium on Agricultural Health and Safety, Keystone, Colorado, June 20-24, 2004.
(7) Costello, T and Mirka, G, (2004) “Work related musculoskeletal discomfort (WMSD) Prevention and care brochure, ” National Symposium on Agricultural Health and Safety, Keystone, Colorado, June 20-24, 2004.
(8) Costello, T and Mirka, G, (2004) “Ergonomic benchmarking of North Carolina Field crop production to guide intervention focus and prioritization, ” National Symposium on Agricultural Health and Safety, Keystone, Colorado, June 20-24, 2004.
(9) Southard S, Freeman, J, Drum J and Mirka, G, (2004) “Ergonomic Interventions for the Handling of Livestock”, 2003 ASAE ANNUAL INTERNATIONAL MEETING, Ottawa CANADA, August 1-4.
(10)Jiang, Z., Shin, G., Freeman, J., Reid, S. and Mirka, G. (2005) “Lifting Performed on Laterally Slanted Ground Surfaces” Proceedings of the 49th Annual Meeting of the Human Factors and Ergonomics Society, p.1325-1329.
(11)Shin, G., Mirka, G., and Loboa, E. (2005) “Viscoelastic Responses of Lumbar Spine During and After Prolonged Stooping” Proceedings of the 49th Annual Meeting of the Human Factors and Ergonomics Society, p.1269-1273.

(12)Jiang, Z., Shin, G., Freeman, J., Reid, S. and Mirka, G. (2005) "Lifting Performed on Laterally Slanted Ground Surfaces" Proceedings of the IIE Annual Conference and Exposition, May 14-18, 2005, Atlanta, GA, Paper No. 379.

2. Peer Reviewed Journal Publications

(1) Shu, Y, J Drum, S Southard, G Shin and GA Mirka (2005) "The Effect of a Repetitive, Fatiguing Lifting Task on Horizontal Ground Reaction Forces", *Journal of Applied Biomechanics* 21(3): 260-270.
(2) Jiang, Z, G Shin, JH Freeman, S Reid and GA Mirka (2005) "A Study of Lifting Tasks Performed on Laterally Slanted Ground Surfaces", *Ergonomics* 48(7): 782-795.
(3) Mirka, G, G Shin, K Kucera and D Loomis (2005) "Use of the CABS Methodology to Assess Biomechanical Stress in Commercial Crab Fishermen", *Applied Ergonomics* 36(1): 61-70.
(4) Shin, G, Y Shu, Z Li, Z Jiang and GA Mirka (2004) "Influence of Knee Angle and Individual Flexibility on the Flexion-Relaxation Response of the Low Back Musculature", *Journal of Electromyography and Kinesiology* 14(4): 485-494.
(5) Shin, G and GA Mirka (2004) "The Effects of a Sloped Ground Surface on Trunk Kinematics and L5/S1 Moment During Lifting", *Ergonomics* 47(6): 646-659.
(6) Brandenburg, D and GA Mirka (2005) "Assessing the Effects of Positive Feedback and Reinforcement in the Introduction Phase of an Ergonomic Intervention", Human Factors 47(3): 526-535
(7) Southard, SA, JH Freeman, JE Drum and GA Mirka (Accepted) "Ergonomic Interventions for the Reduction of Back and Shoulder Biomechanical Loading when Weighing Calves", To Appear in *International Journal of Industrial Ergonomics*.

3. Education / Training / Outreach

a. Training Seminars:
(1) Seminar: "NCOSH ERC Seminar: Ergonomic Intervention Effectiveness Research", North Carolina
Occupational Safety and Health, Chapel Hill, NC, January 27, 2005.
b. Academic Training:
(1) 3 PhD students (one graduated in 2005, two on-going)
(2) 3 Master's students (all graduated in 2005)

4. Other Products (cumulative):

A. Project Innovations
(1) Height-adjustable tobacco sorting table (wooden prototype)
(2) Height-adjustable tobacco sorting table (steel prototype)
(3) Tobacco conveyance system (both wet and cured tobacco system design)
(4) Beef calf lifting mechanism – lever system (functional prototype)
(5) Beef calf lifting mechanism – modified handle system (functional prototype)
(6) Pepper harvesting work method / cart mechanism (functional prototype)
(7) Sweet potato harvesting system (laboratory prototype)
(8) Tobacco topping hand tool (laboratory prototype)
(9) Tobacco harvesting hand tool (laboratory prototype)
B. Others
(1) Agricultural Job Task Ergonomic Survey Instrument (Costello)

(2) Clinic Intake Form (Costello)
(3) Work related musculoskeletal discomfort (WMSD) Prevention and care brochure (Spanish and English versions) (Costello)

Factors Affecting Youth Decision-Making Concerning Agricultural Tasks
PI: David Griffith, PhD, East Carolina University
Type: R21 Research

Description:
This study addresses the heightened need for information regarding the ways youths working on North Carolina farms make decisions regarding the hazards of working in agriculture. It is designed as a pilot project to lay the groundwork for a longer-term project that assesses the occupational risks facing young farm workers throughout the U.S. South. Using Rapid Ethnographic Assessment Procedures (e.g. open-ended interviewing, focus groups, social and cultural mapping), project staff are collecting data from African-American, Latino, and White males and females under the age of 18 who are working on farms, as well as from knowledgeable individuals who work with young women and men on the farm. Data collection includes probing about working and living conditions, risks of occupational injury/illness, and the social contexts of injuries and illnesses, etc. Group interviews and other methods are used to flesh out data collected in open-ended interviews. Data will be analyzed by post-coding for SPSS and with the use of a text analysis program, searching for key themes to use in constructing hypotheses for the larger, multi-state project.

Activities/Accomplishments:
1) Griffith has traveled to the target counties in the southeast portion of the state (Duplin, Craven, Bertie, Henderson and Bladen) to observe farming practices and the layouts of farms and to make contacts with local members of the farming communities. Major crop and livestock production on these farms are apples, tobacco, cucumbers, cotton, hogs, chickens and turkeys.

2) The PIs have been collecting background data (census, cropping statistics, etc.) in each of the target counties. Activities and resultant findings include:
    a) Hired farm labor -- Duplin, Henderson, Bladen, Craven, Bertie, Rowan, in that order, were rated most to least dependent on hired labor.
    b) Interviews with 27 male and female youths including Anglo, Hispanic, and African Americans showed that youths engage in a variety of hazardous behaviors in part because they perform the same tasks as adults, are subject to peer pressures, and move between work and play around hazardous areas of the farm.
    c) Interviews were conducted with over 30 other persons knowledgeable about farming practices and youth in the target counties to examine hazardous tasks and the use of protective equipment.
    d) Transect walks on farms (walks through farms with youth and farm owners to locate hazards) revealed that many hazards are not perceived as hazardous by youths or farm operators, (e.g. small machinery like weed eaters or lawn mowers, livestock confinement areas, or livestock).

Products:

Presentations:

- "Immigration and Rural Health" Seminar given at Iowa State University, March 5, 2003.
- "Occupational Health Among Youth in Agriculture." ECU Agromedicine Center, NIOSH site visit, July, 2003
- "Work, Occupational Health, and New Immigration into small U.S. rural communities." Rural Sociology Meetings, Montreal, Canada, July, 2003 and Metropolis conference, Vienna, Austria, October, 2003.

Publications

- "From States with Pretty Names: Guest Workers in America" (2006) Griffith, D. Penn State University Press, In Press

Other:

- 3 research proposals prepared and submitted: one on conditions of children in agriculture (with Aguirre International) and two on the use of alternative health care among rural workers. None were successful.

Farm Vehicle Public Road Safety
PI: Michael Schulman, PhD, NC State University
Type: R21 Research

Description:
The long-term objective of this project is to address NC farmer's health and safety concerns about the risk of farm vehicle safety of public roads. This problem is increasing as the urban population moves out into traditional rural areas. This project is a state-wide study of farmers regarding farm vehicle risk factors and behaviors leading to crashes and near misses on public roads. A randomized population-based case control study design is being used, targeting 400 NC farmers by phone survey. Cases are NC farmers reporting a farm vehicle crash within the last 12 months (obtained from NC accidents reports). Controls are selected from the NC farmer population using a stratified randomization sampling strategy.

Accomplishments in 2002:
1) Survey Instrument and Measurement
The draft survey instrument submitted as part of the original proposal has gone through several stages of refinement and development. We have received feedback from other researchers and are currently conducting some informal pre-tests with farmers. In particular, we have clarified and refined the constructs and the measurement of those constructs.

2) Crash Data: Three stratas were identified (based on per 100,000 county population farm vehicle crash rates). Eleven counties fall into either a high (7 counties) or medium (4 counties) crash rate group and account for over 30% of total crashes reported 1999 (average 300 crashes per year in NC). The remaining crashes (approximately 70%) are in the low crash rate group (89 counties).

The project is a case control study using cases of farm vehicle crashes and controls randomly selected from the general farm population. We met with and the University of North Carolina Highway Safety Research Center, the NC Department of Labor, the Applied Research Group of NCSU, the NC Department of Transportation and the NC Division of Motor Vehicles. A request to have special permission to receive files from the NCDMV to use for the crash case was submitted

and approved. Through the NC Department of Labor, we have been given access to a special file on NC farmers to identify the controls. While name and address information was received, a special request to receive phone numbers is currently under review.

3) Survey Administration:
Our original purpose called for the survey to be administered in early spring 2002. This was not accomplished and we have rescheduled the survey for early spring 2003. The telephone survey has been pre-tested with subjects in the farm community prior to fielding.

4) Additional Data Collection Efforts:
A survey was conducted among 193 farmers attending the 2002 Southern Farm Show, to test questions regarding perceived risk and safety behavior and obtain initial data on variables such as vehicle miles traveled. Another pilot Study is being conducted among NCSU transportation human factors students to provide data on farm vehicle public road safety from the perspective of non-farm vehicle operators.

5) Manuscript in Preparation:
"North Carolina Farm Vehicle Public Road Crash Danger and Safety Behavior" (previous study).

Accomplishments in 2003:
1) The questionnaire for the farm vehicle public road safety project interviews was given to the NCSU Center for Urban Affairs for pre-testing and for entry into the Computer Assisted Telephone Interviewing Systems. After pre-testing, changes were made in questionnaire length, wording and organization. Using a database on farm operators in NC, we drew random samples of NC farm owners and farm operators.

2) Interviewing of farmers with the final questionnaire began in February. The 200 controls (farmers without a farm vehicle crash in the last 10 years)were completed quickly. It took additional time and calls to find the 200 cases (farmers with a farm vehicle crash on a public road in the last 10 years), but the case interviews were completed in December. The data is currently being coded into SAS data sets for statistical analysis.

3) In addition, we conducted interviews at the Southern Farm Show in January with a short Questionnaire on perceived risks of using farm vehicles on public roads.

Accomplishments in 2004:
Data analysis including basic descriptive statistics completed. Multivariate statistical analysis progressing. Preliminary findings disseminated in reports and professional meeting presentation. Journal articles being drafted.

Products:

1. **Presentations**:

- Costello, T., & Wogalter, M. Driver Attitudes, Beliefs and Reported Behavior Associated with Sharing Public Roads with Farm Vehicles. HFES 47th Annual Meeting, Denver, CO, October 13 – 17, 2003.
- Costello, T., & Schulman, M. Risk Factors for a Farm Vehicle Public Road Crash. 2004

National Symposium on Agricultural Health and Safety. Keystone Resort, Colorado, June 20-24, 2004, 2003.

- Schulman MD, Costello, TM "Risk Factors of Farm Vehicle Public Road Crashes " Paper presented at the NIOSH OEP Site Visit University of Kentucky, Lexington KY December 2004
- Costello TM, Schulman MD "Risk Factors of Farm Vehicle Public Road Crashes" Paper presented at the 2004 National Symposium on Agricultural Safety and Health. Keystone CO June 2004

2. Publications:

Refereed:

- Costello, T, Schulman, MD, Luginbuhl, R, (2003) "Understanding the Public Health Impacts of Farm Vehicle Road Crashes in North Carolina" Journal of Agricultural Safety & Health 9(1):19-32

Other

- Costello, T., & Wogalter, M. (2003). Driver Attitudes, Beliefs and Reported Behavior Associated with Sharing Public Roads with Farm Vehicles. Proceedings of the HFES 47th Annual Meeting.
- Schulman, M.D. and Slesinger, D. (2004). "Health Hazards of Rural Extractive Industries and Occupations." Pp 49-60 in N. Glasgow, L. W. Morton, and N.E. Johnson, eds., Critical Issues in Rural Health. Ames, Iowa

Skin Disorders in Commercial Fishermen

PI's: William Burke MD, East Carolina University Brody School of Medicine
David Griffith, PhD, East Carolina University

Type: R01 Prevention/Intervention

Description:

Commercial fishermen experience a higher incidence of skin disorders than those who work in other industries. However, fishermen have proven to be a difficult population to reach with health care. This is due in part to low levels of health insurance, problems with access to appropriate health care providers, and the demands of their jobs. This project will develop educational materials, based on research among commercial fishermen's key sources of information, to point out and reduce the risks of skin disorders among people who work on the water. Project personnel will conduct skin screening sessions in North Carolina, Alabama and Maryland. Specific objectives are:

- To hold educational/screening sessions in North Carolina, Maryland and Gulf Coast (Alabama/Florida) targeting commercial fishermen.
- To conduct a survey of commercial fishermen regarding their skin disorders.
- To develop and disseminate educational materials to educate commercial fishermen about the dangers of working on the water.

Activities/Accomplishments:

Accomplishments in 2002:

Skin disease screening was done at:

1) Commercial Fishing Show, New Bern, NC, February 23-24, 2002.

2) Engelhard Seafood Festival, May 18, 2002
3) Hoboken Blessing of the Fleet, June 15, 2002
4) Swansboro Mullet Festival, October 13, 2002
5) Millcreek Oyster Festival, November 2, 2002

A total of 432 individuals were screened, 9% of whom were commercial fishermen. Data was collected on the history of skin disorders among those screened. Data is being entered into a central database over the course of the project. The seafood festivals tended to have few fisherman attendees than expected. The research team has met with several individuals to narrow down our list of shows, festivals, and other activities where we may best intercept fishermen for future screenings. In addition, the team initiated contact with members of commercial fishing auxiliary groups for their assistance with potential future screening sites.

Dr. Griffith has begun collecting data on the various places and ways fishermen receive health information, and the ways they engage the medical profession, through open-ended interviewing in fishing communities, particularly among crabbers and shrimpers, the two largest groups of fishermen in the state.

Accomplishments in 2003:
Skin disease screenings were done at the Commercial Fishing Show, New Bern NC, Feb 22-23, 2003.

Accomplishments in 2004:
Completed survey and analysis of data from survey for commercial fishermen in North Carolina, Virginia and South Carolina. Continued in-person screening/educational sessions in Alabama (May 1-2, 2004).

Products:
Presentations:
- June 2004 National Symposium on Agricultural Safety and Health (Keystone Resort, CO): "Skin Disorders in Commercial Fishermen" presented by Dr. David Griffith.

Publications: Refereed
- Burke WA, Griffith DC, Scott CM, Howell ER. Skin problems related to the occupation of commercial fishing in North Carolina, NC Medical Journal (in review).

Publications: Other
- Articles on skin disorders of fisherman published in Coastwatch and NC Sea Grant "Blueprint

Hydration Methods in Preventing Heat Disorders in Field Workers
PI: John Sabella, EdD**,** East Carolina University
Type: R01 Research/Intervention

Description
Concerned by the increasing reports of heat related illness, researchers in this project are conducting a study to assess impact of different fluid intake protocols on the physiological health status of farm workers, primarily Hispanic working in produce and tobacco field operations in

high heat conditions. The study builds on baseline assessment data collected through a grant funded by the United States Department of Agriculture in 2000-2002. NIOSH supported the intervention component of the study 2003-2005.

Information gained from this study will be useful in identifying and incorporating best management practices in the field aimed at maintaining and/or improving workers' sense of well-being, their cognitive function, and their productivity. In addition, educational programs/materials based on findings of these studies potentially will benefit both farm workers and farm owners by promoting health, preventing heat-related illness, and increasing productivity.

The research team is comprised of a nurse, a culturally competent bilingual interpreter, and a trained assistant for collecting physiological measures from each subject every two hours during the workday. An Industrial Engineering team member documents data related to heat load obtained from environmental instruments at three locations in the field. Physiological measures of temperature, pulse, respirations, blood pressure (supine and standing), and cognitive function are taken from each study participant at two-hour intervals throughout the workday. Observations regarding appearance (clothing worn, perspiration, etc.) as well as self-reported data such as foods eaten and hydration activities the night and morning before reporting to work are also recorded. Worker productivity is measured by tracking the number of buckets picked over the period of the workday.

Accomplishments:
In 2003-4 one hundred and nine farm workers (mean age 31years) were observed in the filed for a total of 268 person –observation days. Data was collected from three main sources. The enrollment form was used to gather information on demographics, general health status, and previous work experience. Daily sheets were completed by the field team to record information from assessments made before work began, at two hour intervals during the work day, and at the end of the work day. Physiological measurements taken included: pulse, respirations, lying and standing blood pressures and tympanic temperatures. Workers were also questioned regarding signs and symptoms related to potential health stress. Environmental monitoring of heat measurements was conducted using two to four instruments in the fields throughout the work day. Each instrument provided a record with readings for dry bulb, wet bulb, relative humidity and heat index every five minutes for one to three sessions during the day, with around 35 records being made per session.

Each day in the fluid intervention component of this study, in addition to what the workers drank on their own initiative, some received supplemental fluids. Approximately one-third of the workers received 8 ounces of water at the end of each assessment period and one-third received 8 ounces of Gatorade. The remaining workers were not offered any additional fluids.

Conclusions: Based on the findings of the 2004 and 2005 years of study, the following preliminary conclusions can be made:

- If field conditions for workers are carefully monitored, with appropriate administrative controls used to allow breaks for fluid/food consumption, the relatively young, healthy workers in our study tolerate well hot, humid summer field conditions.

- Workers have very limited knowledge of the signs and symptoms of heat related illnesses. Workers generally were able to correctly identify only two of 12 signs or symptoms related to various levels of heat stress.

- H2A workers are usually young, healthy Hispanic males from Mexico with few pre-existing health problems. The median age was 30.4 years (range 20-49).

- Supplementation of usual fluid intake by an average of 24 to 32 ounces (8 ounces given at three to four different times during the day) had no significant effect on vital signs or productivity. Supplementation with made from two to five times during a day with one third of the workers receiving water, one-third receiving Gatorade and one-third receiving no additional fluids beyond what they drank on their own initiative. There were few statistically significant differences and no clinically significance differences found in tympanic temperature, pulse, respirations, or blood pressure. Productivity was also unaffected.

- No serious adverse health effects were noted for any worker during 268 POD (Participant Observer Days) over the two years studied. There were some reports of muscle spasms, fatigue, headache, and nausea. There were no reports of vomiting, confusion, above normal temperatures or other signs/symptoms of heat stress.

- Existing environmental temperature monitoring equipment is difficult to use in field work environments. Multiple units are necessary to accurately profile field conditions. Each unit requires ongoing maintenance and monitoring by dedicated personnel to ensure accurate performance. Multiple types and numbers of measurement require analytical interpretation.

In an attempt to further define and describe the relationship among variables, key self-reported and measured physiological indicators of heat stress were plotted against the daily heat index. It appears that this heat stress index establishes a measurable relationship between the heat severity of the day and the level of heat stress experienced by the worker. There is an upward trend in overall worker stress as the severity of the heat index rises.

Currently secondary analysis is being conducted on subsets of subjects from each year and the combined data from both years. The heat stress index is being further tested for reliability and validity. Also being further examined is the preliminary conclusion of this study.

Other accomplishments for 2003-5:

- Met with potential growers to gain permission to have access to their farms and field workers for the study
- A data analysis expert has been contracted to perform statistical analysis of current data and to ensure the database is consistant in preparation for 2004

assessments

- Recruited Heat Stress Team members for 2004-5 assessments
- Trained Heat Stress Team members on all phases of the assessment procedures
- Contacted farmers and gained assess to four farms for conducting 2004 Heat Stress assessments
- Upgraded and improved our study data base with the assistance of representatives of the Bio Statistics Department at ECU
- Completed all 2004-5 field assessments
- Worked with Bio-Statistical faculty at ECU to assist with the development of the data base
- Data analysis continuing

Products

Presentations

Presentation of Heat Stress Study, El Foro, State-wide gathering of Hispanic Farm workers, Durham, NC, April 6 & 7, 2002.

Presentation of Heat Stress Study Project, Department of Labor Board of Advisers Meeting, Raleigh, NC, July 11, 2002.

Presentation, Assessing Heat Stress in Agriculture Field Workers, Dr. Karen Elberson, 13th International Nursing Research Congress, July 24-26, 2002, Brisbane Sheraton, Greensland, Australia.

Preventing Heat Stress in the Field, Migrant Fiesta, Migrant Education Program, Greenville, NC, September 7, 2002.

Dr. Karen Elberson, " Assessing Heat Stress in Agriculture Field Workers", 13th International Nursing Research Congress, July 24-26, 2002, Brisbane Sheraton, Greensland, Australia.

Assessing Heat Related Illness in Field Crop Workers in North Carolina, Carol Maxwell Ph.D. 2004 National Symposium on Agricultural Health & Safety, Keystone, CO. June 11, 2004

Hydration Methods in Preventing Heat Disorders in Field Workers, Dr. John Sabella/Dr. Susan Gustke. Golden Leaf Growers Meeting, Mt. Olive College, February 28, 2003

Hydration Methods in Preventing Heat Disorders in Field Workers, Dr. John Sabella/Dr. Susan Gustke. Golden Leaf Growers Meeting, Strickland-Dail Dining and Catering

Hydration Methods in Preventing Heat Disorders in Field Workers, Dr. John Sabella. Semana de Agricultura Organica, Montevideo, Uruguay. June 5, 2003

Hydration Methods in Preventing Heat Disorders in Field Workers, Dr. John Sabella Presentation to Physician Assistant Students, East Carolina University, July 6, 2003

Publications:

"Research Aim at Heat Illness among Farm Workers", People, Publication of University Health Systems of Eastern North Carolina and the East Carolina University Division of Health Sciences, July/August 2002

"Assessing Heat Stress in Agricultural Field Workers", The Cultivator, The Bulletin of the Agriculture Safety and Health Bureau, Number 20, October 2002

"Project Tries to Lessen Likelihood of Heat Stress", Edge Magazine, East Carolina University Research and Creative Activity, Spring 2003

Assessing Heat Stress in Agricultural Field Workers, Edge Magazine, East Carolina University, August 1, 2004

Heat Stress Study to Help Migrant Farm Workers. The East Carolinian, East Carolina University Student Newspaper, July 7, 2004

Breaking a Sweat; ECU-based researchers near end of 4-year heat stress study. The Daily Reflector, Greenville, NC. August 9, 2004

Educating Agricultural and Health Practitioners About the Agricultural Health Study
PI: Julia F. Storm NC State University
Type: R01 Education

Description
The Agricultural Health Study (AHS) is a large (90,000 participants), prospective cohort study of farmers and farm families in North Carolina and Iowa and is being directed by investigators from the National Cancer Institute, the National Institute of Environmental Health Science, and the Environmental Protection Agency, in collaboration with the National Institute for Occupational Safety and Health, Battelle Centers for Public Health Research and Evaluation in North Carolina and the College of Public Health at the University of Iowa. It is the largest epidemiological study of agricultural chemical exposures and potential adverse health outcomes conducted to date in the United States, and the only one that is prospective in design. Because the Agricultural Health Study is a landmark study of agricultural exposures and health outcomes, the investigators and collaborators of this education project, as well as the principal investigators of the AHS, think it is paramount that the agricultural community and the health care providers who serve them be fully informed of the findings of the AHS and their implications for work practices and preventive care. This education project (Educating Agricultural and Health Practitioners about the Agricultural Health Study) has received enthusiastic support for and cooperation from the scientists conducting the Agricultural Health Study.

The long term goal of this education and outreach project, Educating Agricultural and Health Practitioners about the Agricultural Health Study, is to increase the awareness, knowledge, and understanding of the Agricultural Health Study among the following primary audiences: the agricultural community, Extension educators, and rural primary health care providers. The

overall objective of this project is to develop and disseminate educational materials and training, designed specifically for these audiences, in collaboration with AHS principal investigators, AHS field directors, and collaborating agricultural and health educators.

Specifically, the educational materials to be developed to meet these goals and objectives include:

- Print and on-line publications for the agricultural community and Extension educators summarizing and synthesizing the major findings of the Agricultural Health Study published through 2004,
- Presentations for the 3 major audiences: agricultural community, Extension educators, and rural health providers;
- A "frequently asked questions" document for lay and professional audiences in PDF format for on-line access,
- An interactive, online (web-based) feature called "ask the specialist" to facilitate answers to questions from the public by the AHS investigators, and
- Resources for Spanish-speaking agricultural workers.

The specific delivery and dissemination objectives of the project include:

- Delivering information and educational sessions, continuing professional education, and train-the-trainer sessions to agricultural and health provider audiences, primarily in the Southeast and, to a limited extent, throughout the United States;
- Posting materials for on-line access; and
- Sharing educational materials produced through this project with collaborators in Iowa.

Project tools:
For agricultural community and extension educators:
Storm, J.F., W.G. Cope, W.G. Buhler, K. McGinnis. Understanding the Agricultural Health Study. A PowerPoint presentation with speakers notes. September 2004.

For health providers:
McGinnis, K. A. Branigan, S. Gustke and J. Storm. Pesticide Related Illness and Health Issues, an on-line health provider continuing education course (funded primarily through other sources, but based on training developed through this grant; development version 8 produced September 2004; scheduled to go online in January 2005)

Accomplishments
The major project products were reviewed, revised and published during 2004. Agricultural Health Study Executive Committee members were highly involved in the review of educational materials throughout their development and expressed enthusiastic support for these materials. Representatives of all target audiences reviewed educational materials and feedback was incorporated during the development of educational materials. Feedback on all educational materials was positive.

Presentations on the Agricultural Health Study were made on 8 occasions during the project period to audiences including Extension educators, pesticide regulatory personnel, pesticide applicators (farmers and commercial applicators) and health and safety professionals from the United States and Canada. Overall, project outcome evaluation indicates a significant increase in awareness and knowledge among the members of these target audiences, with an overall increase in awareness of 89% (234 out of 264 training participants evaluated). It is estimated that 600 individuals, including Extension educators, other health and safety professionals, and agricultural community members were reached through Year 3 training sessions and educational presentations. A one-day in-service training for North Carolina Cooperative Extension Field Faculty (agents) responsible for pesticide applicator training in their counties was delivered on May 18, 2004. Educational materials developed through this project were introduced at this training. In addition, Principal Investigators and Study Coordinators for the NC Field Office of the Agricultural Health Study presented scientific findings from the study and served on a discussion panel. Funding acquired competitively from the NC Cooperative Extension Service provided travel funds for Extension agents to attend the training. Workshop evaluation showed that over 80% of attendees found resources beneficial and 87% increased knowledge as a result of the workshop. The PowerPoint presentation and other educational resources for agricultural audiences will continue to be delivered and disseminated to state pesticide safety education coordinators in the United States and to county Extension agents in North Carolina throughout the remainder of 2004 and beyond. In addition, the principal investigator of the project served on the Program Committee for the 1st Professional Development Conference, "Pesticide Toxicology and Risk Assessment" of the American Association of Pesticide Safety Educators (AAPSE) held June 9-10, 2004 in St. Louis, MO. The Agricultural Health Study was featured in this professional development course attended by about 30 Extension educators.

During 2004, grant funds from other sources were used to extend the educational resources for health care providers developed through this project (based on the on-site continuing medical and nursing education course entitled Pesticide Related Illness and Health Issues held in Greenville, NC on November 22, 2002 which offered 5 credit hours of continuing medical education and 6.1 hours of continuing nursing education). Pesticide exposure and chronic health effects findings of the Agricultural Health Study were incorporated into the course content. The one-day, on-site training was used as the basis for the development of a 3 hour on-line health provider continuing education course, with funding from other sources. The on-line course will be offered for at least one year for continuing education credit to health providers throughout the United States for a nominal charge (~$25) through the North Carolina Area Health Education Center (AHEC) Program's AHEConnect service beginning January 2005. Outside funding allowed for the development of a course addressing the full breadth of the pesticide health area, not just the chronic health findings of the Agricultural Health Study, considered the most effective way to meet the continuing education needs of busy health providers. Both courses were designed to fulfill objectives outlined in the National Pesticide Competency Guidelines for Medical & Nursing Education and the National Pesticide Practice Skills Guidelines for Medical & Nursing Practice published by the National Environmental Education and Training Foundation.

Products

1. Presentations

- Pesticide Exposure and Human Health, Julia F. Storm, Pesticide Applicator Recertification Training, Burlington, NC, December 3, 2003. (133 participants)
- Understanding the Agricultural Health Study (1993-2003), Julia F. Storm, Annual Meeting of the N.C. Aerial Applicators Association and Aerial Applicator Recertification Training, Williamston, NC, February 19, 2004. (41 participants; 93% response rate on evaluation; outcomes: 42% increase in awareness, 95% increase in knowledge and understanding)
- Communicating the Agricultural Health Study to the Agricultural Community, Julia F. Storm, Annual Meeting of the Agricultural Health Study National Advisory Panel, Bethesda, MD, February 26-27, 2004 (69 participants)
- Understanding the Agricultural Health Study and the Farm Family Exposure Study, Julia F. Storm, W. G. Cope, W. G. Buhler, R. McRackan, NC Cooperative Extension Long Range Plan Training, Raleigh, NC, May 18, 2004. (50 participants; outcomes: 87% increase in knowledge)
- Understanding the Agricultural Health Study, Julia F. Storm, Annual Meeting of the Southern Region Pesticide Safety Education Program, Asheville, NC, June 13-16, 2004 (40 participants)
- Educating Agricultural and Health Practitioners about the Agricultural Health Study, Julia F. Storm, W.G. Cope, W. G. Buhler, K. McGinnis, 2004 National Symposium on Agricultural Health and Safety, Keystone Resort, Colorado, June 20-24, 2004 (250 participants)
- Overview: Southern Coastal Agromedicine Center and NC Cooperative Extension Farm Safety and Related Projects, Julia F. Storm, Southern Region Extension/NIOSH Centers Joint Farm Safety Symposium, Nashville, TN, May 10-12, 2004 (35 participants)
- Understanding the Agricultural Health Study, Julia F. Storm, Southern Extension Research Activity -19 Rural Health Meeting, New Orleans, LA, October 13-15, 2004 (18 participants)

2. Publications (peer reviewed):

- Storm, J.F., W.G. Cope, W.G. Buhler, K. McGinnis. Understanding the Agricultural Health Study, Part 1: Overview. Publ. No. AG-MED-24. NC State University, North Carolina Cooperative Extension Service, Raleigh, NC. 6pp. September 2004.
- Storm, J.F., W.G. Cope, W.G. Buhler, K. McGinnis. Understanding the Agricultural Health Study, Part 2: Pesticide Exposure. Publ. Nos AG-MED-25. NC State University, North Carolina Cooperative Extension Service, Raleigh, NC, 8 pp. September 2004.
- Storm, J.F., W.G. Cope, W.G. Buhler, K. McGinnis. Understanding the Agricultural Health Study, Part 3: Health Findings Publ. No. AG-MED-26. NC State University, North Carolina Cooperative Extension Service, Raleigh, NC, 6 pp. September 2004.
- Storm, J.F., W.G. Cope, W.G. Buhler, K. McGinnis. Understanding the Agricultural Health Study, http://extension.tox.ncsu.edu/
- Storm, J.F. 2005 "Understanding the Agricultural Health Study." NC Sate University, North Carolina Cooperative Extension Service, Raleigh NC 1 October 2005. http://extension.tox.ncsu.edu/4_presentations.htm

Timber Medic Certification
PI: Juan March, MD, East Carolina University
Type: R01 Education

Description
Logging is one of the most hazardous occupations in the country with a high incidence of death or permanent disability associated with injuries. The forest logging operation is a very difficult environment in which to affect a rescue and is a very foreign environment for most emergency medical personnel. The proposed Timber Medic Training project will develop a certification course for emergency medical technicians (EMTs) that includes a field component working with logger equipment and with loggers acting as first responders in simulated rescues. The training program will be delivered through the community college system. There will also be a "Train the trainer" component to provide adequate numbers of instructors.

The effectiveness of the training will be evaluated two ways. Pre and post course testing for content will evaluate the value of the course content. To evaluate the impact of the training on actual rescue outcomes, EMT's and logger "first responders" at actual rescue events will be surveyed and data will be collected on medical outcomes. Rescue events in which the responding EMT's were Timber Medic Certified will be compared to those where the EMT's did not have training.

Accomplishments
2001-2002
- Through survey at the 2001 Logging Show, loggers perceived emergency/rescue and safety issues were identified. This information confirmed appropriateness of specific key training objectives the project team planned to address in the Timber Medic program curriculum.
- November 2001 through January 2002, complete prototype curriculum developed.
- February 2002, prototype curriculum presented and critiqued.
- September 2002, final stage curriculum presented and critiqued.
- September 2002, photo shoot at a live logging site. Photos of loggers working together with Emergency Medical Services personnel, logging equipment, and logging hazards.
- September 2002, photos of real trauma injuries obtained.
- September-October 2002, flyers (brochures) of the first two Timber Medic courses made available at the State EMS Conference

2002-2004
Since the inception of the Timber Medic program, safety and training issues were identified. The information confirmed the specific key training objectives to be addressed by the Timber Medic program curriculum. The revisions in presentation, photographs, illustrations and wording have enhanced these objectives in the curriculum. Brochures and flyers were distributed and five courses were presented during October 2003 through May 2004. Numerous community college and rescue-fire agencies have expressed interest in hosting a Timber Medic program. Potential instructors have expressed interest in expanding the course program

throughout the State of North Carolina. The final program cycle saw an administration change within the NC Forestry Association, thus leaving a period of time with limited course promotion and delivery. The proposed Trainer-the-Trainer program for potential instructors was discussed but was not able to be completed during this final grant period. The shortage of instructors limited the number of courses that could be presented throughout the State of NC. The expansion of the Timber Medic program may continue with the monitoring of potential instructors and further promotion of the curriculum through the distribution of brochures and flyers to community colleges, fire and rescue agencies, logging firms, forestry agencies, and related conferences.

Final revisions of the curriculum; an educational track over viewing the Timber Medic course program was presented at the NC State EMS conference, EM Today, October 2003; five courses were scheduled and taught (Beaufort Community College, Stanley/Anson Community College, Alamance Community College, Ridgeway VFD and Vance/Granville Community College). A student CD-ROM was developed, reproduced, and mailed to 158 students who have completed the Timber Medic course program since its inception. A course evaluation and an instructor evaluation form was mailed to all course participates (158). Evaluations returned indicate the Timber Medic course program is "generally" to "very" interesting and helpful in increasing safety awareness and patient care.

Products
Presentations:

- Meetings Presentations: presented at the NC State EMS conference, EMT Today in October 2003

Education / Training / Outreach

- Project Products: Timber Medic Curriculum CD-ROM for the student (MS PowerPoint); Evaluations; Flyers (Brochures)

Cultural Ergonomics To Eliminate Pesticide Exposure
PI: Tonya L. Smith-Jackson, PhD, Virginia Tech University
Type: R01 Prevention

Description
AIMS: Specific Aim #1: Psychometric instruments assessing locus of control and self-efficacy will be used to compare risk perception of migrant and seasonal farm workers who are language and ethnic minorities to non-minority farm workers.
Specific Aim #2: To identify user-centered design guidelines for pesticide warning labels based upon the characteristics of ethnic and language minority groups and conduct a heuristic evaluation of the usability and effectiveness of the design guidelines.
Specific Aim #3: To disseminate design guidelines in the form of a warning design specification to employers, safety and training groups, minority-serving agencies, and community-based advocacy and education groups.

Description

The Cultural Ergonomics Project has completed Specific Aim 1 and has completed all of Specific Aim 2, with the exception of the Goal 1, which had to be terminated due to the project cycle ending on 9/29. The funds for the project in the initial budget period were allocated 5 months after the contracted time line, causing a loss of participants. Our participant base is highly nomadic, and due to seasonal migrations, we had to postpone data collection until the end of year 1 (when migrant workers returned to this region and we could use our limited travel funds to conduct data collection activities). In Specific Aim 2, due to the seasonal problems, we altered the order of events, such that the comprehension testing and prototype brochures and pesticide labels would be tested for comprehension before the elicitation procedure was done. We were driven by the need to recruit farm workers early in the farming cycle (spring of 2004) so that we would not get behind schedule during the migration season of early fall. Because funding ended in September, we were not able to travel during the harvest month of October, which would have served as an ideal time for data collection.

With the gracious assistance of travel funds from the Agromedicine Center, we were able to travel to Jacksonville, Florida from March 19 – 21 with 3 additional undergraduate students. This trip supported our urgent need to collect data from Latino farm workers early in the Spring farming season. We collected data from 71 Latino farm workers and 7 African-American farm workers. The African-American farm workers were added to the project in order to at least pilot test the perspectives of a second ethnic minority group. The pilot data will be used to support further studies with African-American and Afro-Caribbean farm workers. In addition, NC State collected data from 48 white farm workers in the Wake and Durham county areas of NC. The data from Specific Aim 2 have not yet been fully analyzed; however, I have attached some of the qualitative data from interviews and some of the guidelines we used to develop test stimuli. Specific Aim 1 results were reported in the 2003 annual report, but are also attached to show the findings thus far. Total number of participants thus far = 136.

1. Completed Specific Aim 1 and analyzed data.
2. Developed test stimuli from SA1 results and guidelines developed from SA1 and literature review.
3. Completed comprehension testing of culturally centered prototype brochures and pesticide labels and usability testing of prototype prevention information.
4. Completed pilot interviews of 7 African-American farm workers.
5. Specific aims 2 and 3 are not completed
6. Searchable ACCESS Database to support culturally centered design of prevention information related to pesticides and label design.
7. Will require a 6 month extension beyond 9/2004 due to initial delays in project funds and data collection.

   Initial time table in project proposal follows:

Objective/Aim	Activities	Effort in Months
1. Psychometric instruments assessing locus of control and self-efficacy will be used to	1. Develop and validate Spanish language versions of psychometric instruments. 2. Assess risk perception, locus of control, self-efficacy in minority and non-minority	14

compare risk perception of migrant and seasonal farm workers who are language and ethnic minorities to non-minority farm workers.	farm workers. 3. Assess effects on comprehension and intent to comply.	
2. Identify user-centered guidelines for pesticide warning labels based upon cultural needs and preferences.	1. Design elicitation instrument. 2. Identify guidelines. 3. Assess warning design effectiveness.	13
3. Disseminate design guidelines through warning design specifications and educational tools.	1. Design guidelines using heuristic analysis and expert review. 2. Disseminate knowledge products.	9

We are in Objective/Aim #2 and are completing step 1 (steps 2 and 3 have already been completed). Objective/Aim #3 has not begun.
Products include:

1. Culturally centered information brochures in English and Spanish for farm workers. These will be based upon usability testing and are cognitively and socially valid for Latino farm workers.
2. Culturally centered prototypes of pesticide labels in English and Spanish for farm workers. These will be based upon usability testing and are cognitively and socially valid for Latino farm workers.
3. Specifications and guidelines to support further efforts to design culturally centered risk communications.
4. Data in the form of usability problems with existing prevention literature.

A final report identifying the factors associated with culture, hazard exposure prevention, and pesticide warning label design will be disseminated to various groups who impact exposure prevention and education. This report will consist of content explaining the factors, identifying those designs that are likely to have the greatest impact on prevention and knowledge of hazards, recommendations, and information on methods to apply to guidelines to the design of other risk communications. In summary, this research will produce recommendations for format and content of warnings and how to build on existing knowledge and attitudes when designing warnings.

Specific Aim 1 Summary:
The preliminary research conducted so far includes 40 participants, 23 migrant farm workers and 17 European-American farm workers. The quantitative data so far have shown that migrant workers who work in pesticide usage environments are less likely than European-American to receive protective clothing and equipment from their bosses. Also, proportionately more migrant

workers do not receive training related to pesticide usage, which includes application, field reentry, health hazards, and prevention methods. More migrant workers reported nervous system exposure systems such as dizziness, edginess, and weakness. Surprisingly, migrant workers were aware of the risks associated with pesticide exposure. They reported significantly higher perceptions of risk compared to European-American farm workers. However, migrant workers also reported a significantly lower sense of control over preventing exposures. They reported less confidence in their ability to protect themselves. Significantly more migrant workers reported that they had no control over the level of their exposures and were more likely to believe that exposure was in the hands of their bosses.

We also acquired qualitative data from face-to-face interviews of participants in the same sample. Participants reported issues related to problems encountered in their farm work. Issues were content analyzed to isolate what we call "cultural critical incidents" (CCIs; Smith-Jackson, 2003) or safety-related incidents that arise because of cultural differences, including power relationships, empowerment, differing world views, and communication styles. Here are three examples of CCIs:

Migrant Worker: We work even when the wind is blowing hard and the pesticides are blowing through the air. We aren't told what type of pesticide is being used; usually we recognize it just by smelling it in the air.

Migrant Worker: I can't read the labels even though I would like to--they are all in English. I worry a lot about being exposed to pesticides. I want to be able to protect myself more and I wish the boss would treat us better.

Migrant Worker: Sometimes the wind blows pesticides on us from other areas that are being sprayed, but we do not stop working. My boss doesn't provide us with any protective equipment-- we have to buy it ourselves. It would be nice if my boss treated us better, by giving us some protection and looking out for our safety.

Our follow-up plan is to expand this pilot study by increasing the sample size. We are also designing more usable pesticide labels and educational brochures that will be tested in the field environment against the labels and brochures already available on products and provided by extension agencies and the EPA.

<u>Specific Aim 1 Results Summary:</u>
n = 23 Latinos, n = 17 European-American Farmers

1. Fishers Data
    i. Fewer Latinos can get all of the protective clothing and equipment needed if they ask for it. All EAs said "yes".
    ii. No differences on exposures
    iii. Proportionately more Latinos have not received any training
    iv. More Latinos work in tobacco.
    v. More Latinos wear long pants, bathe after spraying,
    vi. Fewer Latinos wear masks, goggles, or read pesticide labels
    vii. More Latinos report dizziness, weakness, jumpiness, edginess

viii. More EAs report skin rashes, allergic reactions, upset stomach, excessive sweating
ix. More Latinos had more incorrect answers for symbol identification for symbol C (voltage). No other differences.
x. Fewer Latinos knew meaning of pesticide drift. Not other differences.

2. Ratings
   i. Latinos gave significantly higher risk perception ratings on pesticide effects on children, farm workers' experience with health problems due to pesticides, their own experience with health problems due to pesticides, and giving higher priority to work over their own health. Four of the 7 risk perception ratings were significantly different.
   ii. Only two of the locus of control items were significantly different. Latinos expressed lower control over the amount of pesticides they would be exposed to. Latinos expressed more agreement that their exposure depended on the supervisor or farm owner.
   iii. Self-efficacy differed significantly on 4 of the 7 items. Latinos expressed significantly lower self-efficacy for preventing exposures, getting advice on safe handling, using PPE, and using PPE in hot weather conditions.
   iv. Only one significant difference on behavioral intent. Latinos expressed stronger intent to wear gloves if labels tell them to wear gloves.

Products

1. Presentations:

- International Society for Occupational Safety and Health, Houston, TX, May 2004
- NC A & T State University, Greensboro, NC, November 2003
- Society for Risk Analysis, Washington, DC, December 2003
- American Society for Pesticide Safety Educators, June 2002

2a. Refereed Publications

- The 3-phases each have components that require comprehensive integration. We have not yet submitted manuscripts because the research is not complete.

2d. Other Publications

- Socially valid interview protocols and questionnaires to assess such variables as locus of control, pesticide-related symptoms, and use of personal protective equipment. These are in both Spanish and English.

5. Other Products:

- Web-based guidelines tool to design pesticide-related risk communications for Latino farm workers and other groups (prototype 1 is completed).
- A prototype (2^{nd} iteration) pesticide brochure in both English and Spanish has been developed.
- Research-based negotiation script have been developed.

Expansion and Maintenance of the National Agricultural Safety Database (NASD)

PI: Carol J. Lehtola, Ph.D, University of Florida

Type: R01 Education

Description
The goals of this project are: 1) to solicit, acquire and review materials for inclusion in the National Agricultural Safety Database (NASD); 2) to review materials in NASD for relevance and accuracy; and 3) to promote the use of NASD.

Activities/Accomplishments
Editorial Review Board
Oversight of NASD content and review of new materials are provided by an editorial review board composed of agricultural safety specialists from a variety of institutions and from Canada as well as the U.S. These specialists provide a broad range of expertise to the NASD review process. The complete board is as follows:

Dr. Carol J. Lehtola (University of Florida), Chair
Mr. Glen G. Blahey, CSRP (Workplace Safety & Health Division, Manitoba Labour, Canada)
Ms. Sheri Burgus (Farm Safety 4 Just Kids)
Mr. Eric Hallman (Cornell University)
Mr. Murray Madsen (University of Iowa)
Dr. Chip Petrea (University of Illinois)
Ms. Laura A. Powell (Polk Co. Florida Cooperative Extension)
Dr. Risto Rautiainen (University of Iowa)
Dr. Deborah Reed (University of Kentucky)
Dr. Julia Storm (North Carolina State University)
Dr. Roger Tormoehlen (Purdue University)

Clientele Served
Statistics indicate that the number of people using NASD continues to increase (see Table 1). Comparison of a three-month period in 2004 to a three-month period in 2005 shows just over 10% more total visits. Unique visitors increased by a similar amount. On average, visitors to the site are spending more time, and viewing more pages. As the number of full-time agricultural safety specialists continues to decrease nationwide, NASD becomes a more important resource for the increasing number of people responsible for safety training.

The statistics give a limited picture of the users. Certainly, the majority of visitors are one-time visitors who click through to NASD from a search engine. The list of most visited pages reinforces the idea that the majority of these one-time visitors are members of the general public seeking specific information on general safety issues such as stress management, back injuries, and first aid for bee stings.

It is important too that NASD serve its primary audience, educators who deliver agricultural safety programming. The 67,000+ repeat visitors probably include these professionals. We have an indication that they do find NASD very important based on the voluntary user survey

conducted in the early months of 2003 (results of this survey are available on the NASD Web site).

Table 1. Comparison of NASD Usage			
Measure	7/2004 – 11/2004	4/2005 – 8/2005	Percent Increase
Total visits	459,716	507,611	10.4
Unique visitors	370,625	409,997	10.6
Average time on site	6.35 min	9.47 min	50.1

Publications Added

During the current year, approximately 80 publications have been reviewed, prepared for submission, and submitted to our technical contractor for addition to the NASD Web site. These publications comprise over 800 pages of new material. (See the 'What's New' section on the NASD Web site for a partial listing of new publications.) The technical contractor, Conceptual Arts of Gainesville, Florida, has supplied a complete list in their annual report. Total number of publications and abstracts in the database exceeds 2400.

Full-Length Videos Added

In 2003, the capability to view full-length videos was added to the NASD Web site along with the first video. In 2005, six more were added:

- "Be Safe and Sound (Says Safety Hound)" (13 min; University of Vermont Farm and Rural Safety Program)
- "Helping-Four-Legged Friends Survive the Storm" (18 min; University of Florida Cooperative Extension)
- "Sound Advice for Farming" (7 min; Southeast Center for Agricultural Health and Injury Prevention, Kentucky)
- "Visiting a Farm? Be Safe and Sound (Says Safety Hound)" (12.5 min; University of Vermont Farm and Rural Safety Program)
- "We're Going to Hound You about Winter Safety" (7 min; University of Vermont Farm and Rural Safety Program)
- "Livestock Safety for Kids" (Spanish; 11 min; Oklahoma State University)

Marshfield Collaboration

Work continued in 2005 with the National Children's Center for Rural and Agricultural Health and Safety (Marshfield, WI) on a project to evaluate all children's materials in NASD. The first two years of the three-year project are now completed. As of September 20, 2005, the project director reported that the first two specific aims of the project were complete. The specific aims are as follows:

1. Establish reference criteria for assessing the suitability of resources for the child safety section of NASD.
2. Apply the new inclusion/exclusion criteria to the child safety resources currently on NASD, removing resources that do not meet acceptable criteria.
3. Actively seek out new and revised resources that meet inclusion criteria.

4. Conduct regularly scheduled upgrades to the NASD child safety topic section, including modifications based on industry trends, customer requests and feedback, and relevant emerging issues bearing implications for children in agriculture.
5. Provide recommendations for modifying other NASD topic sections based on our experience with this project.

NASD Promotion
NASD is regularly featured in the monthly newsletter, Safety News & Notes. This newsletter is developed by Dr. Carol Lehtola and is distributed to safety professionals and Extension agents nationwide. NASD materials are referred to in virtually every newsletter and special additions to NASD are usually the subject of feature articles. View Safety News & Notes on the Florida AgSafe Web site: www.flagsafe.ufl.edu.

Evaluations of Trauma in Hispanic Farmworkers
PI: Bernward Steinjorst, MD, MA, Brody School of Medicine, East Carolina University
Type: R21 Research Discretionary

Description
The Level I Trauma Center at the University Health Systems of Eastern Carolina serves a rapidly growing number of Hispanic patients many of whom ate farm workers, who have either permanently settled in the area or are migrating according to the labor requirements of the crop cycle. Specific health related risks of this group have been studied in the past and a propensity of Hispanics in general to fall victim to trauma has been shown recently. While a number of surveys have pointed at the farm as a high risk workplace with regard to trauma, no recent data have been generated regarding the epidemiology of trauma in general among Hispanic farm workers. A small pilot study suggests that risks and injury patterns are quite different from the general population. If this can be confirmed in a larger study and those trends linked to certain behavior patterns resulting from the particular socioeconomic background, prevention strategies can be developed.

Patient data will be generated for the time period from 1991 to 200 1 from the Trauma Center Database and patient charts and compared to the service population in general as well as subgroups sharing certain characteristics (ethnicity, workplace, material means). This will not only describe the scope of the problem but also allow us to identify risk factors which may be related to the particular working and living conditions of resident and in particular migrant Hispanic farm workers in Eastern North Carolina.
In concert with future studies, which directly examine those conditions in the field, this study could lay the groundwork for intervention strategies aimed at reducing this population's risk for traumatic injuries: Also, by identifying subgroups of patients within the Trauma Center Database, further research on these will be greatly facilitated. Because the problem of farm worker trauma may be similar across the nation, this study may serve as a template for the design of statewide and even national surveys.

Activities/Accomplishments
262 out of 793 total Hispanic trauma patients admitted between July 1st. 1992 and June 30, 2002 were farm workers. At least 118 of those were migrant workers. While Hispanic patients have

almost tripled (62/year to 154/year) during those ten years, which is consistent with the increase of the Hispanic population (.9% to 3.2% from 1990 to 2000 census) within the Trauma Center Service area, the number of admitted farm workers has remained constant. There seems to be a high work related injury rate for Hispanics in general (agricultural, construction and manufacturing jobs).

Project begun in 2002

Agricultural Injury And Illness Surveillance Project. Hillsborough County, FL – Phase II
PI: Martha I. Arrieta, MD, MPH, University of South Florida
Type: R21 Research Discretionary

Description
The project is the second phase of a study aiming at the development of a surveillance system to quantify the occurrence of occupationally related injuries and illnesses experienced by workers in crop agriculture in the state of Florida. The major objective was to define the number of occurrences of specific occupational conditions among farm workers seeking health care in rural clinics in Hillsborough County

Activities/Accomplishments
Four hundred and fifty-six visits to the clinics were reviewed. Presenting clinical problems were eye conditions, allergic rhinitis, asthma/bronchitis, Carpal tunnel syndrome, peripheral neuropathies, back pain, and sprains/strains. We tested the performance of data collection instruments and documented 21.3% of visits by farm workers as occupationally related.

Agromedicine at the Grassroots
PI: John Wheat, MD, MPH, University of Alabama School of Medicine
Type: R21 Education Discretionary

Description
Agromedicine at the Grassroots I is a one-year exploratory education, prevention, and research project whose aim is to establish the feasibility of student farm safety evaluation teams to involve students, teachers, extension agents, physicians, and local farms in agricultural health and safety exercises. This is but the first step in a long- term plan to reduce the frequency and severity of occupational injuries and illnesses in agriculture, forestry and fishing through the application of the methods of agromedicine. Still a concept confined largely to university and governmental circles, agromedicine seeks to develop at the local level a culture of cooperation among agricultural extension personnel and rural physicians to improve transmission and use of health care, health, and safety information among the farm community. Agromedicine at the Grassroots seeks to tap into familiar activities and persons at the local level to instill the values and processes of agromedicine in rural community and farming culture.

The specific purpose of Agromedicine at the Grassroots I is to form an agromedicine partnership at university and local levels and adapt existing and popular 4-H and FFA programs to teach and demonstrate farm health and safety in schools serving rural areas, culminating in student teams engaging in farm safety evaluation competition. This first step will pilot this idea as a model

involving at least two teams. The next step (Agromedicine at the Grassroots II) will extend the model, if successful, to include additional states and additional teams within states. A significant component of this pilot project will be a formative evaluation, documenting steps taken and lessons learned in building the model. A larger, summative evaluation with outcomes assessment will be incorporated in subsequent extensions of the program.

Accomplishments
The first phase of the Agromedicine at the Grassroots project conducted over the past year was concluded recently with the West Alabama Agromedicine Scholars Bowl held on September 25, 2003 and a trip to Canada for the winning team. Agricultural extension agents submitted over 200 questions. Teams from seven counties participated.

Toolkits: Agromedicine education toolkits were prepared based on guidance from county extension agents and health professionals. The kits contained forty-eight separate items divided into categories of ATV safety, chemical safety, hunter safety, machine safety, animal safety, and general farm safety. These toolkits were distributed to county extension agents along with material to use with 4H student groups.

Collaborators on the rural health and safety project were the University of Alabama's Department of Community & Rural Medicine and West Alabama county extension agents with the Alabama Cooperative Extension System. Agromedicine at the Grassroots I Feasibility of Student Farm Safety Teams, involved local farmers, students, teachers, extension agents, and physicians in agricultural health and safety exercises. Justin Hughes, Graduate Research Assistant to Professor John Wheat, MD, MPH, coordinated the project for which Dr. Wheat served as Principle Investigator. Dr. Bob Ebert, Extension Animal Scientist and Co-Investigator, helped to initiate the project and served as announcer for the student competition.

Environmental Causes of Arthropod Allergens: Distribution And Mitigation Strategies to Reduce Cockroach Allergens in Swine Farms and Workers' Homes
PI: Coby Schal, PhD, North Carolina State University
Type: R21 Research Discretionary

Description
Swine production is an important component of the agricultural economy of several States, including North Carolina. Cockroaches have long been recognized as the most important arthropod pests in swine production and severe infestations may contribute significantly to the maintenance and transmission of swine diseases. However, management of cockroach populations is severely constrained by many factors including cultural and production practices used at the farm, building design, and inadequate sanitation, as well as frequent re-introduction of cockroaches by workers and suppliers. In addition, regulatory restrictions on the types and classes of pesticides that can be used in such facilities frequently result in overuse of several broad- spectrum chemicals, increasing the potential for insecticide resistance to develop in the cockroach population German cockroaches have been shown to carry a number of pathogenic microorganisms, Including multi-drug resistant microbes, and cockroaches are a significant etiological agent in allergic respiratory diseases, especially bronchial asthma.

The overall goal of this project is to elucidate the spatial and temporal distribution of cockroach allergens in the confined swine production system. We also propose to evaluate mitigation strategies to reduce exposure of workers and their families to potentially harmful allergens that are known to cause asthma. The specific objectives are to (1) determine the spatial distribution of a major cockroach allergen, Bla gl, in cockroach-infested confined swine farms and in workers' homes, (2) determine temporal changes in its distribution in relation to animal production practices, and (3) determine the efficacy of German cockroach mitigation efforts on Bla. gl levels. The project will involve the coordinated efforts of entomologists and farm workers. Cockroach allergens will be collected in swab samples from surfaces, vacuum samples, and by air sampling, and an ELISA will be used to quantify Bla gl levels. Cockroach eradication and extensive power washes will be used to reduce Bla gl levels. This project constitutes the most comprehensive application of basic research to gain a thorough understanding of a harmful environmental allergen that contributes significantly to occupational morbidity. The link between occupational and residential exposure is a particularly innovative component of this project. The findings will result in innovative approaches for the control of cockroach infestations, reduction of environmental allergens associated with them that are responsible for allergies and asthma and lessening the potential for transmission of pathogenic bacteria.

Accomplishments

Determine the spatial distribution of a major cockroach allergen, Bla g1, in a cockroach-infested confined swine facility and in workers' homes: Collected numerous samples by vacuuming and swabbing; developed procedures for air monitoring.

Determine the efficacy of German cockroach mitigation efforts on Bla g1 levels in swine farms and workers' homes: Work is going well in the swine farm. It has been difficult to obtain access to workers' homes.

Publications

Refereed:

- Gore JC, Zurek L, Santiago RG, Stringham SM, Watson DW, Schal C (2004) Water Solutions of Boric Acid and Sugar for Management of German Cockroaches Populations in Levestock Production Systems. Journal of Economic Entomology 97: 715-720
- Zurek L, Schal C, (2004) Evaluation of the German Cockroach, Blattella germanica, as a vector of verotoxigenic Escherichia coli F18 in confined swine production. Veterinary Microbiology 101:263-267

Other:

- Waldvogel M, Schal C. (2003) North Carolina Agricultural Chemicals Manual. "Industrial and Household Pests". North Carolina State University Extension Service.
- Gore JC, Schal C. "Something to Sneeze at: German Cockroaches as a public health pest" Pest Control Technology.

Tractor-Related Farm Deaths

PI: Judy Bernhardt, PhD**,** East Carolina University

Type: R21 Research Discretionary

Description

The purpose of this study is to increase knowledge regarding fatal injuries on farms in North Carolina, with particular interest given to those deaths resulting from the occupation of farming. A study of tractor deaths, including those involving both full-time, part-time and non-farmers is included.

A. Specific Aims

The aims of this research project are to examine injury deaths on farm premises from 1998 through 2002 in order to:

Establish the incidence of injury deaths occurring on farm premises (excluding homicide and suicide)
Characterize those deaths that occurred in youths ages 16 and younger
Establish the incidence of occupational agricultural injury deaths
Characterize occupational agricultural injury deaths
Establish the incidence of tractor-related injury deaths
Characterize tractor-related injury deaths

Accomplishments

A request was made to the Office of the Chief Medical Examiner (OCME) for the State of North Carolina for a computer file listing cases meeting the broad definition of deaths on farms. Criteria used were: Place of injury or death in one of these categories: farm and other rural land; farm utility buildings, farm lake, pond, or other body of water; farm, cultivated land or pasture; livestock pens; farm or logging road, non public *OR* ICD-9 cause code = E9190 *OR* MEANS of DEATH in one of these categories: animals, farm tractor, other agricultural machinery *AND Excluding* CAUSE of DEATH as homicide or suicide.
The numbers of cases listed for each year were:

1998- 136
1999- 152
2000- 156
2001- 173
2002- 78

Data entry into the OCME data base is incomplete at this time- Entries are made as coders have time; they are concurrently entering 2003 and 2004.

After receiving the file, deaths due to the following causes were removed without review of the files: alcohol, cocaine, combined alcohol and other, morphine, operative treatment, therapeutic drugs, and multiple drug toxicity and other drugs.

It was at this time that the determination was made as to whether a case was excluded from further study because it did not fit the aims of this study or retained as a part of the database for this research. If the fatal injury occurred in North Carolina the case was included even if the victim was not a North Carolina resident. If the death occurred in North Carolina but the injury occurred in another state, the case was not included.

In addition, it was decided that, as the largest category of deaths on farms received from the OCME included motor vehicle accidents (MVA), and that these files were going to be reviewed, consideration should be given to motor vehicle fatalities that potentially were related to the

occupation of farming. Criteria were developed to use in determining which cases might have been related to farming from those that occurred to farmers but were not occupationally related or from those that occurred on a farm or in a rural area but were not related to agriculture. For a MVA to be considered as farmer occupational, the injury event must have included a victim who is identified as a full-time farmer, occurred on a rural road (one or two lanes), at a reasonable time of day for farm activities (depending on the month), and there must have been no other apparent reason to think the person was not doing agricultural work (ex. dark hours in winter months, small children in the vehicle, fleeing from police).

In each file the Report of Investigation by the Medical Examiner (RIME) and the Medical Examiner's Certificate of Death (MECD) were examined. When available, toxicology reports, autopsy reports, newspaper clippings, file correspondence, photographs and any other items in the file were reviewed. For each case included in the database, forty data elements (demographic, medical, situation, etc.) were gathered from the file or derived from file information whenever available:

As the Principle Investigator became unexpectedly ill in April, 2004 and was able to work very little until October, 2004, the data collected have not been analyzed. It is anticipated that the OCME will complete data entry for 2002 in the next few months and additional cases from that year will be collected. Data analysis, interpretation and a written report of the findings will be completed by September 30, 2005.

Assessing Vehicle Shocks & Vibration on Operators of Off-Road Farm Vehicles; A Data Acquitition System
PI: Thomas F. Burks, PhD, PE, University of Florida
Type: R21 Discretionary Research

Description
Shock and vibration can cause the operator (or passenger) to unintentionally actuate controls or evenfall from an off-road vehicle. Also, long-term exposure to whole-body vibration can affect a person's health. A novel data acquisition system to measure geo-referenced shock and vibration events from an agricultural tractor is proposed. This system will then be used in on-going research to evaluate the effect of such events on operator health and safety.

The data acquisition system consists of tri-axial accelerometers that are mounted on the rear axle and seat pad. They are connected to a National Instruments Modular Signal Conditioning Carrier (MSCC). The carrier is equipped with six ICP signal conditioners, one per accelerometer channel. It also contains six first order low-pass electrical filters that can cut-off any frequencies above 100 Hz. A Differential Global Positioning System (DGPS) receiver is interfaced to the serial port of a laptop. Lab View provides a graphical users interface (GUI) to the data acquisition system. It is used to manage data acquisition and store accelerometer and DGPS signals. An obstacle course was constructed to simulate rough field terrain. The tractor was driven through the course at prescribed velocities while data was collected from the accelerometers and the DGPS. A position map was created to mark the obstacles and provide a ground truth of known obstacles. Correlations could be made between the known obstacles of varying magnitude and the measured shock and vibration events as a function of ground speed.

Specific Aims:
1. Develop data acquisition software and hardware system for acquiring geo-referenced shock and vibration data. National Instruments' Lab View graphical programming language will be used in conjunction with a modular data acquisition and signal conditioning system, and a Differential Geographic Positioning System (DGPS) to geo-reference shock and vibration events.
2. Build a prototype vehicle obstacle course, which will introduce spatially varying shock events to vehicles as they transverse the course. Obstacles will consist of both repetitious and discrete events. The prototype course will use furrow and mound construction of various depths and heights to provide discrete events of varying intensity. A vibration track constructed of landscape timbers will be used to provide a known frequency excitation, which depends on the speed of the vehicle.
3. Conduct preliminary investigation into the shock and vibration relationships between the rear axle and the passenger seat. Additionally, acceleration magnitude levels and primary frequencies will be measured to determine the range of vibrations being experienced by the operator. All preliminary tests will be conducted at moderate speeds.

Accomplishments
A data acquisition software and hardware system was developed for acquiring geo-referenced shock and vibration data using National Instrument's Lab View graphical programming language in conjunction with a modular data acquisition and signal conditioning system, and a Differential Geographic Positioning System (DGPS) to geo-reference shock and vibration events. A prototype vehicle obstacle course was constructed, which introduced spatially varying shock events to vehicles as they transverse the course. Obstacles consisted of both repetitious and discrete events. A series of preliminary investigations were conducted into the shock and vibration relationships between the rear axle and the passenger seat. Experiments were conducted under various operating conditions to insure system robustness under various conditions.

The GDAQ system has demonstrated significant potential, allowing for the acquisition of geo-referenced acceleration data from six accelerometer channels simultaneously. Spectral and time-domain plots of the data demonstrated expected results and gave confidence that accurate accelerometer readings were being acquired. The use of geo-referenced data records proved to be beneficial in isolating and extracting significant data segments from a continuous record. However, the original goal of using the GIS plot to isolate major shock and vibration events is somewhat elusive and will require additional research to perfect. Data filtering or other geo-spatial techniques may be needed to develop a methodology for locating major shock events from the GIS plots.

Products

Presentations

- Balasubramanian, K.*, T. Burks, C. Lehtola, and W. Lee. 2004. Development of an Off-Road Vehicle Data Acquisition System for Assessing the Influences of Vehicle Shock and Vibration on Operator Health and Safety. 2004. National Symposium on Agricultural Health and

Safety. Keystone, CO. June 21-23,2004

Publications refereed:

- Balasubramanian, K.*, T. Burks, C. Lehtola, and W. Lee. 2005. Development of a Data Acquit ion System to Assess the Influence of Shock and Vibration on Off-road Vehicle Operators Health and Safety. Journal of Agricultural Health and Safety. (in review).

CD-ROMs or other Computer-Based Training Programs:

- A data acquisition software and hardware system for acquiring geo-referenced shock and vibration data was developed using National Instruments' LabView in conjunction with a modular data acquisition and signal conditioning system, and a Differential Geographic Positioning System (DGPS).

Dynamic System for Monitoring and Predicting Occurrence and Spread of West Nile Virus in Mississippi
PI: William H. Cooke III, PhD, Mississippi State University
Type: R21 Research Discretionary

Description
West Nile Virus (WNV) represents an emerging infectious disease in the United States and has the potential to impact the entire country. The disease has already had severe impacts on birds and other wildlife as it has moved westward from its point of introduction in New York. Because WNV is apparently carried by migrating birds, there are growing concerns over its impact on wildlife populations and the ripple effects on recreational activities like camping, fishing, and hunting. Outbreaks of the virus in temperate regions generally occur during late summer or early fall, coinciding with the arrival of large concentrations of migratory birds (and mosquitoes); these outbreaks often occur among humans living in or near wetlands where high concentrations of birds come into contact with large numbers of ornithophilic mosquitoes (primarily Culex sp.)

Fears of a West Nile Virus 'epidemic' have frightened people into staying indoors or using copious quantities of mosquito repellant when they venture outside. As pesticides are applied to kill a particular target insect, many other non-target insects and other wildlife are exposed to chemicals in the process. Aggressive spraying campaigns raise important health issues for humans and wildlife.

Development of a system for predicting, monitoring, and responding to outbreaks of mosquito and tick vectored diseases is a critical need for community well-being including; public health and water management, disaster management, and agricultural competitiveness. Creation of a geospatially-based dynamic monitoring and prediction system that is sensitive to changing environmental, social, and political variables is the ultimate goal of this project. A coordinated team effort is needed among organizations and agencies that share data and/or are end users of the system. Robust 'Regression-tree' modeling techniques will be used that optimize the input

of continuous and categorical variables. Interpretability of models is an advantage over 'Neural Network' modeling techniques.

Accomplishments
Developed a risk prediction system that indicates where natural resource managers, field crews, and the public are at increased risk for West Nile Virus infections. Assessed the usefulness of ecosystem variables and climatic data for modeling risk of West Nile Virus Infections A Dynamic GIS-based system has been created that updates risk with each monthly precipitation minus evaporation update.

Products
Presentations:

- **2004 National Symposium on Agricultural Health & Safety**, Title: A Dynamic System for Monitoring and Predicting Occurrence and Spread of West Nile Virus in Mississippi. June 20-24, 2004, Keystone, Colorado.
- **Final Report and Presentation to Mississippi State Department of Health.** Title: GIS as an Analytical Tool to Assess the Significance of Environmental Variables for 2002-2003 West Nile Virus Human Occurrences. August 11, 2004, Jackson, Mississippi.
- **Invited Presentation.** Geospatial Technologies for Health (West Nile Virus), Association of Southern Region Extension Directors and Association of Extension Administrators, Fall Meeting, University of Arkansas Cooperative Extension Service, August 27 – 29, 2003, Little Rock, AR

Publications:
Internet GIS News Article, Mississippi University researcher uses GIS to examine dangers of West Nile Virus. GIS Development, The Geospatial Resource Portal, www.GISdevelopment.net http://www.gisdevelopment.net/news/viewn.asp?id=GIS:N_hwqteobdli&cat=Industry%20Application&sub=HealthDeadly West Nile Virus. May 10, 2004. Syndicated releases: Merck Source, Picayune Item.com

North Carolina Farmscape Interactive Modeling
PI: Kofi Boone NC State University College of Landscape Architecture
Type: R21 Education Discretionary

Description
This project provides a theme-learning package of materials that broadens current definitions of farm safety from solely avoidance of human hazard, to raising awareness of farm impacts of local ecology, to broader trends of agricultural land use changes in the mountains. The project is focused on providing educational materials, including a hands-on model, for use in ongoing farm safety education efforts targeting elementary and middle school children.

Project Tools:

- Farm Safety context:
  Features a series of diagrams and images identifying the scope of the problems, the affects they have on farm children, and the project study area.
- Farmscape evolution:

Follows the changes over time on a prototypical North Carolina mountain farmscape, ranging from pre-settlement to a sustainable "future farm" highlighting best management practices.

- Farmscape model:
  A physical model of the sustainable farm to be used as an orientation and teaching tool for safety educators.

Accomplishments
Research was conducted of the historic cultural and environmental trends affecting the North Carolina mountain farm landscape. Materials were development for use in coordination with ongoing youth-oriented farm safety programs. These materials include presentations of farm safety issues at the scale human safety (hazard and exposure), farm safety (ecological impacts of farming on the land), and broader regional safety (impacts of broader trends of declining agriculture).

- Review of these materials with farm safety educators was postponed due to hurricane related flooding in the project area, and the crisis needs of key project participants in the project area.
- Refining the materials per feedback will not occur until farm safety educators become available.
- Delivery a prototypical "kit" for use by farm safety educators will not occur until review and refining per feedback.

Products
Publications:
Abstract accepted by Council of Educators in Landscape Architecture (CELA) Conference 2004

Mountain Pesticide Education and Safety Outreach – A Pilot Program for Christmas Tree Worker Safety in Western North Carolina
PI: James Hamilton PhD, NCSU Wataga County Cooperative Extension
Type: R21 Prevention Discretionary

Description
The specific goal of the Mountain Pesticide Education and Safety Outreach (PESO) pilot initiative was to develop and execute appropriate pesticide and safety training approaches relevant to the Christmas tree industry for Hispanic workers to reduce pesticide exposure and farm injury risks of (primarily) non-English speaking workers in Watauga County by:

1. *Providing direct safety training for farm workers in the field on pesticide and farm safety concerns specific to the Christmas tree industry.*
2. *Developing appropriate bilingual training to facilitate worker-grower communication regarding work related tasks and commonly used work site terminology.*

Activities/Accomplishments
In early 2004, the PI advertised the program in local newspapers, the quarterly Watauga County Extension Newsletter, and among Christmas tree growers through the Watauga Nurserymen's

Association Newsletter. By early April, five Watauga County Christmas tree growers had indicated interest in participating.

The 'tailgate training' program was developed by the PI, Watauga County's Extension Agent and Pesticide Education Coordinator, with input from two leader Christmas tree growers in the community, and the past president of High Country Amigos (a former Christmas tree worker) and was based on conclusions and recommendations in Hamilton's 2004 study of the labor dynamics in the Christmas tree industry. Input from growers indicated that training emphasis be placed on communicating the importance of proper safety equipment use for specific chemicals and application procedures commonly used in the production of Christmas trees. These growers and interview participants in Hamilton's 2004 study indicated that while personal protective equipment is issued to workers before fieldwork, many farm-workers remove equipment such as masks and protective eyewear before work is completed. The principal investigator collaborated with the North Carolina Department of Agriculture's Pesticide Section Bilingual Coordinator for baseline bilingual educational materials available for the training of Hispanic farm-workers with an emphasis on exposure routes, proper use of personal protective equipment, and other aspects of pesticide safety relevant to the Christmas tree industry. .

There is one restricted-use pesticide that is applied by large numbers of workers. Growers who were interviewed mentioned that workers apply Di-Syston, a granular organophosphate pesticide, during late spring to combat the 'twig-aphid' for harvest year trees. For more specialized insecticide spraying, with high-pressure sprayers, growers mentioned that few workers participate in this type of application and that workers who do more specialized spraying get more training on site. Herbicide treatments with Round-up, a non-restricted herbicide, are also applied by large numbers of workers on the majority of farms during the summer months to eliminate weed competition. Emphasis was therefore placed on training farm-workers on proper safety equipment use and application practices with granular, high-pressure, and 'backpack' pesticide applications with these common Christmas tree chemicals.

Training events were coordinated with each grower to maintain rapport and avoid work schedule conflicts. Each training event took place in early morning before fieldwork began and lasted for approximately 1 hour followed by equipment distribution and questions/answers. The "Tailgate Training" program was delivered at 5 Christmas tree farms to 55 workers in Watauga County. Each training event covered the following items and was followed with a 'Q&A' session where workers voiced their questions and concerns about pesticide application:

- Exposure routes of pesticides, acute toxicity vs. potential long-term health effects of improper safety/application practices.
- Chemicals used in Christmas trees and PPE required for each type of application (granular, high pressure, backpack).
- Handling, mixing, and re-entry intervals
- Hand-washing in the field and proper clothing protocol for post-application.

At the end of each training event, each worker was provided their own pair of gloves, safety goggles, respirators, rubber boots, and 2 Tyvek suits to encourage their proper use in the field. Handouts in Spanish were also distributed as supplemental materials that outlined proper hand-washing and handling of contaminated clothing. Posters from the North Carolina Department of

Agriculture on pesticide safety were provided to the participating employers to post at their offices and areas where workers congregate before work.

Feedback from the PESO project has been overwhelmingly positive. Growers who participated in the project have indicated that their workers properly utilized their safety equipment during pesticide applications. Use of safety goggles and respirators was noticeably improved from past years-especially with Di-Syston and Roundup application. Seven workers interviewed a month after the safety program indicated that they felt more knowledgeable about proper application practices after the training sessions and were more conscientious about proper use of safety equipment. Workers and growers appreciated the informal atmosphere of the training that allowed for interaction and questions. Providing free equipment to workers was seen as a positive incentive for grower participation in the program. While growers/employers are required to provide this type of equipment anyway, free equipment offset any perceived loss of productivity by having their workers in training for part of a workday.

Leg-guards and first-aid kits ordered for the proposed 'shearing-safety' component of the PESO program did not arrive in time for 2004 training, so this element of the program will be conducted during the 2005 production season.

55 Hispanic Christmas tree workers were trained on five farms and provided personal protective equipment for pesticide application.
Improved communication and rapport established with Watauga County Christmas tree grower community concerning pesticide safety issues with their farm-workers.
Increased public awareness of pesticide safety issues through two articles in local newspapers increased availability of pesticide safety information in High Country Amigos office for Hispanic farm-workers and their families. Several hundred copies of pesticide safety materials were produced for workshops, field days, and safety programs offered to the Hispanic community by High Country Amigos.
Increased interest in opportunities for future pesticide safety classes to Christmas tree farm-workers expressed by growers in Watauga County.

Products

1. **Presentations:**
   Results and impacts of the Mountain PESO project were presented at the 2004 Summer Meeting of the North Carolina Christmas Tree Association (NCCTA) and will be updated and presented at the 2005 Winter Meeting of the NCCTA.

2. **Publications**

   Peer Reviewed Journal:

   2004. Hamilton, J.Y. Extension's Role in Hispanic Farm worker Pesticide Safety. Journal of Extension. In progress.

   Other Publications:

   - “Uso de Pesticidas Agrico1as de Manera Segura". A publication (handout) on pesticide safety published by the CropLife Foundation.
   - “Los Pesticidas y La Sa1ud Humana". A publication of North Carolina

Cooperative Extension.

- "Protejase de 10s Pesticidas" (Protect Yourself from Pesticides). A poster from the North Carolina Department of Agriculture and Consumer Services.

Other:

Project received coverage in local media to promote program and then to report results.

Projects begun in 2004

Hospital Discharges & Deaths Associated with Cysticerrrcosis in NC
PI: Maria Correa, PhD, NC State University
Type: R21 Research Discretionary

Description
Specific Aims

1. To determine the hospital and admission/readmission rated for cysticercosis in NC
2. To review deaths certificates for cysticercosis in NC from 1990-2003 and
3. To estimate the costs associated with hospitalization and treatment for neurocysticerosis in NC.

Accomplishments

1.Obtained the discharge database
2.Summary of the first-time discharges has been completed
3.Draft of the first publication will be completed and sent for publication.
4.Initiated evaluation of death certificates.
5.Extraction tool is being developed to obtain information from medical records of patients.

Publications
Correa MT, Ghneim GS, Smith CG, Maillard J, Angel J, Levy M. Hospital Discharges due to cysticercosis in North Carolina. (to be submitted)

"El Puente" (The Bridge): Health Implications of Transnational Communication among Honduran Families Separated by Migration
PIs: : David Griffith, East Carolina University and Raquel Isuala, Hondouras National University
Type: R21 Prevention Discretionary

Description
We hypothesize that this project will result in lessening the risk of occupational injury and illnesses among migrant Honduran agricultural workers in the US who participate in the research by improving their overall mental health. However, we also anticipate that this research will yield information that we use to develop a larger, more inclusive project on the relations among communication, transnational migration and health in the rural Americas. Specific aims are:

1. Establish communication centers in Honduras and North Carolina where migrants and

their family members can communicate through e-mail messages via compatible computers and software.
2. Facilitate more in-depth communication between migrants and their families with the use of video letters and other methods proposed by the families we enroll in the study.
3. Assess the impacts of these forms of improved communication on migrants and their family member's health.

2004 Accomplishments: We have completed the first round of interviewing and are now working to establish or enhance communication centers in North Carolina and Honduras.
2005 Accomplishments: We were able to complete the project successfully, establishing the two communication centers that are still in use. Honduran workers who participated in the project found it beneficial to their mental health. Further evaluation of the physical health consequences of this communication await continuation of this project.

Presentation:

Abstract at the Society for Applied Anthropology Meeting April 2006 (accepted)

Child Health Needs of Rural Alabama Latino Families
PI: Lynda Harrison, RN, PhD, University of Alabama at Birmingham
Type: R21 Prevention Discretionary

Description
Our long-term goal for this project is to promote children's health and positive parenting and family relationships for rural agricultural Latino families in Alabama. Given the recent and rapid Latino immigration to Alabama and particularly Marshall County, there is a great need for services that are culturally competent and theory-based, and that promote interagency collaboration among organizations that serve the Latino community in rural Alabama. We conducted 16 focus-group interviews with mothers and fathers who have children under the age of 12, to identify their perceptions and concerns related to children's health and parenting. The specific aims of the project were to identify the knowledge, attitudes, beliefs, and perceptions of Latino families working in agriculture in Albertville (Marshall County), Alabama related to:

1. physical and mental health needs of children;
2. parenting issues and concerns; and
3. services needed to address child health needs and parenting concerns.

Activities/Accomplishments
We completed 16 focus groups with 88 Latino parents, transcribed all interviews and completed preliminary data analysis. We presented findings to a group of 16 of the original focus group participants, who confirmed the accuracy of our interpretations. We have also presented findings at a community town hall meeting held to explore interest in developing a taskforce to promote Latino health in Marshall county. In addition, we presented a summary of our findings to the Latino working group of the University of Alabama at Birmingham Center for Minority Health and Education.

Products
Presentations:

Harrison, L. (September 29, 2005). Child health needs of rural Alabama Latino families. Presented to Latino Working Group, UAB Center for Minority Health and Education

Education / Training / Outreach
We presented findings to approximately 40 people who attended the organizational meeting of the Marshall County Latino Health Partnership on July 31, 2005. The findings from this pilot study have been used as a basis for organizing the partnership and identifying projects for the partnership.

Academic Training
One undergraduate minority student research intern helped to enter some of our qualitative coding into a computer software program. Three undergraduate nursing students and one doctoral nursing student have worked on various aspects of this project, including helping to present educational programs in Spanish based on needs identified during the focus groups, and helping to support activities to organize the community partnership as a follow-up activity to the focus groups.

Development of a Medical Curriculum to Provide Knowledge and Training in Treating the Injuries/Illnesses of Agriculture in Eastern NC
PI: Julius Q. Mallette, MD, Brody School of Medicine, East Carolina University
Type: R21 Education Discretionary

Description
This project will be a strategic planning initiative to determine the curricular areas in medical education that are necessary to produce physicians who are Agromedicine literate and functional health professionals. The strategic planning initiative will allow us to achieve the following goals:
Goals:
1. To identify the existing medical school curriculum areas that will enhance the development of primary care physicians with Agromedicine literacy and functionality.
2. To supplement the existing medical school curriculum areas with elective experiences as part of the existing clinical experiences.

Objectives:
1. To identify the educational needs of current health care providers for treating the illnesses/injuries of people employed in agriculture, fishing and forestry.
2. To identify the didactic areas in the existing medical student curriculum related to the diagnosis and treatment of injuries/illnesses encountered in the occupations of agriculture, fishing and forestry.
3. To design a supplemental lecture and clinical rotation experience utilizing a computer modular learning system.
4. To design the clinical experiences that will enhance the existing didactic instruction.

Activities/Accomplishments
1. Training of two undergraduate honors students to moderate focus groups.
2. Completion of eight focus groups composed of farmers and farmers wives and single farm women in four counties in eastern North Carolina: Beaufort, Bertie, Halifax and Lenoir(N=47).
3. Qualitative analysis of data collected from focus groups.
4. Collation of existing databases on eastern North Carolina farm injuries and illnesses.

5. Mapping of medical school curriculum components related to agricultural injuries and illnesses.
6. Identification of curriculum additions from qualitative date analysis and database analysis.
7. Approval of curricular additions by curriculum chairs and executive committee.

Products: Three videotapes to be used for medical student education.

Factors Associated with Injuries and Illness in Puerto Rican Agricultural Workers
PI: Jaime L. Matta, Ph.D. Ponce School of Medicine, Puerto Rico
Type: R21 Research Discretionary

Description
Puerto Rican agricultural workers are exposed to a variety of environmental, chemical, biological factors. The use of machinery and incorrect ergonomical position can generate additional effects on their health and can induce short and long-term disease and injuries. Puerto Rico has an agricultural tradition that is quite unique to the island. This suggests that some of the risk factor for injuries and health will be specific for Puerto Rican farmers while others not. Consequently, it is necessary to identify risk factors for disease and injuries in the farming population, in order to establish the basis for conducting long-term prospective studies for their education and prevention. This project was funded with the following objectives: a) Develop a questionnaire directed to our population of farmers and agricultural worker that elicits exposure to biological, chemical, environmental agents and health and injuries related to their work. The questionnaire will be developed in Spanish (culturally relevant) because this is the native language in Puerto Rico, and an English version for the grant. b) Administration of this questionnaire to a small sample (n=15) will allow us to collect the first data on risk factors for injuries and diseases related to Puerto Rican farmers and agricultural workers. This small sample population will be used to validate the questionnaire. An epidemiologist will evaluate the final version of the questionnaire. c) Statistical analysis will be used to identify the most common injuries and disease that affect the small (n=15) population of agricultural workers that will be studied d) These will focus the attention on the agricultural health and safety and will provide basis for the future development of educational material to reduce occupational health and injuries risk.

Progress Report Narrative
During the last year we have been working in the previously stated objectives. Information on environmental, mechanical, biological, ergonomical and chemical factors that can cause injuries and adverse health effects in relation to agricultural workers were searched. The sections above mentioned were searched from OSHA general guidelines for workers. Only those aspects that are relevant to our population of agricultural workers were included in the questionnaire. Questions addressing chemical expositions were developed following the EPA guidelines. The information mentioned above in most cases was available in the web; we used some of that information to create the questionnaires. The information gathered allowed us to create the first version of the Spanish questionnaire. The questionnaire was evaluated by Dr. Diego Zavala, Director of the Epidemiology and Biostatistics Core Program at our Institution. He made valuable suggestions and recommended changes to some particulars of the questionnaire. We develop the final version consisting of 9 pages and 119 questions of the Spanish questionnaire

which is culturally sensitive to the population being studied. An English version was prepared and submitted for the purpose of this grant. These are included in the Appendix 1.

Using the Statistical program SPSS 12.0.1 (Chicago, IL), we created a statistical data sheet for programmed analysis of the epidemiological data collected in this pilot study with fifteen participants. The population studied was not representative of the overall farming population of Puerto Rico, because the size limitations of this pilot study. The participants age range from 22 to 89 years old and were all Puerto Rican. Twelve of the participants were male and three female. All the 15 participants worked in the same farm localization of Puerto Rico; four were farm owners, 8 farm worker, and three were farmer relatives and farm worker part time. Fourteen of the participants worked in a farm administered by the owner, who was a full time farmer.

Table 1. Environmental and lifestyle factors	n
Sun exposure	15
▪ Use of sun block	2
▪ Three hour or more of sun exposure	13
Use of:	n
Short sleeve	10
Long sleeve	5
Long Pants	14
Skirt	1
Boots	4
Sneaker	9
Safety shoes	2
Cap	9
Safety glasses	2
Personal protective equipment	1

Table1. Numbers of participants (n) exposed to the sun during their farm work and hours of sun exposure. Also shown is the type of clothing used, protective equipment and sun block.

Chemicals	N
Use of chemicals (herbicides, pesticides)	7
Liquid form	7
Powder form	2
Chemicals mixture	3

Table 2. Number of participants (n) that utilized chemicals (liquid or powder form) and prepared chemical mixtures for agricultural activities.

All the participants performed work activities involving sun exposure, and 13 of them worked three or more hours in the sun. Only two of them used sun block, some of the used clothing that reduced sun exposure (Table 1). Seven of the participants worked with liquid chemicals during their farming activities (e.g. herbicides, pesticides). Only two used powdered chemicals and three prepared chemical mixtures as part of their work (Table 2). Powder forms and the mixture increase the risk for inhalation or other reaction during the mixing. It is of significant concern that only one participant used personal protective clothing all the time while handling these chemicals (Table 1).

Biological Factors	N
Insects bites	15
Allergic reaction to insects bite	3
Allergic reaction to plant contact	2
Animals in the farm areas	
Dogs	13
"chickens"	12
Horse	2
Cow	2
Cat	1

Table 3. Number of participants (n) exposed to biological factors during their farm work. All participants suffered insect bites; but only three had an allergic reaction to the insect bite or plant contact. Domestic animals were present in most work areas.

Because Puerto Rico is a tropical island, it has a high diversity of insects as part of its fauna. All the participants had been bitten by more than one species of insect. They had experienced local skin irritation; three developed a more severe allergic/immune reaction involving swelling and severe pain. Two of the participants developed skin or eye allergic reaction as result of plant contact. Some domestic animals can be carrier of diseases.

Health issues	n
Arthritis	1
Vertigo	2
High levels of cholesterol	1
Diabetes	3
Sinusitis	1
Total	8

Table 4. Health problems reported by eight participants in this pilot study.

All the participants work in a farm in which has at least one of the following animals is present: dogs, cats, horses, cows, and chicken (Table 3).

The participants showed some general health problem as shown in table 4. The stress is part of our society and a major concern of stress in the agricultural population was the possible occurrence of natural disasters. Puerto Rico is exposed to a lengthy hurricane season (June-November). A hurricane can adversely impact the entire agricultural community of the Island. The second concern is the raining season which can affect the farms in their soils and the plant and cultures. The third concern is finances and the last is presence of droughts. None of the participant apparently showed stress related to health or job security. None of the participants reported any explosion or major injuries associated with their work activities although seven worked with electrical machinery, two with gas machinery and two other with heavy equipment. Thirteen moved heavy equipment but none of them have suffered any injury during work (Table 5).

This pilot study allows us to some quantitative and statistical conclusions of the risk factors in our population of farmers and agricultural workers. The preliminary data gathered can provide the basis for a case-control study to identify factors risk factors in our population of farmers and agricultural workers. A prospective study of injuries and illness related to the agricultural occupation in Puerto Rico can be developed utilizing the findings and the questionnaire developed in this study. Educational materials aimed at reducing occupational health and injury risk can be the product of this and future studies. In addition, the questionnaire created can be revised and adapted to study similar issues in farmers from different ethnic groups in the US mainland. Recently, a pre-proposal was submitted to the NC Agromedicine Institute, East Carolina University and was accepted to be part of the NIOSH competitive renewal application. Some of the findings of this study will be included as part of that application.

Type of Machinery	n
Electrical	7
Heavy	2
Gas	8

Table 5. Number of participants (n) that used electrical, heavy or gas machinery. None reported injuries during work associated with these equipments.

Products
Spanish (culturally relevant) questionnaire on factors associated with injuries and illness in Puerto Rican agricultural farmers

Spanish language educational brochures on variety of health topics, e.g., sun exposure, heat stress, etc.

The Development of New Tools to Study, Identify, and Prevent Ovarian Cancer
PI: Paul Mozdziak, NC State University
Type: R21 Research Discretionary

Description
The long term goal of this project is to develop a model system using hen ovary cells to examine the effects of pesticides and other environmental contaminants. The project relates to the health

of rural farm woman because the model cell system to determine which pesticides or other contaminants can induce ovarian cancer. Currently, it is possible at NCSU to stage large scale chemopreventive trials on birds. However, it is inefficient to screen chemopreventive candidates or therapeutic candidates using large scale animal trials. It is important to generate an in vitro model system because it can be useful to screen chemopreventive or potentially therapeutic drug candidates. Secondly, the cancer cell lines would make it possible to perform mechanistic studies in vitro that can be correlated with actual in vivo data. Objective 2 Elucidate the role of CA-125 in Ovarian Cancer CA-125 is a cell surface glycoprotein that is characteristic of ovarian cancer and it is used as a diagnostic marker for ovarian cancer in women. In women, CA-125 is only expressed on cells located on the periphery of the tumor, whereas preliminary data from our laboratory suggests that CA-125 is strongly expressed throughout the whole tumor. The up-regulation of CA-125 is well established and studies will be undertaken to understand any causative role of CA-125 in the cancer phenotype. Objective 3 Determine the origin of Avian Ovarian Cancer. It is presently unknown whether the majority of ovarian cancers actually arise in the germinal epithelium of the ovary or the epithelial cells of the oviduct because the tumors usually present at both locations when they are discovered at necropsy in the hen (Fredrickson, 1987). Therefore, it is important to understand the location of origin of the ovarian cancer to fully understand the avian model and understanding where the cancer arises in the hen may provide insight into the human disease process.

Approach Objective 1 Develop Ovarian Avian Cancer Cell Lines Brief Experimental Plan Briefly, tumors will be harvested from chickens that present the classic symptoms of ovarian cancer. The tumors will be gently digested with 0.2% trypsin, and seeded onto cell culture plates. The cells will be grown to confluency and split 1:10. When the mass cultures surpass 20 passages, clones will be established by limiting dilution or the use of cloning rings. Subsequently, clonal cell lines will be expanded and frozen in liquid nitrogen. Between 10 and 20 cell lines will be developed to meet Objective 1. If the cells do not spontaneously immortalize then cultures of ovarian cells will be immortalized using B95-8, Epstein-Barr virus suspension, ATCC. Approach Objective 2. The possibility that CA-125 expression plays a role in inducing the cancer phenotype will be evaluated by over-expressing CA-125 in primary ovarian cultures. Briefly, ovarian cultures will be established and the cells will be transfected with a retroviral expression construct encoding CA-125. The phenotype of the cells following over-expression of CA-125 will be evaluated as well as the expression of other cell cycle regulatory proteins. Objective 3 Determine the origin of Avian Ovarian Cancer NC State University has generated the first lines of experimental chickens that express reporter genes. We currently have transgenic chickens that carry the lacZ reporter gene and express bacterial beta-galactosidase, and the founder lines of chickens are from a strain (Bovans) which is predisposed to ovarian cancer. The lacZ gene is a stable heritable marker, which will label all cells that arise from the initially infected cells. Therefore, we propose to transplant ovaries from the transgenic chickens into wild-type chickens. Subsequently, the chickens will be allowed to survive for 18 months post-surgery when they will be killed (24 months of age) and assayed for the presence of tumors. When any tumor is observed in the birds, the tumor and surrounding tissue will be harvested, stained with X-Gal (substrate for beta-galactosidase), histologically sectioned, and observed with a microscope. The transgenic nature of the tissue will also be confirmed by PCR and Southern blots. In a second series of studies, a concentrated retroviral vector (CXL Mikawa et al. 1991, Mozdziak et al., 2000) will be injected into the ovaries of 24 week old hens (Bovins).

Subsequently, the chickens will be allowed to survive for 18 months post-surgery. The chickens will be killed and examined for the presence of tumors. When any tumor is observed in the birds, the tumor and surrounding tissue will be harvested, stained with X-Gal (substrate for beta-galactosidase), histologically sectioned, and observed with a microscope. The retroviral vector will provide a stable heritable marker that will label all mitotically active cells from the ovary that contacted the virus. In either case, tumors expressing beta-galactosidase will support the hypothesis that ovarian cancer arises from the ovary.

Activities/Accomplishments

Firstly, Human and Chicken Ovarian tumors have been compared for CA125 (Generally Accepted Ovarian Cancer Marker) expression. It was discovered that CA125 was expressed only on the surface epithelial layers of the human tumors, while it is expressed throughout the entire chicken tumor.

Secondly, ovarian tumors were harvested and their growth was monitored in vitro. Growth curves for the cultures have been generated for the first and second passages. Currently. CA125 staining for the cultures is being evaluated coincident with the growth curves to determine the changes in the proportion of CA125 positive cells with time in culture. Lastly, cells are still being cultured in an effort to establish immortalized cell lines. Ovarian cultures have been maintained in vitro for several months and they are beginning to show signs of immortalization.

Creating a Safer Environment for Greenhouse Vegetable Workers: Production and Validation of Native Entomopathogenetic Fungi *V. Lecanii* And *P. Fumosoroseus* To Control Whitefly *T. Vaporariorum*

PIs: Alda Rodriquez Dos Santos, Ph.D., Director of Research and Training, Batovi Instituto Organico - Internacional (BIO Uruguay), & John Sabella Ed.D, East Carolina University

Type: R21 Research/Education Discretionary

Description

Within the last decade, the use of greenhouses to produce vegetables has been widely adopted by small family producers throughout the United Sates and throughout the Americas. Greenhouse tomatoes in particular represent a major economically important horticultural crop. Today, in fact, practically all commercial tomatoes are produced in greenhouses. For example, in 1999, greenhouse vegetable acreage in Canada, the US and Mexico were estimated at 630, 280 and 450 ha, respectively, showing substantial increases from 1995 mainly because greenhouse tomatoes represent an increasingly important segment of North American tomato consumption.

One of the major factors that have limited greenhouse horticultural production has been damage caused by infestations of whitefly (*Trialeurodes vaporariorm*. Once whiteflies are well established within greenhouse crops, they develop rapid resistance to malathion, permetrina and other synthetic piretroids. Whitefly control through applications of conventional chemical pesticides has become increasingly more difficult in the past several years. Many greenhouse producers have been applying pesticides at the rate of two applications per week, which has served to accelerate the insects resistance as well as killing beneficial insects that naturally prey on whitefly larva and causing threats of water and soil contamination. Additional, most greenhouse workers wear little if any protective clothing or breathing devises while applying these toxic chemicals in the enclosed greenhouse structures, greatly increasing their risks of

exposure. In the South American nation of Uruguay, between the years 1997 - 2001 Uruguay imported approximately one billion US dollars worth of insecticides specifically for whitefly control, primarily imidacloprid, buprofezim, diafentiuron, butocarboxim and pyriproxyfen. According to data from the Center for Toxicology Research, however, in 2001 there were 1,200 reported cases of pesticide poisoning in Uruguay, the majority of these cases occurring as a result of exposure to imidccloprid, the most widely used pesticide in Uruguay for controlling whitefly infestations in greenhouses. Imports of imidccloprid average approximately 200 kg annually at a cost between 144 -598 thousand US dollars. This is just one reason why there is growing awareness and concern among farmers and consumers in Uruguay concerning the human health and environmental hazards resulting from the accelerated and largely unregulated use of toxic chemical pesticides.

These factors have created the urgency for research to find safer, biological means of control that can be integrated into IPM management planes. Among the alternative methods that are considered to have great potential for controlling horticultural greenhouse pests are entomopatogenetic fungi, which have been proven to be safe for humans, animals and the natural environment.

This project seeks to provide safer working environments and reducing the risks of pesticide exposures for agriculture greenhouse workers throughout the United States and the Americas by testing the viability and effectiveness of cultivating and applying bio-pesticides derived from native entomopathogenetic fungi such as *V. lecanii* and *P. fumosoroseus* to control pests such as whitefly *T. vaporariorum* in greenhouse vegetable production.

Accomplishments
1) Developed a systematic cultivation protocol for the mass production of native entomopathogenetic fungi utilizing locally available substrates at Batovi Instituto Organico-Internacional's Biological Control Laboratory, located in Tacuarembo, Uruguay.

2) Conducted participatory on-farm evaluations of the entomopathogenetic spores with greenhouse vegetable producers in Uruguay to determine the effectiveness, appropriate application rates, proper doses, timing of application etc. for the control of whitefly *T. vaporariorum*

3) Documented and disseminated all findings through demonstration, field days, workshops, on-farm visits, conferences and publications etc. for researchers, farmers and students throughout the United Sates and the Americas.

Food Security and the Diets of Young Latino Children from Migrant Worker Families: Creating a Culturally Competent Intervention for Healthy Weight among NC Migrant Day Care Center Participants
PI: Kristen Borre, Ph.D., MPH, East Carolina University
Type: R21 Prevention Discretionary

Description
This research will accomplish the following objectives over the course of one year:

- Develop a database to monitor the growth patterns of migrant day care center children, specifically to compare the BMI percentiles of migrant children to national and state standards;
- Determine current food behaviors among migrant families including food purchasing patterns, preparation and consumption patterns;
- Determine food and nutrition beliefs currently held by migrant day care teachers and staff and migrant parents;
- Make recommendations for a protocol for training curriculum and materials for migrant day care teachers, staff and families.

Activities/Accomplishments
The project was successfully completed in two Migrant Head Start Center sites. We met with the staff of the centers and then with the parents of children and recruited them into the study. We enrolled a total of 79 families to participate in interviews and/or home visits. We enrolled 17 teachers to provide interviews. Two focus groups were conducted with volunteers to discuss our preliminary results and to suggest ways that the problems of food security might be addressed in culturally appropriate ways.

From preliminary data analysis, we determined that the families actually are well aware of the advantages of eating a diet that promotes health and understand the problem of overweight for themselves and their children. The majority of the families are concerned about the quality and adequacy of food they can provide to their children. Those families who work with a crew boss have the most difficult time obtaining access to foods for their families because they are often dependent on the boss for money and transportation. One of the biggest problems with obtaining food is lack of local markets that provide quality fresh fruits and vegetables. All families reported being unhappy with how expensive grocery stores were for fruits and vegetables. They also reported that meats and sugars were cheap and thus, were purchased in greater supplies than they would have eaten at home. Most families wanted to develop some kind of neighborhood market for themselves with local fruits and vegetables sold at reasonable prices. Focus group discussions also led to a list of occupational health and safety concerns for the parents and to social concerns, including safety and the poor quality of housing they have to live in while in NC.

Products

1) Focus Group Question Schedule to Determine Food Security, Health and Nutrition Needs and Potential Solutions (Spanish and English versions)

2) Migrant Families "Greatest Concerns" Survey Form (Spanish and English Versions**)**

Presentations:
Kristen Borre; "Food Security and Nutrition Problems among Migrant Head Start Families." NC Direct Services East Coast Migrant Head Start Project
Health Services Advisory Committee Meeting, September 27, 2005

Assessment of Minority Farmer Health & Safety in Selected NC Counties
PI: Jimo G. Ibrahim PhD, North Carolina A & T University

Type: Research, R21 Discretionary

Note: This discretionary R21 project overlapped and was subsumed by the following R01 type project. A combined project report is presented.

Assessment of Health & Safety of Black Farmers in the Southern Coastal Region: Minority Farmers Survey
PI: Alton Thompson, PhD, North Carolina Agricultural & Technical University
Type: R01 Research

Description
Specific Aims:

- Develop a database of current and comprehensive information about the rate, nature and severity of agricultural injuries and the general health status of Black farmers in the seven states of the Southern Coastal Agromedicine Center (SCAC) region (VA, NC, SC, GA, AL, MS, and FL).
- Demonstrate the ability of the 1890 Land Grant Universities to form a collaborative multidisciplinary, multi-state, multi-university Agromedicine Alliance to work on identification and control of the common regional problem of the agricultural health and safety of Black farmers.
- Use this project and the development of the Agromedicine Alliance as a model for the 1890 Universities to collaboratively address safety and health issues among Black farmers and thus help to reduce health disparities on Black farms.

Activities/Accomplishments

Demonstrated the ability of the 1890 land grant universities to form a collaborative multidisciplinary alliance by submitting three proposals in response to the Call for Pre-proposals for project inclusion in the NIOSH Center Grant Renewal Application

"Agromedicine, Food Safety and Nutrition" is a major program initiative of the 1890 land grant universities. This initiative is an interdisciplinary collaborative structure designed to synergistically use available research, education, and outreach expertise and resources to address the health and safety needs of agricultural forestry and fisheries communities and consumers of agricultural products with special attention to underserved communities. To achieve this, the initiative promotes multidisciplinary collaboration among faculty and the establishment of partnerships with private, state, and federal agencies that share similar mission. Six major focus areas represent the thrust of this initiative. These are nutrition, occupational health and safety, food safety, zoonotic diseases, nutraceutical, functional, and organic foods, and minority and environmental health. The need, current activities, proposed strategies, and expected outcomes for each one of the six focus areas of the Agromedicine, Nutrition and Food Safety Program Initiative are discussed a concept paper.

Signed and formalized a Memorandum of Agreement to establish an "1890 Agromedicine Alliance" among the 1890 Research Directors, the North Carolina Agromedicine Institute and the Southern Coastal Agromedicine Center

Products

- Agromedicine, Food Safety and Nutrition Concept Paper
- Memorandum of Agreement – 1890 Agromedicine Alliance
- Interview Training Manual

States the project was active in
Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, Virginia

Projects begun in 2005

Crossing Local Borders: East Carolina Scholars Educational Immersion Program in the Migrant Latino Community
PI: Michael Bassman, PhD, East Carolina University
Type: R21 Education Discretionary

Description
Objectives

- Prepare emerging health-care providers for service in rural communities, particularly with the Latino population
- Provide understanding and appreciation of another culture
- Put in practice theories learned in the classroom
- Provide assistance in developing reading and communication skills of at-risk, underserved K-2 students, including take-home reading materials
- Encourage students to study abroad
- Encourage students to study Spanish at East Carolina University

Beneficiaries

- Primary
  - Emerging health care providers Freshmen EC Scholars
  - Latino K-2 students at Belvoir Elementary School
- Supporting
  - Belvoir K-2 teachers
  - Latino families
  - Community to be served by future health-care professionals from this program

The primary objective of the project is to provide educational experiences for emerging health care providers that promote and develop community and cultural awareness and understanding of the migrant Latino community while providing valuable tutoring for Latino Kindergarten through Second Graders. EC Scholars represent ECU's largest and most academically motivated group of potential health care professionals who will serve in eastern North Carolina. It is critical to begin sensitizing these students as early as possible to the differences in culture and the complexities of health care for migrant Latino farm families. Because of the progression of academic coursework, second-, third-, and fourth-year students focus on the specifics of their major- related coursework rather than on the valuable immersion learning opportunities available to them. Therefore, it is important that students take part in educational experiences during their

first year in which they will gain understanding and appreciation of the cultural, social and occupational diversity of this community, apply the theory learned in the classroom, and be able to incorporate their learning into future educational experiences. As future health-care providers, these students must understand what a day of life working on the farm is like and the daily medical dangers and health risks these workers face. It is crucial that they see this first-hand and gain insight into the community, families, health issues and home life of these Latino migrant farm workers and put theory into practice by stepping outside the classroom and into the world of their future clients.

Additionally, students will be encouraged to study abroad in Mexico, and in Central and South America, and to study Spanish while at East Carolina University as part of a fully-integrated, comprehensive educational experience that will more fully prepare them for service to this community as health care professionals.

PROCESS: Each year, an EC Scholar will be paired with a Kindergarten, First Grade or Second Grade student at Belvoir Elementary for the duration of the ECU academic year and will be involved with visits to the families' homes, a working farm, agricultural industrial sites such as Mt. Olive Pickle Company, Inc. and Carolina Turkey, migrant health clinics, BSOM/PCMH Emergency Room, and trips into the families' community. Elementary students will receive their own books to continue to practice reading and learning. The mentors will begin with an orientation and neighborhood tour sponsored by Belvoir Elementary on the first day of class. They will continue to work with the Spanish-speaking elementary students for two hours per week by tutoring reading in a combination of in-classroom shadowing and one-on-one work away from the classroom. EC Scholars will also visit the Museum of the Native American and the U.S. Holocaust Museum in Washington, D.C. Term projects will involve students in examining community issues and city and state government involvement. Scholars will be required to conduct a case study as part of their follow-up course, HNRS 2316, documenting what each has observed and learned in working with the K-2 students regarding home life, environment and the effect on health. Scholars will see the housing in the migrant farm workers' community and will learn about the work carried out in the agricultural arena. Additional activities such as interaction events with parents and families will occur at Belvoir Elementary.

Accomplishments—Project is ongoing. Evaluation set for summer '06.

The Northeast Center for Agricultural Health

The NEC is a collaborative effort of investigators from institutions throughout the New England and Mid-Atlantic states. It is based at the New York Center for Agricultural Medicine and Health (NYCAMH), where it's Administrative Core resides. NYCAMH is a division of Bassett Healthcare (a multi-hospital rural health system with clinical sites in ten central NY rural counties). An outgrowth of pioneering research into agricultural respiratory and injury problems in the early 1980's, NYCAMH was established by the New York legislature in 1987 with funding to address research, educational and clinical consultative needs related to occupational problems in NY farming. NYCAMH is a member of the NYS Department of Health's Occupational Health Clinic Network. This network of eight clinics (plus satellites) is funded by New York State to address public health issues relating to occupational exposures and illness.

The Northeast Center's director, John May, MD, reports to NIOSH, with oversight by Bassett Healthcare. Dr. May and NEC evaluator Susan Ackerman, RN have responsibility for coordinating and overseeing the NEC's various projects. Traditionally considerable effort has been made to interfere as little as possible with the project PI's as long as progress and reporting are appropriate. NYCAMH's business manager coordinates contracting and budgeting with Bassett Grants Accounting.

The Director and Administrator make daily management decisions with regular input from the Internal Leadership Team (includes Drs. Jenkins, Gadomski and Earle-Richardson). The leadership and PI's routinely seek the counsel of an Advisory Board that represents the farm community with farmers and agribusiness from various commodities and locations across New York State. This Board also reviews and advises extensively on all NYCAMH and NEC activities on a quarterly basis. In the coming five years, larger issues affecting the direction of the NEC and of its Feasibility priorities will be decided with the advice of the NEC External Advisory Panel. These boards both serve in an advisory capacity, with the PI remaining ultimately responsible to NIOSH for decisions on direction of the center.

The NEC was first designated by NIOSH in 1992. Since that time all 12 of the states have been involved in at least one NEC activity. Over the years most NEC activities have centered in New York, Pennsylvania and Maine. There has been moderate activity in Vermont, Connecticut and Delaware. The states with the lowest level of center activity have been Maryland and Rhode Island (the latter having virtually no agriculture). Over the years NEC's Outreach activities have involved tens of thousands of farmers in health screenings, safety demonstrations, or personal protective equipment education and sales at myriad farm community events in all states.

The NEC enjoys extensive involvement with the farm community at a variety of levels. Feedback is provided through near-daily contacts with farm families, and many NEC projects have internal farmer advisors. The center collaborates actively with a Farm Community Advisory Board, which meets quarterly and advises actively. In addition, half of the NEC staff live on farms or were raised on one and they remain deeply rooted in the farm community. Few large gatherings of farmers occur in NY or PA without NEC being represented by either an informational booth or health screening or safety demonstration. Staff visits farms or farm community sites somewhere in the region on a nearly daily basis. Ties to agriculture and agribusiness are extensive and

longstanding. The single characteristic of the NEC that may distinguish it most from its peers among the NIOSH agricultural centers is this deep involvement in the agricultural community, which may relate to NYCAMH's origin in a rural hospital rather than a university. Because of this level of involvement with the farm community, the NEC is well suited to deliver services to the Northeast region – a region that with a few notable exceptions is bereft of safety and health support for its farm families.

Two other features of the Northeast Center may distinguish it somewhat from most of the other NIOSH Ag Centers. First, the NEC is based in a rural hospital system rather than a university. This has meant that from its establishment, the NEC has actively sought collaborations throughout its 12 state region. Many of these collaborations have involved universities, but also state departments of health, farm organizations, migrant health programs, other migrant programs, etc. The second characteristic of the NEC is that many of the activities have been effectively leveraged with funds from state agencies and private foundations. Over the years, NYCAMH has been able to expand its programs with activities funded by the NYS Department of Labor, the NYS Dept of Health, the NIH, the WK Kellogg Foundation, the Agway Foundation, the NYS Grange, etc. Throughout this report there will be references to projects that were not directly supported by the Northeast Center, but were important components of the NEC's overall program in one area or another. Since it is important to be aware of these projects, they will be mentioned with their non-NEC funding source being noted.

Epidemiology The NEC is fortunate to have some helpful epidemiologic data to draw upon in determining priorities. The NIOSH-sponsored Farm Family Health and Hazard Survey gathered information from roughly 1700 NY farms in counties that were specifically chosen based upon commodity distributions. This sampling strategy produced a cohort that bore striking resemblance to the state's agriculture as a whole. The FFHHS combined on-farm inspections (Cornell) with periodic telephone surveys (NYS DOH) and individual multiphasic health screens (NYCAMH) to produce a wealth of data on the occupational health and worksite hazards experienced by the NY farm community. Prominent on-farm hazards involved mechanical equipment, particularly tractors – nearly 2/3 without rollover protection. Substantial numbers of farmers had problems with joint disease – knees, shoulders, hips, hearing loss, malignant and pre-malignant skin lesions and allergic disease.

The Occupational Health Nurse in Agricultural Communities (OHNAC) project in NY divided the state into three segments, each tracked by a designated surveillance nurse. All fatalities and serious injuries, respiratory incidents and injuries involving children resulted in a nurse follow up. These involved a visit to the home or hospital, interview of victims, co-workers and family, review of EMT and hospital records and inspection of the scene and the involved equipment. These injury investigations were nearly always done in partnership with an agricultural engineer (funded by NEC) and resulted in a detailed database depicting the injury pattern on farms across the state. Prominent in this pattern were mechanical and animal-related injuries and falls. The leading cause of serious and fatal injuries was the farm tractor. Children were injured in a pattern that was biphasic by age, with very young bystanders and teenage operators suffering the majority of the serious injuries and fatalities. The Maine OHNAC project uncovered far fewer incidents and generally did not investigate these with the same degree of detail. Efforts by the NEC to hire local agricultural engineers to supplement the Maine nurses'

investigations failed because of the paucity of engineers and their limited commitment to the effort.

The Northeast Region The area served by the NEC includes: Maine, New Hampshire, Rhode Island, Vermont, Massachusetts, Connecticut, New York, Pennsylvania, New Jersey, Delaware, Maryland and West Virginia. These twelve states contain 170,000 farms occupying 26.5 million acres.

Northeastern farms differ from other regions of the US in several significant ways. They are much smaller, averaging 156 acres vs. the US average of 441 acres. Average farm size ranges from 81 acres in New Jersey to 226 acres in Delaware. The 12 states have notably diverse agricultural industries: Several states are highly ranked for poultry (DE, MD, PA), others for milk production (NY, PA, VT). Vegetables are major crops in a number of states and tobacco in several (CT, MA, MD). Production per farm in Delaware is ten times higher than in West Virginia.[1] In some of these states agriculture remains the largest industry, while in others it is rapidly fading.

Commonalities shared by many of the states in the target region include the fact that nearly all their farms (80%) are family farms, many of which are under considerable financial stress. With an average age of 54.3, the farmers in these states are aging and the next generation is far less interested in farming. Tractors and equipment used on farms in the region are often old. [2,3] As production in some states shifts toward nursery, vegetables and orchard fruit, there is increased dependence on migrant and seasonal farmworkers from Mexico, Central America and the Caribbean. With less availability of traditional hired workers, there is increasing reliance upon less experienced Hispanic workers in the dairies of the Northeast.[4] In many of these states farmers are pressured by encroaching urban and suburban expansion.

Another characteristic of the Northeast region is the paucity of agricultural safety and health resources. Throughout much of the region, the commitment of the land grant universities to agricultural engineering is gone. In most of these 12 states, there is no identifiable individual or entity with responsibility for providing safety-related training or services to farmers.

This is unfortunate because epidemiologic work at NEC and elsewhere has identified a number of areas in which Northeastern farmers are at high risk. Farmers operating older tractors on hilly terrain might be expected to have higher rates of overturn fatalities, and this is indeed the case in the Northeast.[5] Bureau of Labor Statistics data from the mid 1990's shows overturn fatality rates that are approximately 1/3 higher than other regions of the country.[6] Based upon Farm Family Health and Hazard Survey data (NY),[7,8,9,10,11] surveillance of migrant clinic records (ME, NY, PA, MD, NJ, MA, CT)[12,13] and Occupational Health Nurse in Agricultural Communities (OHNAC) surveillance (NY, ME)[14,15,16,17,18] from the late 1990's, people working on Northeastern farms are at risk of: Serious injury from mechanical equipment, arthritis and other musculoskeletal disorders, skin disorders, respiratory disease, hearing loss, emotional distress, and serious injuries to their children. Children are a population known to be facing increased risk. Rates of child fatality are increased in the Northeast compared to other regions.[19] Migrant farmworkers are another population facing high risk of musculoskeletal (back and shoulder), eye irritation and trauma,[20] skin disorders, falls and other injuries.[21]

Thus the realities of the Northeast region include: farms of small and medium size – usually economically challenged; increasing dependence upon hired (usually immigrant) workers; high rates of mechanical – particularly tractor-related – injuries; a variety of occupational health problems affecting an aging population of farm owners; a growing distance between the farm community and the land grant universities and a paucity of health and safety resources to support the farm community.

NEC Goals The goals of the Northeast Center, in particular the need to collaborate widely and to utilize all resources available within the region, are a response to this set of circumstances:

1) *Focus on issues epidemiologically identified as high risk in the northeast region*;
2) *Address populations known or suspected to face increased risk;*
3) *Reach out to resources throughout the Northeast;*
4) *Collaborate actively with NIOSH and other national resources; and*
5) *Carefully evaluate all Education and Prevention projects.*

These goals are consistent with the input on center priorities that has been provided by the center's advisory board, which is composed of a number of members of the farm community, persons working in agribusiness and persons in agencies with which the NEC commonly collaborates. The input of this group of stakeholders is sought ii quarterly meetings and in periodic (roughly every 5 years) multi-day strategic planning retreats. Additional input is provided by farmers through participation in one of several project-specific advisory groups and also through a series of short questionnaires administered to those attending large agricultural expositions and commodity meetings – currently some 1500 of these have provided information on the occupational health issues that farmers regard as most important (tractor injuries, emotional stress, hearing loss and respiratory problems are the leading concerns and of roughly equal significance).

Over the past two grant cycles, these goals have been pursued by a diverse team of scientists and educators from a number of different states, institutions and professions. The distribution of project PI's has been closely divided between epidemiologists and public health practitioners, engineers and educators with ergonomists and physicians being less common as PI's. Private and land grant universities and state agencies have been most common collaborators, particularly in PA, DE, CT and ME. Traditionally collaborators and projects have been selected based upon their responsiveness to the NEC's stated goals. These selections have been largely determined by the External Advisory Panel, which is composed of individuals with knowledge of the region's agriculture and expertise in occupational safety and health. The proposed projects are reviewed in a blinded fashion and scored based upon their significance relative to the NEC's goals, feasibility and economic efficiency. Proposals that scored highest were generally selected for inclusion by the director; however these decisions were influenced by several other considerations. Proposals that represented extension or continuation of current productive projects were given priority and an effort was made to maintain appropriate balance between the three center cores. In general projects that promoted active community input and projects that proposed engineering or ergonomic rather than purely educational interventions were favored. A brief review of the past funding cycle demonstrates how well this process serves the NEC in its pursuit of these goals.

Recent Efforts in Pursuit of Goals

Goal 1: *Focus on issues epidemiologically identified as high risk in the northeast region.* Among the problems that have been identified epidemiologically are tractor overturn, migrant injury, child injury,[19,22] musculoskeletal injury, hearing loss, and injury from mechanical equipment. Over the past five years NEC personnel have directed 26 projects, feasibility projects and various collaborative efforts at these problems. These efforts have resulted in: 16 peer-reviewed publications (seven more accepted), three submitted papers and numerous presentations at national meetings. Additionally two engineering-ergonomic devices have been significantly advanced toward the marketing stage; an occupational medicine manual for migrant physicians has been produced; six grant applications were submitted, with funding of two R01's (total $1.6M) and one USDA grant for the national Hazardous Occupations Safety Training in Agriculture (HOSTA) Program for youths working on farms; one legislative bill has passed the NYS Assembly and is pending in the Senate. More importantly, NEC consistently translates its research findings into evaluable interventions in the community. Examples include all of the projects in the most recent Education and Prevention Cores; the NY Orchard Safety Program (funded by NYS DOL); the ergonomic apple bucket; the community-based efforts to reduce farmworker injury; health communications for farmworkers based upon findings of the Multi-State Study of Migrant Occupational Injuries; the NYCAMH Farm Partners Project to address occupational emotional distress among NY farmers;[23] and numerous others.[24,25,26,27,28,29,30] Three successful research projects from the last NEC cycle are currently being proposed for translation into practice.

Goal 2: *Address populations known or suspected to be facing increased risk.* The NEC has addressed this goal with considerable energy. A decade ago there were no projects addressing migrant farmworker issues. Since that time, with center funding, with funding from NIH and from other NIOSH sources, state funding and productive collaborations with existing migrant health resources, NEC researchers have built a remarkable record of achievement in this field. Currently NEC personnel have undertaken sixteen surveillance, intervention and dissemination projects. An additional seven feasibility and special supplementary activities have been completed. Fifteen papers have been published (five more accepted) or recently submitted (2) describing this work. NEC is recognized for this expertise and has been sought out by NIOSH, the Migrant Clinic Network and the East Coast Migrant Stream Forum to collaborate on projects.

Children are at increased risk. NEC is directing eight projects, feasibility efforts and collaborations at this issue. To date, these have resulted in three publications[31,32,33] and a large USDA grant for the entire redesign of the nation's tractor certification program.[34] At the level of the community, these efforts translated into the training of 10 Progressive Farmer safety day camp leaders; NEC support or participation in 65 day camps in five states serving over 10,000 children; safety training for children and their parents in 41 Amish and Mennonite schools (1043 children) in three states; and dissemination of quarterly safety advisory sheets to 900 Northeastern agricultural educators. A recent collaboration with the National Children's Center resulted in a successful journalist workshop in NY on child injury.

Goal 3: *Serve the entire northeast region's farm community by reaching out to regional resources.* NEC has built strong and lasting ties with talented individuals and organizations throughout the New England and Mid-Atlantic states. NYCAMH has a history of extensive collaboration with

land grant universities in New Jersey, West Virginia, Maine, New York, Delaware, Pennsylvania, Massachusetts and Connecticut.

In an effort to expand the number of agricultural safety and health specialists in the region, NEC has sought to recruit other experts to the field of agricultural safety and health. In this area, the center has had considerable success and has interested a number of talented individuals in agricultural health projects. Most notable here are experts in occupational health. In recent years partners have included the occupational medicine programs of Yale University, University of Rochester Medical Center, Robert Wood Johnson Medical Center, Harvard School of Public Health, University of Connecticut and SUNY Stony Brook. Prior to NEC's involvement, these institutions had not been significant contributors to the field of agricultural health and safety.

In addition, NEC is currently working closely with other important resources, including the migrant health clinics in New York, Massachusetts, Maine and Connecticut, while it maintains its existing ties with other migrant health programs in Pennsylvania, New Jersey, and Maryland. NEC has also collaborated with the health departments of Maine, Massachusetts, New York and New Jersey.

Goal 4. *Collaborate actively with NIOSH and other national resources*. In recognition of the NEC's expertise in migrant occupational health issues and its close functional relationships with a number of migrant groups, NIOSH has contracted with the NEC for several migrant-related tasks. These have included the pilot testing of the Spanish language version of the "Simple Solutions" publication **("**Soluciones Simples"**)**. Using farmworker focus groups, NEC personnel developed and tested a series of educational materials that effectively communicate the major findings of the National Agricultural Workers Survey (NAWS) to low literacy Spanish speakers. The NEC also collaborated with the Migrant Clinicians' Network, Association of Occupational and Environmental Clinics (AOEC) and American College of Occupational and Environmental Medicine on a proposal submitted to the EPA. The application proposes a joint NEC, AOEC, MCN and ACOEM five-year project aimed at enhancing the occupational health capabilities of migrant clinics across the nation. A key component would be use of NEC's proven IRB-exempt chart review methodology and validated survey instruments to categorize and trend patterns of clinic-specific occupational injuries.

Collaboration with the other Ag Centers has occurred on several levels. At the request of NIOSH, the NEC administrated the contracting and funding for the centers meetings, design and editing, printing and dissemination of the 2005 report on the National Agricultural Tractor Safety Initiative. Subsequently NEC subcontracted the remaining funds for the first steps of stakeholder recruitment. Clearly there was extensive collaboration around the writing and publication of the tractor initiative document. The NEC continues to collaborate with the centers' Tractor Safety Initiative, assisting in the start up of the social marketing project.

As noted above, NEC collaborated with the Children's' Center on a very successful Journalists' Workshop. Later this year, with funding from the NYCAMH ergonomic apple bag R01, the redesigned apple-picking bag will be tested in the State of Washington where work conditions and picking techniques are far different from those of the Northeast. NEC staff will gather information on muscle loading, worker satisfaction and productivity data similar to that collected in NY orchards. Testing of workers stability with the new bag design will use the electronic stability monitoring ladder developed by Dr. Keifer and his colleagues at PNASH.

Goal 5. *Carefully evaluate all Education and Prevention projects.* Over the past five years, NEC pursued five education projects and two prevention projects. Each of these was carefully and systematically evaluated for both process and impact. These evaluation efforts have resulted in three presentations at national meetings, two peer-reviewed publications[35,] and two submitted papers.[36,37] Based upon the results of these evaluation efforts, one popular project was found to be ineffective and discontinued. Evaluation process and instruments for another were substantially revised to more accurately assess the project's impact.

NEC Programs

For the purposes of the National Academy of Sciences review of NIOSH activities, there are seven program areas that encompass many of the NEC's efforts. These programs cut across the spectrum of agricultural illness and injury. In some cases these programs have been deliberate responses to specific epidemiologic findings and in other cases these efforts arise from staff members observations and understanding of Northeastern farmers and farming and the issues that affect this community. These programs often represent multi-faceted approaches to significant problems. They vary in size and scope, some focused within a given state, most aimed at the entire Northeast and beyond. They combine research efforts with education and prevention activities. These initiatives are funded in any way possible – usually a combination of Ag Center funding with other federal funding and support from various state agencies.

Tractor Safety
Child Injury
Safety Training
Personal Protection
Agrichemicals
Migrant Injury
Musculoskeletal / Ergonomic

The Northeast Center was initially funded in 1992, however funding was marginal until 1996 and the report will focus primarily upon center activities since 1996.

Tractor Safety Program

The safety of farm tractors has been an area of research and attempted intervention at the Northeast Center for more than a decade. New York fatality surveillance in the late 1980's showed that 55% of farm fatalities were related to tractors. Of these 52 tractor fatalities, 27 (52%) related specifically to tractor overturns.[38] When NYCAMH researchers calculated the cost of these deaths, it was found that tractor overturns were costing New York State over $2 million (in 1992 dollars) annually in lost income alone.[39] In response to these findings, investigators undertook a series of studies in the 1990s to better define the problem. Three of these involved physical inspections of tractors. Initially, a systematic on-farm inspection of all (605) tractors on 136 randomly selected dairy farms across New York State was performed with NYS Dept. of Labor support. This survey, which was linked with a concurrent one-on-one training session with each farmer, found appropriate ROPS on 33% of the tractors inspected.[40] In a subsequent NEC-sponsored project, all tractors offered at a series of farm auctions across the state – a total of 233 tractors – were systematically evaluated against published ASAE standards. Findings here included the presence of ROPS on 32% of tractors inspected.[41] The most recent and most extensive study of tractors in New York was in the NIOSH-sponsored New York Farm Family Health and Hazard Surveillance (FFHHS), which concluded data gathering in the mid-

1990s. Systematic inspections of the mechanical equipment were done on a cohort of 580 farms that were selected to reflect the size and commodity distribution of all New York farms. The FFHHS project described a fleet of 2,513 tractors with significant safety defects. This included ROPS being absent on 61.4% tractors and seat belts available on only 72% of those tractors with ROPS.[42]

NYCAMH / NEC PROJECTS

Several key NEC studies have examined more closely farmers' utilization of these tractors and some of the factors influencing decisions to retrofit unprotected tractors with ROPS.

Impact of Financial Incentives on ROPS Retrofitting - The first of these projects examined farmers' response to financial incentives of varying size for retrofitting one of the tractors (selected by the farmer) on the farm (Figure 1). In addition to free engineering consultation, farmers were offered a rebate for a portion of retrofit costs. These rebates ranged from zero to nearly 100% of the cost to retrofit. Completed work was inspected and bills submitted for reimbursement. Response rates approximated a sigmoidal curve with low initial rates of compliance that began to rise steeply once 40-50% of cost was offered and began to level off at about 70% of cost. There was a response rate of roughly 80% as the rebate grew to a full reimbursement of retrofit costs. Additional findings of interest included some of the significant non-cost barriers (availability of appropriate ROPS, transportation problems, poor cooperation from some dealers) and the wide variability of retrofitting charges by dealers.

Figure 1. Farmer Response to Financial Incentives

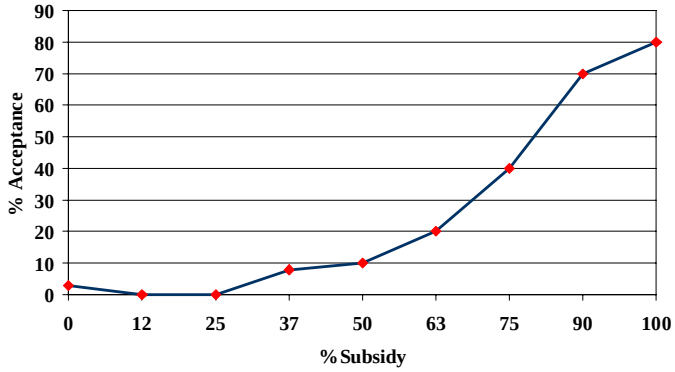


Figure 1: Farmer's Response to Financial Incentives

Farmer's Perception of Risk of Overturn and Intent to Retrofit - In another significant paper, NEC researchers described the actual utilization rates of unprotected tractors by NY farmers. Surveys of 201 randomly selected farms (171 - 85% responders) provided information on the number of hours of annual operation on each of the 677 tractors studied, noting whether this was fieldwork, inside work or stationary use. Adequate rollover protection was present on 33.1% of the tractors described by the farmers. This study showed that the NY farmer is adequately protected while doing fieldwork (i.e. ROPS and a seatbelt) between 8 – 34% of all tractor-operating hours.[43]

Currently the NEC is pursuing the problem of overturn fatalities with two separate and complimentary approaches. The first is an engineering effort based at Penn State University that

aims at monitoring tractor stability in an effort to prevent tractor overturns from occurring. The second is a NYCAMH-based effort to enhance the availability of tractor rollover protection to reduce the likelihood of serious injury should an overturn occur.

Prevention of Tractor Overturn - A low cost microprocessor sensor system was developed to help prevent overturn of agricultural tractors. Tractor roll angle is measured by a MEMS accelerometer. Roll rate is measured by a MEMS rate gyro. Both sensors are calibrated for thermal sensitivity and zero drift. Angle and rate signals are combined in a Kalman state-space filter to help reject noise. Pitch angle and rate are measured in a similar manner. Pitch and roll angle and rate information are externally available over a standard automotive CAN bus for commercial use. A second-generation color LCD display with CAN interface was built to show current roll angle for side overturn as well as recent time history (See Fig. 2). Large numerals show the current roll angle in degrees for quick visual recognition. A moving bar graph uses color coded bars to graphically show safe, marginal or dangerous roll angle over the past ten seconds so that the operator need not watch the display continuously.[44] The display was specifically designed as a learning tool to help tractor operators recognize that recent operating conditions may lead to future potential side overturn. Additionally, a simple ballistic pendulum dynamic model of powered rear overturn was developed. The model uses estimation of pitch angle and rate to provide predictive control for clutch release. The MEMS sensor system and model were successfully validated on a full size umbilical controlled tractor. The system stopped rear overturn for improperly high chain hitching over a wide range of pitch rates and did not produce false positive interventions.

NEC Tractor Safety Social Marketing Initiative. - The NEC tractor safety social marketing initiative represents a serious attempt to put into place the social marketing efforts outlined in the NIOSH Ag Center Directors' call for a National Tractor Safety Initiative[45]. Begun in 2004 with centers supplemental funding, this two-year project has been successful in identifying a target audience for ROPS retrofit marketing and in developing and testing messages aimed at this audience. The goal of this project was not to carry out a social marketing campaign, but rather to develop the strategy and tools for such a campaign.

To date, the tractor safety social marketing initiative has been quite productive and as noted above, the findings have been sufficient to generate a basic strategy and designate a target audience. The formative efforts to date include: 1) a survey of tractors and ROPS availability on 562 randomly selected farms; 2) an assessment of readiness for change on a representative sample of 465 randomly selected NY farms;[46] 3) an exploration of farmer attitudes toward ROPS retrofitting;[47] 4) a systematic review of 112 tractor overturn incidents investigated by NEC researchers and NIOSH FACE investigators; 5) a series of in-depth interviews exploring farmer attitudes, beliefs and decision determinants;[48] 6) a series of in-depth interviews exploring the same issues with farmers' spouses; 7) a survey identifying the most trusted and popularly consulted information sources used by NY farmers.

Based upon information provided by 562 farmers, we now know that:

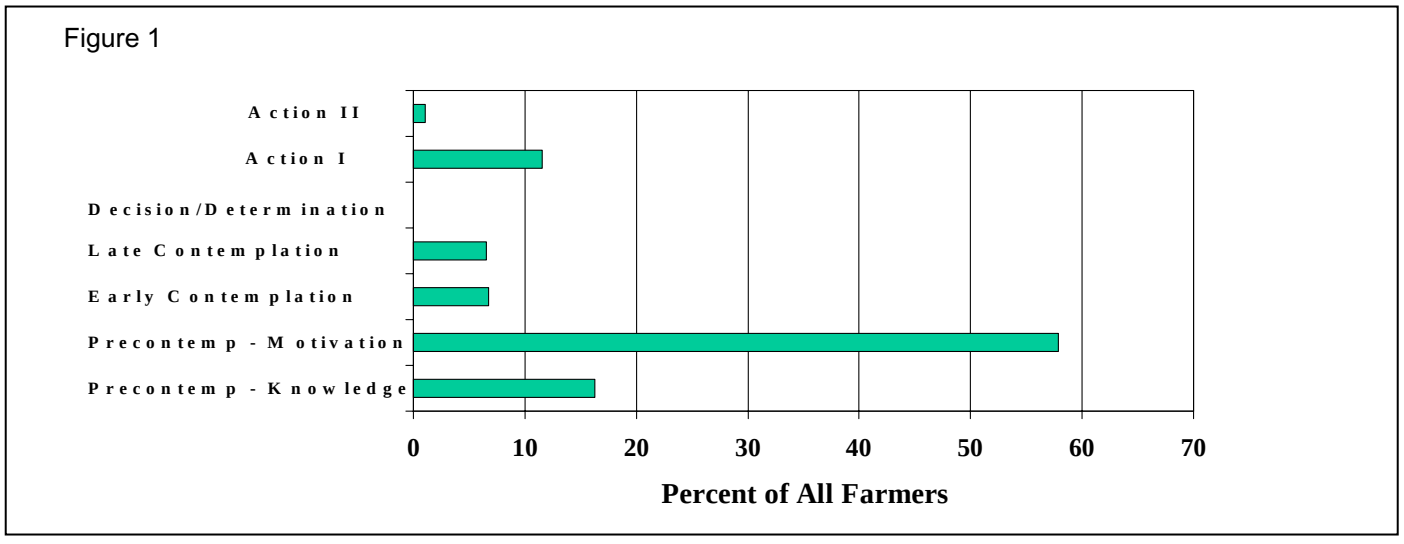
- The proportion of no-ROPS tractors in NY is declining – approximately nine percent over the past decade
- Of 147,000 tractors in these five commodities (86% of all NY farms), 76,000 (52%) have no ROPS .

- 18% of the state's farms have all tractors with ROPS. There are no ROPS tractors on 24.6% of NY farms.
- The percent of ROPS tractors on farms relates to commodity (high - dairy, fruit, vegetable; low - crop, livestock); age of farmer (higher with younger farmers) and size of farm (higher on larger farms).
- Of the 10,162 farms that have no ROPS, roughly 90% of these are crop farms and livestock operations.
- 55% of the no ROPS farms are owned by farmers over the age of 54 years.

Four hundred and sixty-five of these farmers had at least some tractors lacking ROPS and provided information on their personal stage of change relative to retrofitting these tractors:

- Three-quarters of NY farmers were in the "pre-contemplation" stages of ROPS retrofitting.
- Sixteen percent of all farmers were not thinking of retrofitting due to inadequate knowledge.
- 58% were not contemplating despite a good understanding – they had low motivation.
- The number of crop farmers with inadequate knowledge (32%) was high.
- The number of fruit farmers who had retrofitted one of their tractors was high (20%).

Figure 1. Distribution of New York farmers by stage of change, *n*=465.



The vast majority of the farmers contacted readily admitted the importance of ROPS but usually had some reason(s) why this did not apply to their particular farm. The leading reasons given included flat topography of farm, experience level of the farmer and cost of ROPS relative to worth of the tractor. A variety of other reasons justifying the lack of ROPS

have also been documented by this research. A subsequent series of in-depth interviews have generally supported and further explained farmers' reasoning on these items. Although these have been discussed to some degree previously, there is a clear belief among NY farmers that tractor overturns only occur on hillsides; that these events affect only inexperienced and "hobby" farmers; that these occur only when the farmer is hurrying (while at the same time admitting that they often have to "work fast"). There is a strong component of frugality in their cost / benefit considerations. It simply makes no sense to many of these farmers to invest money (theirs or the government's) putting ROPS on an old tractor.

An understanding of these preconceptions or denial mechanisms will prove essential in persuading farmers that rollover risks are real. Examples and statistics that directly contradict these notions will challenge farmers' efforts to minimize the potential risk they face. NEC has completed a systematic review of 112 NEC and FACE investigations of fatal tractor incidents. Among the findings:

- Five times as many experienced farmers die from overturns as novices.
- Hills were the leading contributing factor, but over 40% of overturn deaths did not relate to hills.
- Hired workers were involved in far fewer of these incidents than farmers or their family members.

Farmer Advisory Panels

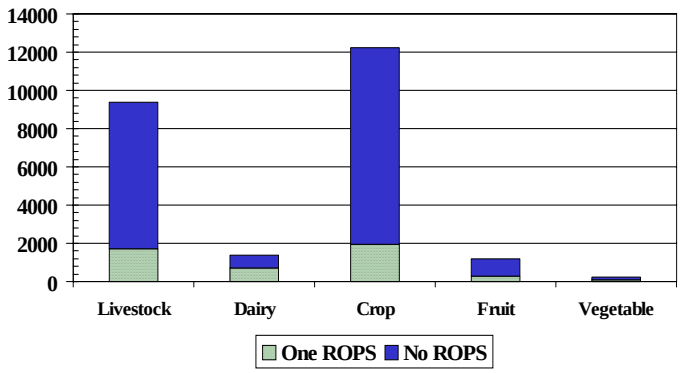
Two farmer advisory panels (total of ten farmers, predominantly crop and livestock) were convened to assist in the prioritization of the Aim 1 behavioral determinants. They will provide similar services and some risk rating in Aim 2. One advisory panel is from western NY and the other from central NY. Panels will meet with project staff as needed between November and March to provide input on project activities. Members are reimbursed for time and mileage.

In summary, much has been gained from previous NEC research and the tractor safety social marketing initiative, in particular. There is now a clear understanding of how many NY tractors currently lack protection, which segments of the farm community are most at risk, how this differs by commodity, how much financial incentive farmers find compelling, how ready farmers are to retrofit currently unprotected tractors, the reasoning that comes into play when a farmer decides whether or not to retrofit and how this reasoning stacks up to actual fatality trends.

Using the Formative Research Build a Campaign Strategy:

The work described above has shown that retrofitting of all NY tractors will involve nearly 80,000 tractors on nearly 30,000 farms at a very conservatively estimated ($500 per retrofit) cost of $40 million dollars. Despite recognition of the desirability of ROPS protection, three quarters of

Figure 5. Number of tractors Needed for a Two Tractor Strategy



NY farmers are not even considering a retrofit on any of their unprotected tractors.

Based upon this preliminary work, NEC investigators propose a different strategy:

- The goal of ROPS on all New York tractors will not be feasible in the immediate future;
- Intermediate strategies that reduce risk while leading toward the long term goal have the most promise;
- An effort seeking a "sufficient number of ROPS tractors" on all farms, when combined with consistent use of these ROPS tractors in situations of moderate and high risk would likely impact injury and fatality rates;
- Availability of two ROPS tractors per farm should provide a farmer with the flexibility to assign ROPS to risky tasks;
- The goal of two ROPS tractors per farm (or one should a farmer only have one tractor) would require retrofitting of 25,132 tractors rather than nearly 80,000;
- Audience segmentation and basic marketing strategy suggest that efforts to assure at least two ROPS tractors per farm are most efficiently directed at crop and livestock farms, which account for 21,639 (86.1%) of these tractors (Figure 5).

Next steps

Having devised the basic strategy, selected the target audience and completed considerable qualitative assessment of the target audience's behavioral determinants, the NEC effort is progressing rapidly toward its goal of having a ROPS retrofit social marketing campaign ready for implementation by summer of 2006.

- NEC researchers have recently provided AED marketing consultants with substantial data on perceived costs and benefits, motivators and barriers to ROPS retrofitting for the target population of farmers;
- Results of a survey of the target audience (1500 crop and livestock farmers) will provide identification of information sources (media, extension, dealers, etc.) judged most reliable by February, 2006;
- New York State Farm Bureau has indicated its support for the ROPS retrofitting effort;
- The Northeastern Equipment Dealers Association has indicated similar support;
- Following extensive discussions with members of the New York Senate it appears highly likely that a $200,000 fund administered by the Department of Agriculture and Markets will be available for partial rebates of ROPS retrofitting costs during the coming year. Funding at this level or higher appears possible for subsequent years. Added support from the NYS Assembly would increase the likelihood of ongoing funding and this is being pursued currently.

Over the spring of 2006, NEC's consulting partners in this effort will process this mass of information into a series of basic messages that have been tested in the target audience. These messages will be placed into formats that have been shown by testing to appeal to the target audience. A plan to utilize the most effective media to transmit these messages will be completed. A baseline assessment of State of Change relative to ROPS retrofit and of key behavioral determinants will be completed in a five county test region.

In summary, the strategy of the current effort is outlined above. NEC investigators intend to translate years of research and preparation into a statewide campaign aimed at reducing tractor overturn injury. This effort will have two major initiatives. The first is implementation of a social marketing campaign for which the foundation has already been completed, i.e. the increase of ROPS protected tractors on NY livestock and crop farms. The total number of farms in these target populations are 11,813 crop farmers and 9,582 livestock farmers. [49]

The second major initiative involves laying the foundation for a second campaign aimed at increasing optimal tractor protection, which would compliment the first initiative and would be subsequently implemented following the completion of current project goals.

Outputs

1) Published papers – 17
2) On-board tractor stability monitor – size 4" x 3" - cost < $50
3) Financial incentive data needed to advise policy initiatives
4) Complete social marketing program will be available for distribution to other NIOSH Ag Centers and for use in NY by summer 2006.
   - extensively tested messages – both financial rebate and non-rebate messages
   - details on target segments' most trusted media sources
   - overall marketing strategy
   - baseline theory of planned behavior data from trial region in NY for comparison with post-
     marketing evaluation.
5) Database of 112 fatal tractor incident investigations.
6) NEC managed finances and organizational functions of the series of meetings leading to publication of the Ag Center director's 2004 "National Tractor Safety Initiative".
7) Two regional NY farmer advisory bodies assisting in the ROPS retrofit program

Outcomes

1) Legislated retrofit rebate program ($200,000 -Year I) – passed by NYS legislature and at this point apparently availability of funds is pending. Interest has been expressed in continuing this rebate program in subsequent years if the funds are used by farmers in this first year.

Emerging Issues

- If the projects noted above succeed in increasing the number of ROPS protected tractors in NY, the next challenge will be to increase compliance with seatbelt use.
- Other emerging technologies may effectively prevent overturns and reduce the need for ROPS.
- A shift toward larger farms and more hired employees could lead to a safer tractor fleet operated by a less experienced workforce.

Future Research

- What is the relative impact of social marketing messages vs. financial incentives vs. social marketing messages plus financial incentives?
- Are rates of ROPS in NY increasing with financial stimuli and social marketing techniques?
- Can an effective NY program be successfully exported elsewhere in the Northeast?
- Do increasing rates of ROPS retrofitting result in falling numbers of farm fatalities?
- Can social marketing techniques enhance seatbelt compliance?

Child Safety Program

New York fatality surveillance in the late 1980's showed that of 94 farm fatalities nearly 1 in 5 occurred in children.[50] Fatality data collected by Dennis Murphy, PhD of the Pennsylvania State University documents 414 agricultural deaths in Pennsylvania during the 1990's. Of particular note was the risk to young people in the farm work site. Tragically, eighty deaths in Pennsylvania - 19% of all deaths - occurred in persons under the age of 20 years.

This pattern of child injury and fatality appears to be similar throughout the northeast – and indeed the entire country. In the 1990's analyses of fatality data showed that children working in agriculture accounted for 22% of all fatalities to young workers. The fatality rate for children in northeastern agriculture was 11.5/100,000 young workers – more than twice that of all workers in the United States.[51] Because of these data, the understanding and prevention of injuries to children has been of importance to the Northeast Center. As with other NEC programs, activities here involve several different approaches. Surveillance, education and prevention, and evaluation have all been key components of the NEC program in Child Safety.

NYCAMH / NEC PROJECTS

Surveillance

OHNAC Injury Data - A detailed analysis of data from the New York agricultural nurse surveillance project (OHNAC) by NEC researchers further clarified the risks encountered by children on NY farms. Again the farm tractor accounted for nearly half of the fatalities with machinery being the next most common cause of fatality. However, the New York data provide considerably more detail on child fatalities and especially on injuries. Of the 164 child injuries reported in New York between October 1992 and September 1998, 29 resulted in death (18% fatality rate). Younger children accounted for 45 percent (n=13) of the fatalities. Older teens represented 31 percent of the fatalities (n=9) while pre-teens represented 24 percent (n=7). Tractors were the main farm implement involved in fatal accidents (24%, n=7) followed by non-

powered wagons (14%, n=4), and then by animals, motor vehicles and powered wagons, all at 10 percent (n=3).[52]

New York Child Agricultural Injuries 1992 - 1998

Age	Injured	%of total	Fatal	%of injured
14-18	63	38	9	14
8-13	59	36	7	12
1-7	42	26	13	31
Totals	164	100	29	18

Reviewing all injuries (age 1-18 years, fatal and non-fatal), the New York data shows that the majority of subjects were male (80%). Nineteen percent of injuries involved tractors. Within the tractor category, tractor runovers (includes falling off, then being run over) were the most frequently occurring combination. The other leading injury sources were animals (14%, n=23), non-powered wagons (12%, n=19) and stationary farmstead machines, (11%, n=18).

Noise Injury in Farm Youth - NEC investigators conducted a feasibility study in the summer of 2003 to develop a noise dosimetry field protocol. This exploratory study evaluated the feasibility of field exposure assessment methods to characterize the noise source and levels that farm youths experience during a typical workday. Detailed exposure assessments were performed with a sample of 10 farm youths working on Vermont dairy farms to characterize potential noise hazards typical in the farm setting (Lander et al., under review). Personal and area noise measurements were taken using noise dosimeters. Information concerning work and non work-related noise and exposure histories was collected via questionnaire. The average age was 15.5 years (SD 2. 5, range 10-18). Youths started working at an average age of 8.4 years (SD 2.3, range 6-12) and worked an average of 41.3 hours per week (SD 32.3, range 2-68). Doses based on the hearing conservation amendment portion of the Occupational Safety and Health Administration noise standard (29 CFR 1910) (action level = 85 dBA, exchange rate = 5 dBA, and threshold = 80 dBA) ranged from 7 to 412%. Two measurements exceeded the current standard and corresponded to doses of 412% and 253%. These values corresponded to 8-hour time weighted averages of 95 dBA and 92 dBA, respectively.

FIGURE 1. Summary of dairy farm work activities and noise exposures in Vermont youth, 2003.

				Activity/ Noise Source
Subject	**Age (year**	**Total hours**	**OSHA Hearing**	

				Milk cows	General barn work	Mechanical silo elevator	Lawn mover	Tractor cab on	Tractor cab off	Skid steer (bobcat)	All-terrain vehicle / 4WD	Wood splitter	Hay wagon	Chainsaw
1	18	13.4	455 [B]	X	X				X	X				
2	15	13.1	412	X					X		X			
3	10	14.6	253	X	X				X					
4	15	12.4	82	X		X			X	X	X	X		
5	19	13.4	73					X	X				X	
6	15	10.6	42	X			X							
7	17	2.6	31	X	X									
8	12	13.6	31					X	X				X	
9	17	2.0	7	X	X									
10	17	5.9	8	X	X				X	X	X			

[A] Percentage of allowable dose according to OSHA Hearing Conservation Amendment
[B] Measurement for subject was done according to The American Conference of Governmental Industrial Hygienists – Threshold limit values (ACGIH- TLV)

Subjects overexposed to noise according to the current occupational standard reported working with tractors, skid steers (bobcats), and all-terrain vehicles and doing general barn work. Additional sources of noise exposure included mechanical silo elevator, chain saw, and wood splitter. The feasibility results showed it was possible to recruit farm families into the study; it was possible to outfit farm youth with noise dosimeters without deterring their farm work, and it was possible to train the farm youth to compete time activity logs. The feasibility work resulted in the field protocols for the larger exploratory investigation proposed here.

Education

Play It Safe - "Play It Safe: The Farm Safety Challenge Game" is an educational game designed to teach children and adults farm safety and health concepts in a fun, competitive atmosphere. Ideally, it is played with groups numbering 2 - 50, targeting ages 10 through adult. Topics include machinery safety, chemical safety, animal handling, emergency management, "what's wrong with this picture?", personal protective equipment and agricultural/rural health. In the 1993 evaluation period, 178 children completed the pretest and played the game. 102 (57%) posttests were received after the 12-week post-game mailing. There was a very small number of children answering incorrectly on the posttest who had answered correctly on the pretest. Otherwise there was improvement in the children's knowledge on all six evaluation questions 3 months after playing the game. The improvement ranged from 24-83%. Play It Safe: The Farm Safety Challenge Game was found to be an effective tool to teach farm safety and health concepts to children. Based upon this, the NEC paid to publish 1500 boxed sets of the game in 1995

Since publication in March 1995, over 1400 games have been sold or given away to individuals, extension and 4H groups, other child safety groups and farm groups. Games have been sent throughout the United States and Canada, Australia and parts of Europe. NEC

educators have used the game as an educational exercise for groups of adults and children ranging in size up to 100 person or more at some farm meetings.

In March 1996, an evaluation form was sent to all purchasers with a return envelope. Fifty six responses and 54 forms (23%) were received out of 233 that had been distributed at that time. Two people wrote that they had not had a chance to play the game. Respondents were mostly female (83%), between 30-39 years old (45%) reporting at least some background in agricultural safety (73%). Seventy one percent played the game 2 - 5 times or more. The game was most often played with family, 4H groups and agricultural classes.

Sixty two percent reported playing the game for 20 - 45 minutes although 12% played the game for one hour. It took 38% of respondents 5 minutes to set up the game, 41% said it took them 10 - 15 minutes to set it up. Forty five percent believe that it took too long to set up the game although many commented that it was easier the second time. Difficulty of questions was judged "just about right" for children less than 15 years (71%), for 15 - 18 year olds (86%) and for adults (67%). In general the questions were rated a little difficult for younger adolescents and a little easy for adults. The majority (92%) believe that answers to questions on the playing cards were sufficiently explained. Ninety seven percent thought the players enjoyed the game. A majority of respondents (84%) reported learning new agricultural safety concepts and 70 - 75% of respondents felt that the players improved their knowledge of farm safety and health. Twenty percent of respondents had noted evidence of changed work behaviors or practices as a result of playing the game.

Ninety seven percent of the respondents believe that "Play It Safe: The Farm Safety Challenge Game" is an effective teaching tool for children and adults and 95% would recommend the game to others interested in learning farm safety and health concepts.

Safety for Agricultural Educators (SAGE) - Early in the 1996 grant cycle, SAGE grew out of a series of interviews and group discussions with members of the New York State Association of Agricultural Educators.
Educators expressed virtually no interest in NEC-developed lesson plans addressing various farm risk and safety topics. For most teachers course timeline and lesson plans were well established and they were unlikely to change this by insertion of entire new lessons. There was interest however in short fact sheets providing current safety information that could be inserted into existing lessons. With input from an advisory board of high school agriculture teachers, a series of 22 colorful two-sided information sheets were developed. These were mailed quarterly to over 700 agricultural educators in 13 Northeastern and Middle Atlantic states over a period of five years. Each illustrated sheet addressed a single topic, providing an overview of the injury epidemiology, describing the nature of the hazard, suggesting approaches to hazard abatement and listing additional resources on the topic. Mailings were often supplemented with posters or overhead transparencies. Topic selection was based upon NYCAMH data on the leading causes of youth farm injury and upon seasonal
considerations. In subsequent years SAGE was mailed to over 900 agricultural teachers in the Northeastern region. Subsequently this was shared with the Southwest Center, which placed it into their format and sent to over 2000 agricultural teachers in their region.

Amish – Mennonite Schools - With the depressed prices of farmland in some portion of the Northeast, there has been an influx of new farm owners of Amish and Mennonite beliefs.

Some recent observations suggest that the children of Amish and Mennonite families may experience higher rates of injury.[53] This suspicion was supported by the observation of the western NY agricultural surveillance nurse (OHNAC), who observed that a disproportionate number of the child fatalities have occurred in this population. Unfortunately access to these groups is often limited and some of the traditional approaches used for outreach to children are not be feasible. With pilot project support from NEC in 1999 and 2000, teaching materials and a program of education for Mennonite school children has been developed.[54] Over the course of this project, farm hazard demonstrations were presented to 1293 children (typically their parents also attend these sessions) in 48 schools in New York, Pennsylvania and Delaware. Follow up narratives written in school by the children not only indicate a heightened awareness of safety issues but some describe significant changes in parental behavior toward safer practices. In addition to the roughly 800 children (with parents) trained in the school setting, health fairs provided an opportunity to distribute literature and teach one-to-one with adults who attend these events in target communities. Evaluation of this activity has been challenging, but investigators have followed a strategy of pictures or short essays describing something that the child learned and hopefully describing changes in practices or hazards on the farm.[55] The evaluation provided on data from 19 schools, 534 students, 28 teachers and 106 parents resulting in Research poster at NIFS 2005. There was clear evidence of understanding of the hazards depicted and some anecdotal evidence of changes in practice. This project continued for the initial three years of NEC's 2001 – 2006 cycle.

Tractor Certification – Throughout the past decade, there have been educational contacts with thousands of young tractor operators and young farmworkers in New York funded by state "Hazard Abatement Training Grants" from the NYS Dept. of Labor.

College Agricultural Safety Course – Supported by New York funding and stipends from the State University at Cobleskill, an NEC educator developed a one semester 2 credit college course on safety for students in the agriculture and farm mechanics tracks at Cobleskill. Approximately 20 students per semester participated in this course over the five year period that it was presented. On occasions specific lectures were presented to other agricultural colleges in the SUNY system either by distance learning technology or by visiting lectures. Changes in personnel at both the college and NEC led to this course being discontinued several years ago.

Hearing Conservation Rural High School Students - A four year longitudinal study of high school students in 7 schools in rural Maine. The study began when the students were freshmen (9th grade). Audiograms, noise histories, pretest-posttest evaluations and education are done annually at each of the schools. At the end of the study signs of NIHL, behavior changes in students and assessment of the effectiveness of varying education strategies would be completed. Seven local schools and nearly 350 students participated in this effort, which included noise histories and pre-post testing of noise hazard knowledge. This study was impacted by the loss of one PI and then a second. Data collection was completed. Results were sent to all parents and the data was sent to NIOSH for further analysis.

A Revised Tractor Certification Manual - With feasibility funding from the NEC an educator at Penn State University developed a pilot for a new design of the decades-old materials used nationally for training young tractor operators. These materials served as the basis for the

subsequent successful Penn State – Ohio State proposal to USDA for a complete revision of the national tractor certification program. The "National Safe Tractor and Machinery Operation Certification Program "is now being introduced across the nation,[56] as part of the Hazardous Occupational Safety Training in Agriculture" (HOSTA) program.

Safety Day Camp Program – Progressive *Farmer* magazine's safety day camp program was introduced into the Southeast and Midwest with no intention to involve the Northeast – an area where the magazine is not distributed. In the mid-1990's, the NEC determined to bring the day camp program into the Northeast region. Staff identified volunteers and the center supported the costs of the training of volunteers from New York, Pennsylvania and Maine. Additionally the NEC underwrote the expenses (roughly $15/child) of each volunteer's initial day camp. Collaborating with the Progressive Farmer Foundation, the NEC arranged for a special training seminar to be brought to the Northeast. Thirteen new organizer/trainer volunteers attended the 1997 training sponsored by NEC. Six camps involving 566 children were subsequently undertaken with NEC training and sponsorship. The Pennsylvania day camps inaugurated in 1998 have continued since then. Three additional volunteers from NY and ME were trained in 1998-99 and seven day camps with 250 campers in these two states took place in 1999. Additionally NEC personnel assisted at four other larger day camps (total of 870 campers) in New York State. In the most recent grant cycle, this effort received only three years of support. From 2001-2004 NEC personnel organized and staffed 10 safety day camps for 368 children. Additionally NEC staff or NEC regional trainers supported day camps by staffing at least one training station. NEC supported 55 day camps in five states serving 14,270 children.

A typical camp will have a local organizer or volunteer team to support the NEC organizer. A series 6 – 10 of teaching stations will be designated and an educator or demonstrator designated for each of these stations. A group of 6-8 children will spend 20-30 minutes participating in the activities at each station before rotating on to the next. They are provided with lunch, snacks, a T-shirt and other safety-related handouts. Often organizers will use the NEC's "Play It Safe" competitive quiz game as one of the day camp stations. An extensive evaluation was completed on 497 children in randomly selected day camps. Questions ranged from use of sunscreen and hearing protection to tractor, PTO and ATV practices. Of these children, 37% lived on farms and 13% worked on farms at least occasionally. Their overall understanding of dangers was adequate in 50.2% pre-camp and 67.5% post-camp. NEC personnel continue to provide these services to the extent permitted by the center's annual outreach funding.

Partners for a Safer Community – NEC contributed feasibility – type funding for one year in both New York and Pennsylvania for support of this FFA-sponsored grassroots community effort at heightening community awareness of farm injuries and appropriate preventive measures. A subsequent evaluation of this national project by NCCRHAS suggested that it had limited impact.

Evaluation

Safety for Agricultural Educators (SAGE) – As noted above, SAGE was mailed to high school agricultural teachers in the Northeast and Southwest for a number of years. Feedback was scant but generally ranged from positive to enthusiastic. Most of this derived from self-addressed postcards soliciting feedback and topic suggestions that intermittently accompanied

the SAGE mailings. After several years, a formal evaluation of SAGE using a postal questionnaire proved to be uninterpretable due to low response. Follow up phone calls could not effectively elicit enough responses to evaluate. Subsequently another approach to evaluation was taken. Postal surveys from 29 teachers who had not previously received SAGE gathered data on class demographics and the amount of class time devoted to a variety of agricultural topics including tractor operation and agricultural health and safety. Teachers were asked to assess their students' awareness of safety and health issues and also to estimate the number of students working in the farm environment. Following a year of SAGE mailings, the same information was gathered from the 24/29 post-SAGE responders. Comparison of pre – post responses from the 24 matched responding educators showed: limited increase in the teachers knowledge of basic agricultural safety information; a decline in the amount of class time devoted to health and safety; a marginal increase in estimated student awareness of health and safety and very little evidence of teacher awareness of SAGE as a safety resource. Most notable was the fact that only 8% of all students were currently working on a farm and teachers estimated that only 6% would be working on farms in 5 years.[57] Based upon the findings that SAGE does not communicate effectively to teachers and that these teachers are not really in contact with the intended audience (working farm youth), SAGE has been discontinued, although it remains one of the more popular locations on the NEC website.

NAGCAT Evaluation – The North American Guidelines for Childhood Agricultural Tasks (NAGCAT) were developed by a team of safety and agricultural experts, parents and other stakeholders in an effort to advise parent on appropriate tasks for a child's specific development level. Bassett Healthcare pediatrician and NEC investigator Anne Gadomski, MD, MPH used NEC personnel and funds to expand her NIOSH R01 study of the efficacy of these guidelines. 462 intervention (single educational visit to the farm with subsequent mailings) and 469 control farms were followed every three months over a two year period for occurrence of child injury events. Only about half (n=86) of the 186 recorded injuries fell into NAGCAT-covered categories. In these situations the intervention farms had a significantly longer time to occurrence (Cox proportional hazard regression).[58]

Safety Day Camp Evaluations – In addition to the simple pre-post knowledge assessments noted above, NEC researchers have undertaken a systematic evaluation of day camp participants that included retained knowledge and also involved farm visits to observe children's work practices following a day camp. The instruments needed for to make systematic observations in this setting have been piloted on a number of farms. These data have not been published, but are no undergoing re-analysis and likely will be submitted for publication once this has been accomplished.

Collaboration

NEC Journalist Workshop – During the summer of 2005, in collaboration with the National Children's Center, the NEC hosted a Cooperstown, NY workshop for journalists aimed at enhancing their appreciation of the issues surrounding child work on farms. Journalists from Canada, Midwestern and eastern US participated in lectures, panel discussions and farm visits. Initial evaluations of the experience by the journalists were quite complementary. A number of

feature articles have subsequently been published based upon the insights they gained in this workshop.

Collaborations

- National Children's Center; evaluation of NAGCAT guidelines
- National Children's Center; Advisory panel on adolescent farm injury with Dr. Vela
- Progressive Farmer Day Camp Program
- Farm Safety for Just Kids

Outputs

- Ten published papers
- "Play It Safe" educational game – published and distributed widely
- 19 SAGE information sheets available on NEC website; 25 issues of SAGE distributed in **ME, NH, VT, NY, NJ,CT,RI,MA,PA, WV,DE, MD, TX, AZ, NM**
- Journalist Workshop on child agricultural safety with subsequent articles in regional and national media
- *College Agricultural Safety Curriculum*
- Materials for safety demonstrations in Amish-Mennonite school settings
- 100 Safety Day camps - 15514 children trained in NY, PA, MD, WV,DE
- series of four "what's wrong?" farm show exhibits for youth education and family discussion This is called the NYCAMH Youth Farm Hazard Display and was exhibited at 6 farm shows in NY and Pennsylvania 2004-2006 with over 500 participants.
- Project with MVLA Library Association – 3 community talks on farm stress and one videoed for PBS. The first farm hazard display circulated in 3 county public libraries over a 1 year period.
- NAGCAT guidelines provided and promoted to 401 NY farms; injury rates then compared to 409 control farms
- 325 safety day camp participants completed evaluations
- NYCAMH Farm Safety Day Camp Farm Visit Evaluation Form developed and pilot tested
- *Developing an Instrument for Effective Safety Day Camp Evaluation* presented at NIOSH conference, 1999
- Formal review of Safety Day Camp model using current public health planning assessment tools: (Haddon Matrix, SWOT Assessment, Intervention decision matrix, and Precede-proceed) as part of academic program at Johns-Hopkins School of Public Health (unpublished, 2000)
- Materials for safety demonstrations in Amish-Mennonite school settings

Outcomes

- National Safe Tractor and Machinery Operation Certification Program a part of the CSREES Hazardous Occupations Safety Training in Agriculture (HOSTA) Program http://www.nstmop.psu.edu/

- Progressive Farmer Day Camp Program ongoing in Northeastern states

- Identification of the need for New York appropriate NAGCAT guidelines;

Emerging issues

- Future of farming and youth. More successful farms are larger, corporate, smaller family farms more financially stressed. As financial stress goes up, research shows youth tend to look elsewhere for career paths. What will happen to the farm workforce, and how will they be adequately trained for safety?

Future research

- **Who stays in farming?** - potential follow-up study with farm youth from KFSS Study after 5 years and 10 years to see what farm factors predict who stays in farming.
- **Child injury surveillance** will be included in the farm injury surveillance study proposed for 2006 using statewide EMS ambulance reports
- **Northeastern NAGCAT guidelines** – NEC work has identified that only about ½ of injuries occurred while performing NAGCAT-defined tasks.

Safety Training Program

One of the distinctive aspects of NEC's approach has always been its nearly continual engagement with the farm community in one way or another. Staff are present at a wide variety of agricultural gatherings throughout the 12 state region. On-farm visits occur with regularity. Participation in safety training is frequent in these situations. In many cases these activities – particularly in New York – are supported with non-NEC funds, another example of the leveraging effect of the agricultural center.

NYCAMH / NEC Projects

NEC Education and Outreach - NEC Outreach/Education activities have taken staff throughout New York State as well as Connecticut, Maine, West Virginia. Delaware, Maryland, Pennsylvania, New Hampshire and Massachusetts. They have presented material on general farm safety, PTO, tractor, hearing loss, chemical hazards, mechanical injury, first aid, respiratory problems, chainsaw safety, skin protection, personal protective equipment, cattle handling, arthritis and migrant safety, depression and occupational stress. Health screening/teaching events included: pulmonary function, blood pressure, cholesterol, hearing and skin cancer.

Farm safety programs for children included chemical, tractor, PTO, electrical, animal, snowmobile, fire, mechanical, solar UV light hazards. Also first aid, disability awareness and NAGCAT guidelines were featured at programs attended by both children and parents. Training for professionals included discussions of occupational health for nurses, agricultural medicine problems for nurses, respiratory and general agricultural occupational health issues for physicians and mid-

level providers. Over the years, many thousands of people in the Northeastern farm community have been contacted by the outreach efforts.

Agricultural Hazard Abatement & Training (AHAT) Program - This program aims at abating farm hazards and identifying the most effective means for teaching job safety to employees. Working with the farm owner or farm safety officer, the AHAT team reviewed various teaching techniques and provided substantial educational materials. This was combined with a walk-through inspection of the workplace to identify and list all potential hazards. Over the past five years the AHAT program has been used by a self-insured workers' compensation group to encourage farm owners to take a more pro-active approach to reducing worker injuries. A total of 187 farm hazard audits have been completed with 1083 trainings for 5328 farm employees.

Fifty farms that began participating during the inception of AHAT in 1999 and continued to be actively involved in the project were the focus of an in-depth analysis of claims with regard to frequency and severity for the years 1999-2002. Insurance data indicated a decrease in the number of claims filed and an overall decrease in loss ratios from 51.7% to 40.2% for the same farms. Loss ratio is calculated by dividing the cost of injuries by the written premium. So, a decrease in loss ratio may indicate a decrease in severity of injuries occurring on these farms.

Initial review of data provided by the insurance company on injury claims submitted by the fifty farms indicated a decrease in frequency of claims over a four-year period.

- 1999 – 90 claims
- 2000 – 74 claims
- 2001 – 69 claims
- 2002 – 50 claims

Additionally, an analysis of the claims data indicates that the injuries occurring to workers from the fifty participating farms were with less severe in terms of lost time, cost, and type, when compared to a group of forty-eight farms that chose not to participate in the loss control program (12).

The effectiveness of a loss control program may also be measured by examining the severity of injuries reported. A severity index was developed in an attempt to examine the reported injuries. Information on type of injury, which was assigned a value, number of days of lost time and cost of workers' compensation claim were entered into this calculation. The severity index for the fifty farms participating in the program ranged from 58.12 – 108.78 over the four-year period of analysis. The severity index for the comparative group of 48 farms ranged from 96.76-334.49 during the same period. This may indicate that the farms involved in the loss control efforts experienced injuries that were less severe in terms of type, lost time and cost (27).

Even more indicative of efficacy is the insurer's decision to transition AHAT into a basic corporate practice. The AHAT staff has now trained the loss control staff of the insurance company to run the program internally. Use of the risk assessment instruments developed by AHAT has been expanded to three other states in which this company insures farms. Finally the company has specifically requested that AHAT conduct risk management assessments on thirty-one farms in NY that had experienced increased injuries or a fatality. This suggests a company movement toward mandatory participation in AHAT activities for high-risk farms.

Northeastern Regional Safety and Health Trainers – To introduce the NEC and its resources, this project organized two regional meetings involving USDA personnel and the designated safety specialists from each of the 12 NEC states. The success of these meetings led the USDA to adopt this model for meetings with NIOSH Ag Centers in other regions of the country. The meetings also confirmed for us the limited interest and safety training sophistication now available to farmers in many of the NEC states.

Table 1. Evaluation of NE Trainer Programs

	Responders		% Correct	
PPE	**Pre**	**Post**	**Pre**	**Post**
safety glasses	637	421	19	47
hearing loss	646	421	26	55
Machine safety				
Guards	183	37	66	79
PTO	178	38	56	76
Tractor Safety				
Seatbelt	441	88	69	86
safe hitch	432	89	62	85

This project recruited, trained and equipped individuals with NEC-designed hazard training demonstrations. Hired for .1 FTE, these trainers augmented or substituted for state safety specialists in delivering safety training activities at safety day camps, farm bureau annual meetings, farm shows and other venues. Over the course of the three years of funding, people from the farm communities of NY, MA, WV and ME became trainers. These individuals crossed state lines to provide services in PA, NH, MD and DE. Trainings focused on tractor safety, mechanical hazards and/or personal protective equipment. Pre-post evaluation of a sample of these training sessions (Table 1) showed improved knowledge. More extensive evaluation proved difficult. There was considerable drop-off in post-response compared to the pre-session. Response rates to subsequent mail / phone questionnaires have been low. We have since simplified the evaluation process to enhance response rates. This project was limited by three years of funding. However, we believe that this type of effort is important to provide needed training and to acquaint Northeastern farmers with the NEC, so at least a portion of this activity has been continued with the Center's Outreach allowance over the past two years. We have funding from the NYS Dept. of Labor "Hazard Abatement" program to support these efforts within NY.

NYCAMH / Northeast Center Website – Abundant safety and health information is readily available on the NEC website at nycamh.com. Much of this is readily downloadable and some is formatted for "mini-posters" that farmers can place in appropriate sites around their operation. Visitors can now easily shift to either Spanish or Creole versions of the website. A growing body of the site's current content has been translated and then independently back-translated to assure accuracy. Specific materials for employers of migrant farmworkers are available for downloading and subsequent printing. Most materials are in PDF files for ready downloading of posters, educational flyers and brochures. The website is able to track users, preferred languages, pages favored, time on each page and most preferred downloads. Short, illustrated documents clearly explain each of the ongoing research projects and identify the appropriate contact for each. Linkages to NIOSH and each of the NIOSH centers are readily accessed.

Participatory Development & Experimental Testing of Agricultural Risk & Safety Messages - The project sought to identify social networks that influence farmer behaviors. These social networks would be one key to changing community norms that accept high risks in agricultural work. The study's experimental intervention attempted to stimulate interpersonal conversations about farm safety issues. The social networks (interpersonal contact networks) provide one key to design a communication strategy for changing social norms of accepted farm risk behaviors. The study

tested both a method for reaching farmers and a strategy for changing behaviors. Field interviews of roughly 100 farm operators in an intervention region and a control region permitted maps of interpersonal networks to be constructed. These focused upon an examination of behavioral, attitudinal and risk perceptions to be examined based on a social contagion model of risk behaviors. Extensive efforts to spread risk and safety messages via interpersonal linkages did not prove to heighten awareness in any measurable way.

Migrant Safety Education (*also noted in Migrant Injury*) - This project utilized the migrant education network to contact migrant farm workers and their families for instruction in basic farm safety and first aid. Migrant outreach workers were used for this training and their efforts were supplemented by NEC personnel. Participants were given personal first aid kits in an effort to attract wider participation. A total of 373 of the 500 kits were distributed in association with health training events. This took place at 12 different migrant education facilities in 5 states. Trainings covered heat stroke, back injuries, hearing protection, protective equipment, AIDS, pesticides, general hygiene and local clinic resources. These events generally took place in local clinics but also on-site at some farms and were attended by both Jamaican and Hispanic workers and worker/parents.

Partners for a Safer Community (*also noted in Child Safety*) – NEC contributed feasibility – type funding for one year in both New York and Pennsylvania for support of this FFA-sponsored grassroots community effort at heightening community awareness of farm injuries and appropriate preventive measures. A subsequent evaluation of this national project by NCCRHAS suggested that it had limited impact.

Safety Day Camp Program (*also noted in Child Safety*) - *Progressive Farmer* magazine's safety day camp program was introduced into the Southeast and Midwest with no intention to involve the Northeast – an area where the magazine is not distributed. In the mid-1990's, the NEC determined to bring the day camp program into the Northeast region. Staff identified volunteers and the center supported the costs of the training of volunteers from New York, Pennsylvania and Maine. Additionally the NEC underwrote the expenses (roughly $15/child) of each volunteer's initial day camp. Collaborating with the Progressive Farmer Foundation, the NEC arranged for a special training seminar to be brought to the Northeast. Thirteen new organizer/trainer volunteers attended the 1997 training sponsored by NEC. Six camps involving 566 children were subsequently undertaken with NEC training and sponsorship. The Pennsylvania day camps inaugurated in 1998 have continued since then. Three additional volunteers from NY and ME were trained in 1998-99 and seven day camps with 250 campers in these two states took place in 1999. Additionally NEC personnel assisted at four other larger day camps (total of 870 campers) in New York State. In the most recent grant cycle, this effort received only three years of support. From 2001-2004 NEC personnel organized and staffed 10 safety day camps for 368 children. Additionally NEC staff or NEC regional trainers supported day camps by staffing at least one training station. NEC supported 55 day camps in five states serving 14,270 children.

Program outputs

- Cornell Agricultural Health & Safety Program Agricultural Hazard Abatement and Training Project (AHAT) provides dairy farm owners with a step-by-step plan to "own" injury prevention on their farms. Key aspects are: a) a strong commitment

and ownership of the safety issue by farm owners; b) a team approach to safety (owners and employees together); c) a well-defined safety policy; d) development of skills and e) provision of incentives for people to move their own ideas into action towards safety on the farm. **Products:** training manual, farm hazard safety audit, individualized farm safety plan

- 778 Farm Safety Trainings reaching 35400 farmers and farm youth in VT, NH, NJ, MA, PA, DE, WV, CT, ME, NY
- Farm Safety Brochures – 17
- Farm Safety Posters (English 17, Spanish 17, Creole 3)
- Farm Safety Demonstrations – 7 - NEC
- Farm Safety Articles/PSA/Ads –271 – NY, VT, PA, WV
- PTO and Driveline Hazards and Shielding Video
- Slow Moving Vehicle Video
- NEC website

Program outcomes

- The Cornell AHAT Project has resulted in reduced physical hazards on the farm as well as Workers' Compensation injury claims.
- Safety Day Camp program in the Northeast

Emerging issues

- research is accumulating that demonstrates that traditional knowledge transfer methods are generally ineffective in reducing hazardous behavior. Behavioral research indicates that motivational, self-image and community support issues are critically important in behavior change

Future research

- A rigorous evaluation of three project outcomes will be made among 75 study farms and 39 control farms: owner attitude change, percentage of identified farm hazards subsequently abated, and owner-reported farm injuries. This will assess whether the positive impacts seen in dairy are also found in other commodities, and among different farm-size groups. This a critically important question to answer before undertaking larger-scale AHAT implementation efforts.

- NEC will increasingly rely upon social marketing and community-based techniques to identify areas of needed educational intervention and to evaluate the impact of efforts.

Personal Protection Program

BACKGROUND

Northeastern farmers are at risk of a variety of occupational health problems related to a variety of their exposures. Studies by NYCAMH and others have documented high levels of noise during the routine work day of New York dairy farmers.[59] Similarly, we and others have measured dust exposures to dairy farmers which on occasion vary from high to incredibly high.[60,61] Elevated dust levels have been documented in animal confinement facilities, in grain

storage facilities and a number of other agricultural settings. Exposure to ultraviolet irradiation from sunlight is also common to virtually all forms of agriculture. Data from the New York Farm Family Health and Hazard Survey (FFHHS) show that NY farmers are likely to have high rates of occupationally-related hearing loss, arthritis, allergic disease and malignant/premalignant skin lesions.[62,63] Of 416 randomly selected participants who underwent NYCAMH's multiphasic health screens, less than half of the women and only 20% of the men had normal audiograms in both ears. Of those with abnormalities, nearly 60% had abnormalities in the 4000-6000 Hz range with median thresholds of 53 – 75 decibels for left ears in this range and 54 – 69 decibels for right ears in this range. These findings are quite suggestive of a noise-induced etiology. Spirometry was abnormal in 12.5% of those screened and eight percent of the participants had symptoms of chronic bronchitis. We identified 41 skin lesions felt to be "highly suggestive" of malignancy and 155 lesions felt to be "pre-malignant".[4] In other skin screening activities with an unselected group of NY farmers, we have reported 276 lesions on 172 farmers (23% of the 732 screened). Among these lesions were basal cell cancers (19%), squamous cell cancers (4%), melanomas (4%) and a large number of actinic keratoses (53%).[64]

Thus New York farmers have high rates of disease processes that might reasonably be expected to be reduced by the use of simple protective measures. The farmers are generally aware of these measures and agree that they would likely be helpful – yet only a minority use any of these protective measures. In the New York FFHHS, 496 (92%) of the owner operators felt that PPE is useful during any operations on the farm. Similar opinions were reported by 837 (78%) of the workers.[14]

Despite this awareness, a number of studies demonstrate that compliance with recommended protective measures is poor among farmers. In a NYCAMH survey of 301 randomly selected, stratified sample of NY farms, 73% of farmers reported using respiratory protection "never" or "rarely". The same responses were elicited from 74% regarding use of hearing protective devices.[65] In the NY FFHHS, 42% of 1215 participants used hearing protection when working with noisy farm equipment.[4]

NYCAMH / NEC PROJECTS

NYCAMH / NEC PPE Sales - Rural populations are often subject to the local feed store's decisions about what protective equipment will be available and how much it will cost. NEC outreach staff gathered information from farmers regarding the acceptability of various types of protective devices. Based upon this input, NEC has selected a limited number of types of approved eye, skin, hearing and respiratory protection. Using funding through the NYS Dept. of Health, an initial (1990) inventory of these devices was established at the NYCAMH office. This is now a self-sustaining, non-profit program in which we offer selected types of safety eyeglasses, respirators, hearing protection, pesticide protective garments, hard hats, universal PTO shields as well as our "Play It Safe" game and SMV emblems and reflective markers. These are sold to farmers at prices that are marginally above our purchase price from the wholesaler. The NYCAMH PPE catalogue provides farmers with a brief outline of recommendations regarding the specific type of protective equipment to assist them in their choice. Currently the NYCAMH PPE program distributes these materials to roughly 1500 farmers in five of the Northeastern states and a number of other states. Approximately 2/3 of the PPE business now

occurs at farm shows where many farmers will seek out the NYCAMH booth to buy a year's worth of equipment. Mail purchasing is increasing since our PPE catalogue was placed on the NYCAMH/NEC website . On this site farmers can download order forms for PPE and farmers in NY can also download New York State tax-exempt forms to accompany their orders. We view ready access to appropriate products as an important component of any program aimed at enhancing use of protective measure in a rural population.

Protective Equipment Sales Tax Exemption – Through the efforts of NYCAMH staff, the NY farmers' sales tax exemption was expanded to cover safety-related items including personal protective equipment. Thus, since 1991, NY farmers have been able to purchase PPE tax-free by simply signing a form that assures that they are indeed a farmer and that the equipment is being used for the farm.

NEC Personal Protection Outreach - As part of its outreach effort over the preceding five years, the Northeast Center has carried out a number of health screening events in the Northeast region. Generally these have been done in the setting of a large statewide farm exhibition, a commodity group meeting or the annual meeting of a cooperative. These have always followed a strict NYCAMH protocol that ensures that the health screening is performed appropriately. However our protocol extends beyond the actual screening technique. It assures the types of information gathered at intake, and the types of information and samples given in the review period. It even extends to the follow up of the participant over the ensuing two years.

NEC Outreach Activities

	Health	Screening	Education	
	# of events	# of particip	# of events	# of partici p
1996	9	585	23	3876
1997	5	684	46	1883
1998	2	126	46	3634
1999	9	483	41	2954
2000	5	218	67	4208
Totals	30	2096	223	16555

Using this approach, farm populations across New York and in five other Northeastern states have been screened in the past five years. These screening have served over 2000 members of the arm community over this period. Those with abnormal findings have been referred to their physicians. Regardless of findings, we have followed those who at intake described inadequate use of PPM. Using mailed questionnaires with phone follow up of a sample of the non-responders, we have tracked the PPM behavior of our participants at 6 months and at 24 months. These results have been carefully analyzed by Laura Marvel, RN, an NEC research nurse. At the meeting in Saskatoon in 1998, we presented our findings of consistent improvements in the use of PPM in the range of 30-40% -regardless of the screening results. Our data shows similar outcomes for each of three target hazards (dust, noise, ultraviolet light). [66]

Health Screening and Disease Prevention/ Hazard Abatement 2001-2003 - This project was funded for three years with the aim of preventing injury to farmers resulting from excessive exposure to loud noise and inhaled organic dust and other potentially toxic materials. Farmers and their families and workers were invited to participate in hearing or respiratory health screenings, usually in the setting of a Farm Bureau or commodity group meeting or an agricultural exposition. After the screenings we reviewed the results with the farmer and family, briefly outlining the concerns about various unprotected exposures. We gave participants samples of appropriate protective equipment with lists of nearby suppliers as well as the NYCAMH PPE catalogue for mail orders. Finally we talked briefly about strategies for hazard abatement. These short individual and family training sessions ended with solicitation of a "Pledge to try" from participants regarding both the use of the specific form of protective equipment and the strategy discussed for abatement of hazard. Participants were contacted by mail six months following their screening to compare current usage of protective equipment to that described at the time of the screening. Information was gathered on efforts at hazard abatement as well. A sample of non-responders was contacted for telephone interviews.

From 2001-2004, a total of 392 farmers underwent respiratory screening, and 209 had hearing screening. Since the purpose of this intervention was to promote PPE usage among non-users, follow up focused on "poor users" - those who described their PPE use in appropriate situations as "never," "seldom," or "occasionally" (79.3% for respiratory and 69.9% for hearing). 54.5% of respiratory and 65.5% of hearing participants responded to the follow-up evaluation through a mail or telephone survey. Subsequent results reflect the weighted proportions of their responses. Of particular interest were "poor users" who converted to "good users" ("usually" or "always").

Table 1: Self-reported exposure, PPE use, pledged and actual use improvement among NYCAMH hearing and respiratory screening participants, 2001-2004

Exposed to Hazard	Respiratory		95% C.I.	Hearing	%	95% C.I.
	(n = 392)			(n=209)		
Poor Users	311/392	79.3%	75.4-83.2	146/209	69.9%	63.7-76.1
Pledges	208/238	87.4%	83.3-91.5	90/96	93.8%	89.1-98.5
# Followed-up	102/208	49.0%	42.1-55.9	74/90	82.2%	74.3-90.1
Improved Use	26/102	25.5%	17.1-33.9	22/74	29.7%	19.3-40.1

Table 2: Hazard identification, pledged and actual hazard abatement among NYCAMH hearing and respiratory screening participants, 2001-2004

Abatement	Respiratory	%	95% C.I.	Hearing	%	95% C.I.
	(n=392)			(n=209		
ID Hazard	385/392	98.2%	96.89-99.51	194/209	92.8%	89.3-96.3
Pledge	55/385	14.3%	10.8-17.8	19/194	9.8%	5.7-13.9
# Followed-up	22/55	40%	27.1-52.9	12/19	63.2%	41.6-84.8
Change	17/22	77.3%	59.9-94.7	7/12	58.3%	30.4-86.2

Thus this respiratory health screening-based promotion of PPE usage and hazard abatement succeeded in converting 25.5% of "poor users" to "good users" of appropriate PPE. Likewise the hearing health screening-based promotion succeeded in converting 29.7% of "poor users" to "good users" of appropriate PPE. In respiratory participants, this resulted in an estimated overall shift of PPE usage from 20.7% to 46.2%. The shift in hearing participants was slightly larger at 30.1% to 59.8%. Results with hazard abatement efforts were less encouraging, although 17(30.9% of pledges) respiratory participants and 7 (36.8% of pledges) hearing participants did report implementation of successful hazard reduction efforts.

Outputs

- 1 publication submitted
- 3 abstracts presented to national meetings
- a health screening methodology demonstrated to increase regular use of PPE by 25-30%
- health screenings on several thousand farmers in various Northeastern states

Outcomes

- NY legislation exempting farmers from sales tax for purchase of PPE
- An ongoing program that provides quality, inexpensive PPE to farmers and rural people

Emerging Issues

- impact of zoonoses
- rising proportion of employees as farms grow in size – many of these immigrant
- increasing need to provide language appropriate information on PPE indications and use

Research Issues

- how to most effectively promote appropriate use of PPE for agricultural exposures
- how to address abatement issues effectively at the same time as promoting PPE use

Agrichemicals Program

In 1997 at the request of local farmers, the NEC provided roughly $5,000 to sponsor a county-wide collection of unwanted agrichemicals stockpiled on local farms. Many of these materials had accumulated on farms for years in lieu of any effective mechanism for disposal. Because of the success of this initial effort, five subsequent collections have been fully or partly sponsored with either NYCAMH or NEC funds, always in the range of $5,000 per year. Following up on this experience, in 1999, the NEC undertook a more systematic assessment of this phenomenon in New York State. Thirty-one of the state's leading agricultural counties were contacted (usually the solid waste officer) to inquire about agrichemical collection experience in

that county. Recent collection events were identified in seven counties and records of the materials collected were analyzed.

A total of 54,214 pounds of material was collected from a total of 123 farms. The median amount per farm in the various counties ranged from 53 pounds to 179 pounds. This material was predominantly pesticides with fungicides and insecticides accounting for 49.6% of the total. Notably, environmentally threatening compounds - organochlorine agents (i.e. DDT) and arsenicals - were the leading classes recovered, despite the fact that organochlorines have been banned for three decades. Twenty-seven per cent of the agrichemicals were recovered in containers that were "unacceptable, leaky or poor". The average cost of $2.20 per pound included the cost associated with analysis of unknown compounds, collection and disposal of the agrichemicals.

The 54,214 pounds came from .32% of the state's estimated 38,000 active farms. It was felt likely that substantial amounts of agrichemicals remained on New York farms - including those that were no longer actively farming.

Survey information from 31 leading upstate agricultural counties indicated that slightly over half (55%) had ever conducted an agrichemical collection. Of those with previous collections, one quarter were planning future events. Of those with no previous collections, 18% were currently planning a collection. Further analysis of EPA funded "Cleansweep" pesticide collection programs showed that NY had its first EPA-sponsored collection in 1993. Of the 17 states that had initiated collections in 1993, nine had permanently funded programs, five had continuous collection programs without permanent funding and three (including NY) had failed to establish an effective ongoing program. As of 2000, only one other state (New Jersey) was relying upon county initiative and funding for such activities. These findings were published in the scientific literature.

The Northeast Center then entered into coalition with the New York Rural Water Association and the Northeast Rural Community Assistance Program to address this issue through policy change. Contracting with the Maxwell School at Syracuse University, two focus groups were convened in 2001 and 2002. These included representatives of various county and state agencies, NYS Farm Bureau, NYS legislative aides, EPA and others. Subsequently coalition members presented their findings to the NYS Soil and Water Board, NYC Department of Agriculture and Markets and various legislators. A NEC researcher completed an in-depth assessment of pesticide use in NY, storage conditions and their potential impact upon human health in the state. This material was communicated in a "white paper" report "*AGRICHEMICAL DISPOSAL INITIATIVE: A Report to New York State on Farm Pesticide Collection"*. This report also examined the experience and design of a number of other states' pesticide collection systems, outlined the barriers to change and recommended a statewide program of annual collections at the farmstead to be financed by a small increase in the state's chemical registration fees. These added funds would be used by the NYS Departments of Environmental Conservation and Agriculture & Markets to establish and maintain the collection program. The white paper was widely distributed to state legislators over the ensuing year.

Senate Bill 4524 "An ACT to amend the environmental conservation law, the agriculture and markets law and the state finance law, in relation to establishing a farm agrichemical and pesticide collection program" was first introduced in 2003. This bill proposed the increase in chemical registration fees and related program described above. At this point the bill is S-4884-B. It has been passed by the NYS Senate and hopefully will be considered by the Assembly in the coming year. The Department of Environmental Conservation has not endorsed the proposed legislation due to concern over having to increase registration fees. However the proposal of this legislation has engendered a considerably more proactive approach to this problem by the department. Since 2002, it has sponsored a total of five regularly schedules regional collections moving around the state. A total of a half million pounds of unwanted pesticide have been collected in these activities. New York's program has progressed from an EPA classification of "intermittent" to "continuous". However the state still has no defined stream of funding for these collection activities and continues to rely excessively upon county-level organization and funding. For this reason the NEC – NY Rural Water coalition continues to press for legislation of a funded, ongoing, statewide program.

Nitrates in Groundwater on Dairy Farms – This feasibility type study followed 11 central NY dairy farms through an entire years with monthly sampling of well water for nitrate levels. Nitrate / manure depostition was quantitated and located relative to the well. Soil type and topography were recorded from county soil maps for each farm. Levels were generally well within acceptable levels. One farm was clearly elevated and remained so throughout the year, another farm had borderline levels and these also did not fluctuate significantly.

Comparison of Pregnant Farmers with Non-pregnant Rural Women – Anecdotal bservations raised concerns that potentially hazardous behavior in relation to work intensity, chemical and pharmaceutical exposure represented a significant risk to pregnant farm women. This study followed pregnant farmers and non-farmers on a monthly and then bi-monthly basis through their pregnancies with detailed questionnaires. Based upon 145 completed questionnaires collected over the course of 31 farmer pregnancies and a similar number of non-farm rural dwellers, we found that the number of hours worked and the intensity of this work are similar in groups of matched pregnant farm women and non-farm, rural women. Careful review of a number of potentially troublesome chemical exposures also showed that there were no statistically significant differences. We conclude, based upon this preliminary data, that pregnant farm women, as a group, are generally not exposed to more hazards - either chemical or exertional - than their non-farm counter parts. The notable exception to this is the exposure to oxytocin, a hormone used on dairy farms which, if systemically absorbed, could have significant impact on the course of pregnancy. The importance of more exposures among their husbands/partners during this period is unclear.

Program Outputs:

- two published papers
- an effective coalition with NY Rural Water and Northeast Rural Community Assistance Program
- a "white paper" publication widely disseminated to state legislators and stakeholders

- two focus group meetings used to spotlight this problem for state agencies and legislators
- numerous group and individual presentations to agencies and legislators
- S-4884-B, a bill to establish a funded, ongoing, statewide solution to this problem

Program Outcomes:

- a clear increase in the intensity and distribution of collection efforts undertaken by the NYS
  Department of Environmental Conservation as documented at:
  http://www.dec.state.ny.us/website/press/pressrel/2006/200657.html

This program is an example of a productive undertaking that was not specifically planned by the NEC. The collection project arose from grassroots interest and the availability of center director discretionary funds for the collections, the study, the "white paper", and contribution to the focus group costs proved to be extremely significant. Overall expenditures for this activity are under $50,000.

Migrant Injury Program

The NEC initially attempted to explore the issue of occupational injury to migrant and seasonal farmworkers in 1994. At that time with feasibility-type funding an injury surveillance questionnaire was developed for pilot testing in western NY. Designed to be administered in the camps by migrant clinic health outreach workers, the survey was long and required written consent for the IRB. This was an abysmal failure, with the vast majority of workers refusing to sign the consent and the remainder unhappy with the length and content of the instrument. Based upon this learning experience, the NEC spent the next year and one half listening to farmworkers, employers and stakeholders regarding acceptable approaches to injury data gathering. The projects described below all flow from this effort and the epidemiologic surveillance methodology that emerged from it. Throughout, the intent of this program was to define the epidemiology of migrant injury on a regional basis and then explore and test potential methods of intervention in partnership with all stakeholders. In all of this there has been a commitment to ongoing, clear communication of problems and solutions to all stakeholders through media that effectively transmit information to the target stakeholder group.

As elsewhere in this report, those projects not directly supported with NIOSH Northeast Center funding are briefly described in italics.

Chronology of the Northeast Center Migrant Injury Initiative

Epidemiology - - - - - - - → **Ergonomic** - - - - → **Intervention** - - - - → **Dissemination**

1. Focus Group Study - 1996
2. Injury Surveillance Pilot Study – 1997
3. Orchard Observation Study – 1999
4. Orchard Training Program 1999
5. Multi-state Study – 2000
6. Communications 2000
7. Pilot Ergonomic Innovations Study - 2001
8. Estimation of NYS MSFW – 2002
9. Migrant Dairy Study – 2002
10. Vegetable Training Program - 2002
11. Occupational Health Manual for Migrant Clinicians - 2002
12. Maine – NY Community-based Interventions - 2003
13. Physiol & Economic Evaluation of Bag Intervention – 2004
14. Migrant Health Utilization Survey –2004
15. Estimation of the Maine MSFW population - 2005
16. Span-Creole NEC Website - 2005

1.) 1996 - Focus group study (n=116) *Purpose:* to obtain descriptive information about the social and political climate within which migrant and seasonal farmworkers operate in New York State, focusing on factors that would impact the design of a future occupational injury and illness surveillance system.

Methods: researchers held focus groups with farmworkers (44), farmworker medical care and social service providers (47), farmworker employers (9) and other farmworker researchers (16).

Results: the following key themes emerged: 1) participants in research (subjects and data collectors) need to understand the benefits of participation; 2) interest and support for this research exists in the employer community; 3) farmworkers are more willing to participate when they have a personal connection to the individuals conducting the research; 4) farmworkers had little awareness of the concept of occupational health and safety, or that working conditions could be improved. The most notable finding was 5) the fear among farmworkers of individual interviews. Such interviews were generally regarded as potential threats to continued employment and possibly giving rise to immigration issues.

Significance: This input led to the decision to base future surveillance upon medical records rather than interview data.[67]

2.) 1997 - Farmworker medical records surveillance study (n=517) *Purpose:* a pilot study to see if a health center-based medical records surveillance model could provide meaningful epidemiologic information on MSFW occupational injury and illness.

Methods: between 1997 –1999 the billing records of all participating migrant health clinics were scanned for diagnoses suggestive of occupational illness. Each of these charts was reviewed with incident details being entered into a SAS database without any patient identifiers.

Results: in all, 693 medical visits were reported from migrant health centers in New York and Pennsylvania, representing 517 cases of injury or illness, involving a total of 473 workers. This preliminary data indicated that within the study region strains (back, shoulder), falls from ladders and contact dermatitis (plant material) were the most common occurrences. Seventy-four percent

of all injuries and illnesses occurred in orchards, reflecting the leading commodities of the region surveyed.

Significance: this pilot study demonstrated the potential of the migrant clinics as partners in an ongoing injury surveillance project. Frequent communication, respect, attention to financial necessities and joint ownership of data were seen to be essential if these partnerships are to be productive.[68]

3.) 1999 - Ergonomic study of orchards in New York (n=84) *Purpose:* to pinpoint source(s) of muscle sprain/strain in orchard workers noted in study 2 (above) and to identify strategies for prevention.

Methods: observational and semi-quantitative research conducted by NYCAMH and ergonomic consultants from the University of Massachusetts at Lowell during the apple and peach harvests of NY and PA.

Results: Eighty-four workers harvesting on 12 orchards were observed during September and October of 1999. The back and shoulder appeared to be impacted by three major factors: 1) downward pressure from the bucket's straps; 2) stress from reaching with elbows over shoulder height; 3) strain from carrying the ladder. Strain to the back appeared to be the result of three different picking circumstances: 1) strenuous picking postures; 2) bending to empty the picking bucket into bin; 3) supporting a full load of apples with the lower back. [69]

Significance: Recognition of these adverse ergonomic conditions led directly to the next series of NEC orchard ergonomic intervention efforts.

4.) *1999- New York Orchard Owners Safety Program (Funded by the NYS Dept.of Labor)*

Purpose: to provide safety training materials and technical assistance to orchard owners in NY.

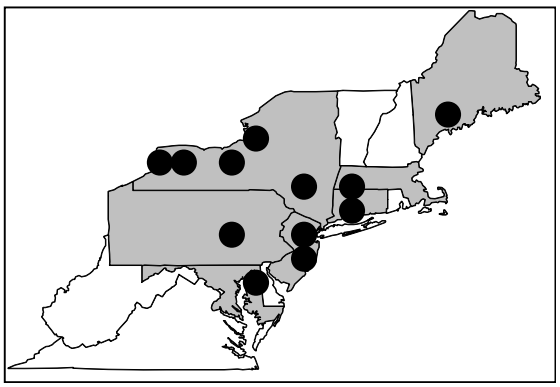
Methods: A NEC educator visited orchards employing MSFW before the harvest season to assist the owners in developing the safety training for their workers. Owners are provided with Spanish language, low literacy safety training materials (posters, brochures, check stuffers) as well as assistance in the actual training sessions.

Results: The NEC trainer annually visits some 170 of the NY's most productive orchards (the vast majority of NY apples come from about 200 orchards). There are no data showing reduced injury, however the program has received very positive response from the owners who often suggest other areas for training support.

Significance: The program has provided NEC with valuable contacts in these commodities that have been of great assistance with the development and testing of various interventions. Eventually this program and its network of orchards will provide an important dissemination mechanism for interventions found to be effective.

***5.**) 2000 - Multi-state study of occupational illness and injury among farmworkers in the Northeast: (NCI R01 support)*

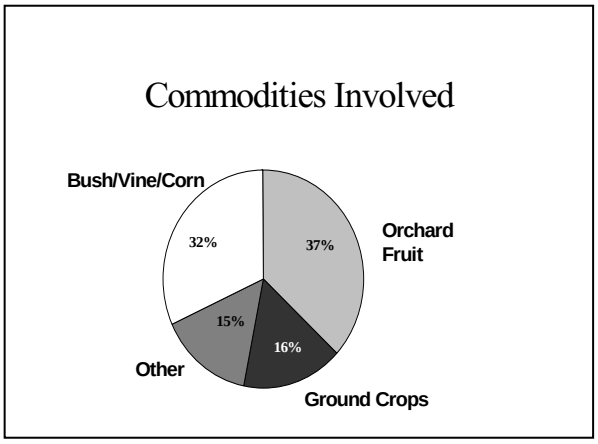
Purposes: to establish an effective occupational injury surveillance system based in federally supported migrant health centers in the Northeast region; to collect data on injury events; to compare these injury rates with Workers' Compensation (WC) rates of injury; to use these data to assist migrant health centers to better understand occupational health problems in their regions.

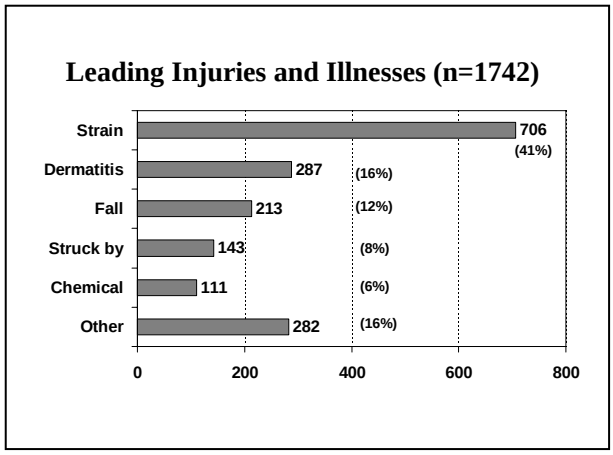


Methods: clinical records and WC data were collected in New York, Pennsylvania, New Jersey, Massachusetts, Maine, Connecticut and Maryland. The study design is a comparison of two methods for estimating the incidence of occupational injury and illness in MSFWs. This is based on data collection in seven states over three years. The incidence of all types of injury/illness are being estimated for each of the subject counties using MHP medical visit counts and then Workers' Compensation claim counts as numerators, and Department of Labor estimates of each state's migrant and seasonal farmworker population as the denominator. The second part of the study design is a purely observational analysis of migrant and seasonal farmworker occupational injury and illness patterns, stratified by worker type and injury severity.

Results: Information on over 1700 injury/illness cases has been collected. This has provided detailed farmworker injury and illness incidence rates that are available for use in this proposed intervention project.

These figures represent the combined findings from seven states. Specific findings, which have been reported back to each MHP, demonstrate considerable regional variation due to differences in crops and possibly differences in the worker populations. This specific data has proven to be of great use to each of the community teams in selecting target problems and designing interventions.





These multi-state injury data help form the basis upon which future steps of the NEC initiative depend. These data are now assisting work teams with the identification of priority problems and can eventually be used in the impact evaluation of attempted interventions. In the project being currently proposed, the placement of project personnel within each of the community based MHPs will assure the steady flow of local data on MSFW injury and illness throughout the intervention and evaluation phases of this project. (Workers' compensation data proved highly variable from state to state in terms of its accessibility. It was consistently unreliable due to substantial underreporting of injuries).[70]

6.) 2000 - Communication of Findings to Migrant and Seasonal Farmworkers: The NEC's growing expertise in migrant occupational health and its ready access to the migrant community have been recognized in recent years by the National Institute for Occupational Safety and Health. In 2000, NIOSH asked NEC to assist in piloting the Spanish language version of their ergonomic publication "Simple Solutions". Subsequently NEC was awarded a NIOSH contract to provide a Spanish language summary of the National Agriculture Workers Survey (NAWS) that makes the NAWS findings readily accessible to individuals of limited literacy.

Methods: A series of focus group meetings with farmworkers explored the utility of concepts such as "percentage" and "injury prevention" in such a publication. An interactive format that stresses the everyday applications of the NAWS findings has been designed with the assistance of our farm workers consultants. It has been pilot-tested at several Northeastern migrant clinic sites.

Results: The format that eventually proved most relevant and comprehensible to Hispanic workers was a derivation of a photonovella in which safety and health data was conveyed as part of a story involving individuals and work situations that seemed realistic to the workers.

Significance: These materials are now available to workers at clinic and other sites. Other NEC migrant informative materials are now being produced in this same format. All NEC-produced migrant materials are available for easy downloading by employers and other interested individuals on the Spanish and Creole sections of the NYCAMH / NEC website (nycamh.com).

7.) 2001- Pilot Test of Ergonomic Innovations in New York Apple Orchards: (n=12) *Purpose:* to identify and test simple, low-cost equipment / procedural changes that reduce some of the hazardous postures noted above.

Methods: Data from the injury surveillance and the ergomonic observations noted above were presented to a series of owner\worker focus groups. Working with the consulting ergonomist these groups produced recommendations for two modifications of the orchard worker's shoulder strap and basket. These were then evaluated for both ergonomic and economic effect in detailed observational studies with 15 workers in two orchards. Following extensive training in the technique of PATH (posture, activities, tools, handling)[71] NEC staff systematically documented workers posture and picking activity every 45 seconds for four days – a total of more than 12,000 individual observations – during the course of a crossover trial of the apple bag modifications. Subsequent preliminary electromyographic (EMG) tests were used to study muscle activation in the more common picking postures.

Results: Modifications aimed at displacing some of the weight of the basket from the shoulders to the hips appeared to be successful. Interviews with workers involved in the trial indicated that well over 80 percent preferred the new design. The trials did point out several problems with the design that are currently being pursued. Pilot EMG work indicated significant unloading of the back muscles with the improved apple bucket.[72,73]

Significance: Eventually we expect that these innovations will be disseminated to apple orchards throughout the state and region by the NYCAMH orchard safety program.

8.) 2001- Enumeration of Migrant and Seasonal Farmworkers in New York *Purpose:* to conduct a detailed enumeration of the farmworker population size in NY, by commodity and county. This provides the needed population estimates for calculating injury incidence rates in the Multi-state Study of Occupational Injury and Illness Among Migrant and Seasonal Farmworkers, described above.

Methods: a specialist in farmworker enumeration was contracted to use a method known as the "demand for labor" approach to estimate the size of the workforce needed to accomplish the total harvest in New York. This work is a refinement of the method used by this same researcher in her work for the U.S. Health Resources and Services Administration, Migrant Health Program.[74]

Result: comparison of these results to the enumeration performed by the Dept. of Labor shows substantial differences, suggesting an undercount by the DOL methodology of nearly 50 percent of the total workers in some areas.[75]

Significance: With a more accurate estimate of workers, injury rates can be calculated for epidemiologic work. The clearer picture of distribution of workers by county helps the planning of various intervention efforts. These findings have proven to be of considerable interest to the NYS Dept. of Labor.

9.) 2002 - The Hispanic Workforce in Northeastern Dairy: Size, Growth and Implications for Health and Safety: (n=294) *Purpose:* to describe the magnitude and growth rate of foreign born, Spanish-speaking workers entering the Northeastern dairy workforce

Methods: Information on hiring practices, current employees and workplace injuries has been gathered quarterly with telephone interviews of owners of 294 large / medium sized dairy farms in NY, PA and VT.

Though these calls we also acquired detailed data on task assignments for Hispanic and non-Hispanic dairy workers and specific information on any occupational injuries experienced by any of the workers

Results: There was a clear trend toward increased employment of Hispanic workers – roughly 30% over the four years of the study (still being analyzed). Hispanic workers have a much narrower range of job assignments – usually milking and work with the herd. These workers experienced about half the injury rate of the non-Hispanic workers.

Significance: We have demonstrated that increased use of Hispanic workers on Northeastern dairies is a significant trend for the future. For reasons not yet explained, but probably relating to the narrower focus of their activities, these workers are currently safer than the traditional dairy worker. Farmers need to recognize that, unless specific strategies are in place, as these workers' jobs expand, their risk is likely to increase also. Because dairy is a major commodity in the Northeast (NY, PA and VT are ranked 3RD, 4TH and 14TH nationally), the results of this work will have substantial implications for the planning of interventions on Northeastern farms.[76,77]

10.) *2002 - New York Vegetable Safety Program: (Funded by the NYS Dept.of Labor) Purpose: to provide safety training materials and technical assistance to vegetable growers in NY.*

Methods: This approach is the same as the orchard program described above, focusing upon the vegetable growers of western and southeastern New York.

11.) 2002 - Occupational Health Manual for Migrant Clinicians: Purpose: NYCAMH data indicates that 15-20% of migrant clinic visits relate to occupational problems. Data collected by the Migrant Clinicians Network show that most clinicians have had very limited instruction in occupational medicine and feel unprepared to deal with many of these problems.

Methods: A loose-leaf manual designed for ready access in the examining room provides information ranging from cultural differences of various migrant groups to descriptions of specific commodity work and the patterns of injury documented for each commodity by NYCAMH research. Treatment guidelines for common problems are included as are photocopy-ready patient information sheets in Spanish and Creole. This manual has been reviewed extensively by both occupational physicians and migrant clinicians. It began beta testing in the fall of 2005.

Results: pending

Significance: This manual will hopefully address a weakness (as perceived by the clinicians) in the services offered by most migrant clinics.

12.) *2003 - Maine – NY Community Coalitions for Migrant Farmworker Safety and Health: (NIOSH Envir. Justice funding) Purpose: use a community-based approach to prioritize occupational health issues and design locally pertinent interventions.*

Methods: Work teams composed of migrant workers and farm employers meet regularly to assess information from epidemiologic research as well as community input gathered from focus groups and key informant interviews of community members.

Results: Musculoskeletal injury in blueberry raking and eye irritation in "black dirt" vegetable production have been identified as priority problems. Interventions are currently under evaluation.

Significance: The experience gathered by NYCAMH staff in the organization and execution of this project has built upon that gathered initially in the orchard ergonomic work. We currently have a clear understanding of the challenges and capabilities of the community-based approach.[78]

13.) *2004 - Physiologic and Economic Evaluation of the Ergonomically-Improve Apple Bag: (NIOSH R01) (n=102) Purpose: Based upon worker satisfaction data and interest on the part of growers, the ergonomic bag is a success. We are still seeking to evaluate this more thoroughly to rule out placebo effect.*

Methods: The bag is being evaluated in several ways. An extensive multi-orchard placebo controlled crossover trial involving 102 workers was carried out in the harvest season of 2004. Data from worker questionnaires, measurements of shoulder and back strength / fatigue and records of picking productivity are currently under analysis. Laboratory-based EMG trials are currently underway with plans for orchard EMG evaluations during the fall 2005 harvest season.

Results: The workers approval rates approached 90%. There appears to be some evidence of reduced muscle fatigue based upon pre-post strength testing. Picking productivity appears to be enhanced. EMG data are pending.

Significance: The re-designed apple bag shows real promise for unloading injury susceptible muscle groups in orchard workers. With refinement of the design and further testing, it will be ready for full production and use in apple and hopefully other orchards as well.[79]

14.) *2004 - Migrant Health Utilization Study: (NCI R01) Purpose: NYCAMH has demonstrated the efficiency and utility of migrant clinic record surveillance for patterns of occupational injury and illness. A clear understanding of what proportion of injured workers seek care at the migrant clinics vs. other potential care providers is lacking.*

Methods: A proven survey instrument will be administered to all consenting workers in selected camps on a weekly basis throughout the work season by Spanish-speaking staff. This will gather information on sites of injury health care and factors affecting the choice of these sites. Data on injuries will be gathered for validation of our existing clinic / ER based chart review surveillance methodology. This will be completed in one NY region in the 2005 season and in Maine in the 2006 season.

Results: pending

Significance: Our surveillance for injuries seen in the clinics is good. We need good data on what proportion of all injuries these represent and whether these are similar to those seen elsewhere to have a complete surveillance system.

15.) *2005- Enumeration of Migrant and Seasonal Farmworkers in Maine (combined NCI + NIOSH R01 funding) Purpose: to conduct a detailed enumeration of the farmworker population size in the state, by commodity and county. This provides the needed population estimates for calculating injury incidence rates in the Multi-state Study of Occupational Injury and Illness Among Migrant and Seasonal Farmworkers, described above.*

Methods: a specialist in farmworker enumeration is contracted to use modifications of the same "demand for labor" approach described above in #8.

Result: pending

Significance: With a more accurate estimate of workers, injury rates can be calculated for epidemiologic work. The clearer picture of distribution of workers by county helps the planning of various intervention efforts. These findings are of considerable interest to the Maine Migrant Council.

16.) 2005 - Spanish – Creole NYCAMH-NEC Website: *Purpose:* As part of NYCAMH's decision to optimize communication of all research findings and all safety information to the migrant and seasonal workforce, appropriate sections of the existing website have been translated into Spanish and Creole.

Methods: Large sections of the research results and educational materials sections of the current NYCAMH website have been translated into both Spanish and Creole. Currently these translations are under review by a secondary translator. In addition to that currently on the NYCAMH English site, downloadable educational materials specifically designed for low literacy subjects (see # 6 above) are also included.

Results: We are currently uploading of these materials onto the website and will add others as they are developed.

Significance: Many of the educational resources for use by employers and workers will be readily available for downloading. Communications regarding the findings of migrant research projects will always be posted here, though other dissemination avenues are more likely to be of primary importance in reaching most workers.

17.) Migrant Safety Education - This project utilized the migrant education network to contact migrant farm workers and their families for instruction in basic farm safety and first aid. Migrant outreach workers were used for this training and their efforts were supplemented by NEC personnel. Participants were given personal first aid kits in an effort to attract wider participation. A total of 373 of the 500 kits were distributed in association with health training events. This took place at 12 different migrant education facilities in 5 states. Trainings covered heat stroke, back injuries, hearing protection, protective equipment, AIDS, pesticides, general hygiene and local clinic resources. These events generally took place in local clinics but also on-site at some farms and were attended by both Jamaican and Hispanic workers and worker/parents.

Collaborations

- close and ongoing migrant health programs throughout the NEC region
- Migrant Clinicians Network
- Eastern Stream Migrant Forum
- Fruit and vegetable commodity groups in NY and elsewhere
- Ag Affiliates – a lobbying and business group for employers of migrant labor
- Numerous orchard, blueberry and vegetable producers in the Northeast
- NIOSH – work on "Solutiones Simples", communication of NAWS data to farmworkers
- Pacific Northwest Agricultural Safety and Health Center – joint trial of ergonomic picking belt is upcoming in fall 2006.
- Penn State University

Outputs

- 14 scientific publications
- a published method for estimating migrant and seasonal farmworker population size using a demand for labor methodology based on published production data
- a commodity-based occupational handbook for migrant health center physicians
- a series of posters on a variety of workplace hazards available in both Spanish and Creole
- a series of Spanish and Creole language safety brochures covering a number of pertinent occupational hazards with a photo novella format.
- a website offering foreign language safety education materials for employers of Hispanic and Haitian workers
- 11 geographically specific occupational injury and illness reports characterizing the catchment areas of the Northeastern Migrant Health programs in terms of patient demographics, common crops and illness or injury types.

- Slide presentations for each region for use by the migrant health programs in talking to lawmakers, other staff and the public about farmworker occupational health in each community
- A “tailgate” safety training curriculum for orchards covering a range of topics including safe lifting, to eye safety, ladder safety, poison ivy, and others.
- A similar “tailgate” safety training curriculum tailored to vegetable crops.

Outcomes

- A hip belt that attaches to the typical fruit harvesting bucket that provides ergonomic support, reducing load on the upper back and shoulders.

- a community-based intervention methodology for migrant farmworkers and their employers

- a functional collaboration with the migrant health programs of the Northeast aimed at addressing occupational health problems

- heightened awareness of occupational health problems and appropriate patient management among migrant health care providers and support staff

- increased cooperation between Dept of Labor, Migrant Health Centers, and farm owners relative to injury prevention

- Recognition that musculoskeletal strain is the most common complaint of migrant and seasonal farmworkers seen at migrant health centers , regardless of crop or region

- Determined that a large number of farmworkers use the hospital emergency room for non-emergent problems

Emerging Issues

- A severe labor shortage in the dairy industry has created a demand for foreign-born former migrant and seasonal crop workers. There are a number of potential health and safety issues related to relatively inexperienced Spanish-speaking workers taking on this work.
- fear generated by the current climate regarding foreign workers in the U.S. has consequences for occupational health and safety. Employers and workers are increasingly anxious and mistrustful of trainers and researchers, fearing that they may be Immigration officers.
- Employing migrant and seasonal farmworkers: an ever-growing regulatory burden on small farms. How do small farms comply with fair labor practices, housing regulations, and immigration law and still have workers in the rural Northeast?

Future research

- Migrant farmworker injury surveillance will be included in the farm injury surveillance study proposed for 2006 using statewide EMS ambulance reports
- A study of how migrant and seasonal farmworkers obtain medical care for occupational injury and illness, and what supports are provided by agricultural employers. This study will also determine what differences there are between migrant and seasonal farmworkers who use the federal migrant health program and those who do not.

Comment

Review of this program demonstrates the importance of the center in initiating and providing the basic support for an occupational safety initiative. These funds can then be extensively leveraged to build a much larger, more diverse and more meaningful program.

It should be noted that several of these projects overlap with projects in other program areas – most notably in Musculoskeletal / Ergonomic. For completeness, these overlap projects will be commented upon in more that one program discussion, but will be budgeted at only one site, the program that most specifically fits the project's characteristics.

Musculoskeletal / Ergonomic Program

Efforts by the NEC in this area initially were concerned with traditional family farmers, particularly dairy farmers. Data from the NY Farm Family Health and Hazard Survey (FFHHS) document a prevalence of osteoarthritis, particularly of the knee that is greater than that experienced by the general population as defined by the NHANES data. As NEC surveillance of migrant clinic medical records became feasible, it was apparent that musculoskeletal problems are the major health issue for many migrant and seasonal workers.

Manual crop harvesting requires rapid, repetitive motions, repeated lifting of heavy weights and holding awkward postures for extended periods. Under the pressure of the short harvest period, they are often paid piece-rate, which discourages adequate breaks and rest. Many are Spanish- or Haitian Creole-speaking and experience cultural and linguistic isolation, uncertain legal status and extreme dependency upon the employer, all of which further exacerbate occupational safety risks.[80,81,82]

Many thousands of these individuals work at orchards in the Northeast each year. The New England and Middle Atlantic states account for more than one fifth of the country's apple production and produce substantial amounts of other tree fruit. The 2.2 billion pounds of apples picked in this region in 2000[83] required the effort of an estimated 15,000 to 20,000 workers — largely seasonal and migrant.[84] Typically the harvesting process involves the use of "apple bags". These are usually ovoid plastic buckets with a tubular canvas extension at the base that can be folded to retain the apples or released to empty the apples through the bottom (see photo, left). A filled bag weighs 40 to 45 pounds and is suspended from the shoulders by canvas straps so that the bucket hangs in front or to the side of the torso slightly below the waist. To gently deposit a

full bag of apples, the worker must bend severely at the waist over a three foot high "bin," which can contain roughly 20 bags or about a half ton of apples. The average worker fills some 4 to 10 bins per day.

These orchard workers are at particular risk for musculoskeletal problems related to harvesting fruit. The New York Center for Agricultural Medicine and Health (NYCAMH) has focused upon occupational injury problems affecting these orchard workers as well as other migrant and seasonal farmworkers in the Northeast for the past seven years. Recent efforts have been guided by NYCAMH surveillance efforts that successfully defined patterns of injury experienced in specific regions and with specific commodities.[85] The most notable finding in this work is the high rate of medical visits related to shoulder, neck and back strain among orchard workers,

NYCAMH / NEC Projects

Hip – Knee Arthritis in Dairy Farmers – NEC investigators recruited 61 dairy farmers aged 55-65 and 31 non-farm rural controls in the Otsego Hip-Knee Study. The farmers had increased rates of radiographic changes indicative of hip osteoarthritis. Rates of changes at the knee were strikingly higher that the hip and the severity of the knee arthritis were notably greater in the farmer group. Presence of arthritis at either joint correlated best with indicators of work intensity such as number of cows milked, number of acres and the ratio of cows milked to workers available.

Farm Family Health and Hazard Study – The joint examinations of 416 farmers examined as part of the NY-FFHHS served to confirm the findings noted above. Arthritic changes at the hips and back were outweighed by changes at the shoulder and all were dwarfed by the frequency of knee problems. These occurred in younger farmers as well as older farmers. Dairy farmers had higher rates of knee disease than other commodities, but not by much.

Ergonomics of Dairy Farming – In collaboration with ergonomists at Univ. Massachusetts – Lowell, a study of dairy farmers in Otsego County, NY was undertaken. Common farm work activities cited by farmers in the Otsego Hip-Knee Study were systematically examined by farm observers using PATH (Posture, Activity, Tools and Handling) analysis techniques. Particular attention was paid to tasks such as milking, feeding, barn chores and field work. Frequency of various postures related forces exerted on major joints were calculated for each of these tasks. Subsequent analyses failed to identify any factors that could be statistically related to presence of arthritis in arthritis farmers vs. non-arthritic farmers.

Ergonomic exposures in apple harvesting – With the recognition of a pattern of excessive musculoskeletal injuries in orchard workers visiting Northeastern migrant clinics, NEC investigators undertook a preliminary feasibility project aimed at assessing ergonomic exposures in apple orchards. Semiquantitative observations of 81 workers in NY and PA apple orchards demonstrated excessive periods of one or both elbows lifted above the head, dangerous reaches and frequent severe forward flexion on the spine with a loaded apple bucket (45 lbs) suspended from the shoulders.

Orchard Ergonomics Pilot Project – This two year pilot project was designed to explore potential solutions to two problems observed during the course of previous NEC work: 1) a large number of visits to migrant health clinics for back and shoulder problems related to apple picking; 2) semi-quantitative observations of ergonomic problems associated with apple picking.[86] Using a unique community-based approach that sought input from both farmworkers and orchard owners, NEC researchers identified the apple-picking bucket as a potential area for intervention. NEC researchers constructed multiple iterations of a new design. Each version was taken back to the community and was, in turn, rejected for reasons that were obvious to workers (but had not been obvious to the NEC researchers). Eventually a design was accepted as suitable for field-testing. After initial pilot tests, a controlled trial of the new bucket vs. the standard bucket was undertaken with 14 workers in 2 orchards. This trial also involved a detailed documentation of the specific ergonomics of apple picking using the PATH (posture, activities, tools, handling) approach.[87] We recorded over 10,000 postures in the 2 days of timed sampling and now NEC researchers know exactly what proportion of picking time is spent in any particular posture.[88] Questionnaire data demonstrated that well over 80% of workers preferred the NEC bucket. Subsequent preliminary work in the laboratory suggests decreased muscle activation by electromyogram (EMG) when subjects assume common postures with loaded NEC buckets vs. standard buckets.[89]

Ergonomic Problems in Fishers - The purpose of this project was to characterize the ergonomic exposures in common types of fish harvesting operations in Massachusetts. As part of understanding these risk factors, this study proposed some solutions to reducing identified risks. Ergonomic exposure data were been collected for four fishing vessels. These vessels represented three different types of fishery operations, namely lobstering, gillnetting, and otter trawling. The majority of boats in Massachusetts are involved in one of these three types of fisheries. Full reports on were completed and several intervention ideas were generated, including a new handle for lobster gauges (ready for testing). Potential exists to use the accumulated video data for an educational tool to develop awareness of ergonomics on fishing vessels, which could be disseminated at trade conferences.

NEC Ergonomic Apple Bucket – Subsequent work in developing this tool was funded with an R01 from NIOSH. Briefly this work has sought evidence of decreased requirements for muscle force and decreased muscle fatigue in orchard workers using the NEC-developed ergonomic apple bucket-belt device. A controlled field trial of over 100 pickers failed to demonstrate a decline in force (dynamometer) or isometric endurance after a day of picking. This effort pointed out a number of limitations inherent in orchard-strength testing. It also confirmed the enthusiasm of both workers and employers for this ergonomic improvement. Productivity studies demonstrated mild increases in productivity with the bucket-belt device. Subsequent work in an ergonomics laboratory used electromyography to identify the specific muscle groups activated in common picking postures and to measure the degree of force reduction in these muscles with the ergonomic intervention. These findings were then confirmed with more limited orchard EMG testing of pickers.

Ergonomic Apple Bucket R-2-P – Currently patenting of the bucket is being explored with the Bassett Healthcare corporate legal team. Preliminary discussions with a manufacturer of ergonomic devices and with the major distributor of apple picking buckets have indicated

considerable interest. Funding for this final step in dissemination of this intervention has been sought in the 2006 NEC application.

Ergonomics in Mushroom Growing – NEC has been approached by the largest mushroom producer on the East Coast to undertake a project aimed at reducing musculoskeletal injury in their sizable workforce. We anticipate using similar approaches to exploring this further with a feasibility proposal in year one of the next NEC cycle – if funded.

Program outputs

- A hip belt that attaches to the typical fruit harvesting bucket that provides ergonomic support, reducing load on the upper back and shoulders.
- 8 published articles
- a doctoral dissertation
- a community ergonomic training manual for collaboratively assessing possible ergonomic interventions on the farm
- a work-sampling measurement tool adapted to orchard use for identifying ergonomically hazardous postures and activities
- lecture with slides on orchard ergonomics presented at the SUNY SPH Dept of epidemiology
- ergonomic acceptability survey in Spanish and English
- photo documented process of measurement instrument development for both muscle fatigue testing and electromyographic testing for intervention evaluation
- several educational mailings to the orchard community regarding orchard ergonomics
- a detailed ergonomic analysis of the postures and loads most commonly encountered in apple orchard work.
- ergonomic tools suitable for adoption by fishermen

Program outcomes

- Ergonomic hip belt that has been demonstrated to be popular with workers, have no negative effects on picking speed, and reduce load on the back along several muscles near the spine.
- Support among a large segment of the orchard community in New York State for use of the ergonomic hip belt
- Farm owners and workers are asking for the hip belt

Emerging issues

- Promoting ergonomics as protecting worker productivity (to workers and employers). How we keep financially stressed farm owners and nervous migrant workers interested in ergonomics.

Future research

- Ergonomic hazard reduction in Pennsylvania mushroom industry
- Research to practice: getting the ergonomic hip belt into regular use
- Electromyographic methods for use in the outdoor environment: developing field methods

Other Activities

The designation of "main program areas" has been a rather arbitrary process for us at the NEC. While much effort and resources have been devoted to the program areas outlined above, one might argue that we might have just as validly identified hearing loss or surveillance methodologies as program areas. There was considerable effort in these and other relevant areas as well. The NEC's goals require efforts to be inclusive, both in terms of geography and in terms of areas of particular expertise. Projects PI's have been nearly equally divided between medical specialists, engineers, public health experts and educators (with a smattering of ergonomists and others). As a result there has been considerable variety in the projects undertaken. Many projects relegated to this "Other" class are ingenious and potential important projects. A couple of examples to illustrate the range:

- a project from Univ. of Rochester Medical Center examined the FFHHS data set seeking evidence of unrecognized risk factors among the farmers with significant hearing loss.
- a project from Penn State University that has developed and validated a fluid dynamic model for optimal ventilation of manure storage facilities. This tool can be easily disseminated and readily used by farmers and contractors building such facilities in the future.
- Another Penn State project examining the accuracy and relevance of Census of Fatal Occupational Injury data to the agricultural industry.

Many of these efforts are not readily classified into a general programmatic theme, but this does not, in our opinion, reduce their validity or their potential value for the farm community of the Northeast.

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Great Lakes Center for Agricultural Safety and Health

September 2001 – June 2006

Director: Thomas L. Bean
The Ohio State University

Table of Contents

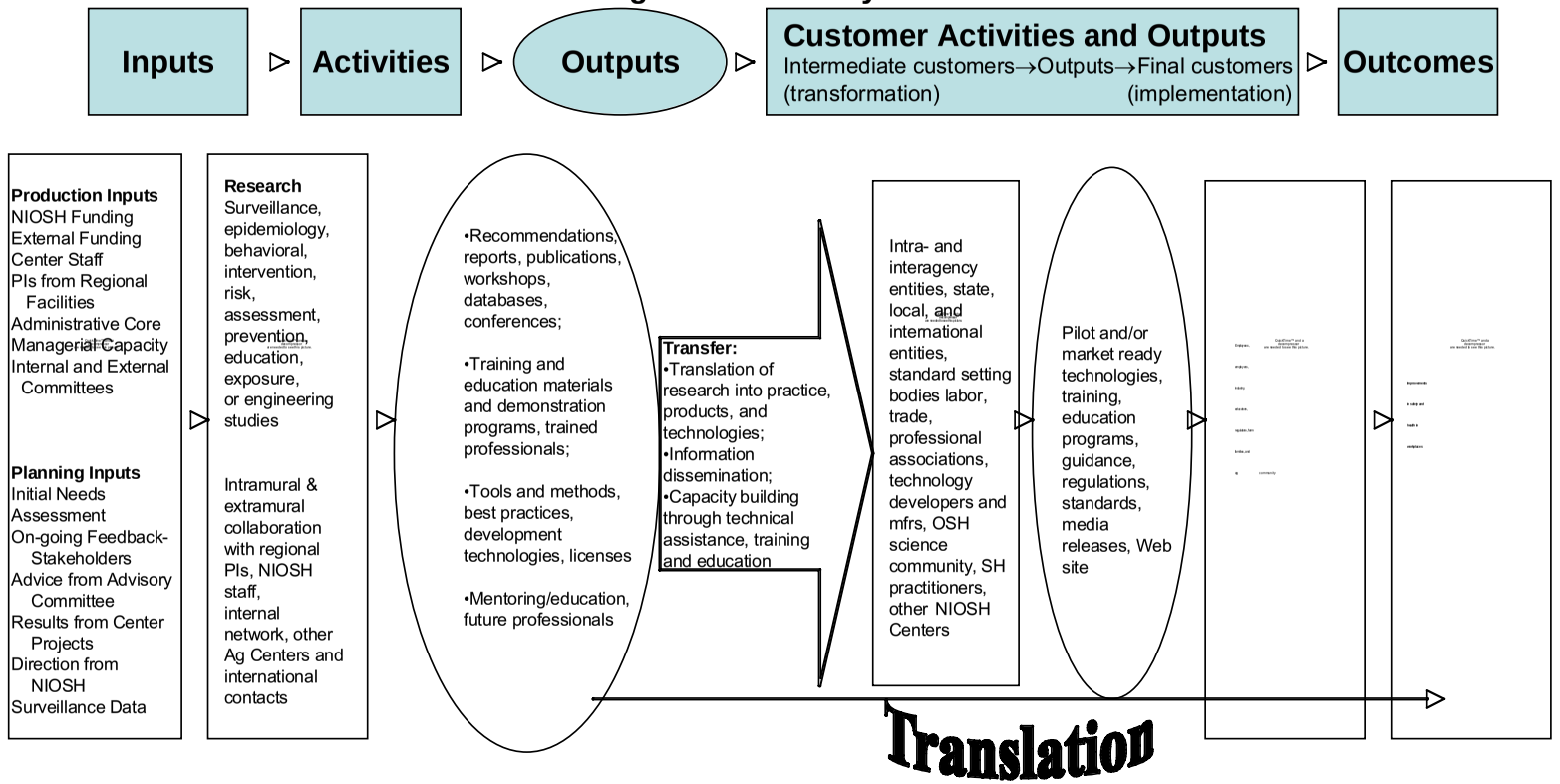
Center Overview

Introduction

The Great Lakes Center for Agricultural Safety and Health (GLCASH) serves the states of Illinois (IL), Indiana (IN), Kentucky (KY), Michigan (MI), Ohio (OH), Pennsylvania (PA), West Virginia (WV), and Wisconsin (WI). The Center is housed at The Ohio State University in the Department of Food, Agricultural, and Biological Engineering (FABE). The Administration team within the Center is a strong collaborative effort between the College of Food, Agricultural and Environmental Science (CFAES) and the OSU School of Public Health in the OSU College of Medicine and Public Health. Dr. Thomas L. Bean, Professor and Department Chair, FABE, serves as the Center Director. Assisting the Director is Dr. J.R. Wilkins III, Professor, OSU School of Public Health, who serves as Deputy Director.

The Center possesses four core areas of operation. First, the Multi-Disciplinary Research Core facilitates/promotes interaction/collaboration among researchers affiliated with the Center; Dr. J.R. Wilkins III directs this Core. Second, the Prevention/Intervention Core facilitates the development and implementation of evaluation projects and intervention effectiveness research; Tom Archer, Associate Professor at OSU, directs this Core. Third, the Education/Translation Core which has a two fold mission: (1) to broadly disseminate agricultural health and safety programs that have proven effectiveness and (2) to strengthen the capacity of agricultural health and safety practitioners and researchers in terms of bringing to bear the latest technology and strategies on improving the health of farm families. Dr. Karen Bruns, Assistant Professor, OSUE Administration, CFAES, directs this core. The final and Fourth Core is the Administrative Core. The Center Director and Cynthia V. Brundage, Center Manager head this Core. Dee Jepsen, Ohio State University Extension Specialist, directs the Administrative Core's outreach activities.

The GLCASH operational plan presented as a logic model
Mission: Protect the agricultural safety and health of farm families



Promote agricultural safety and health through research, prevention, intervention, education and outreach projects.

External Factors: Economic and social conditions and regulatory environment

Background

The states within the GLCASH region share many common attributes, i.e. crops, farming practices, farm size, migrant streams, poverty in Appalachian areas, strong commercial fishing or timber harvesting, and Amish populations. This dynamic agricultural region contains more than 450,000 farmers and an average of 224 acres per farm. The majority of farms are family owned and operated. Because of the breadth of the Center's geographical area, the number of farms in the region, and the nature of Midwest/Appalachian/Eastern agriculture, the GLCASH has the theme "Protecting the Agricultural Safety and Health of Farm Families." The Center's vision is to promote agricultural safety and health for farm, forestry, and fishery employers; workers; families; and their communities in the Great Lakes Region through research, prevention, intervention, education, and translation projects. The theme and the vision is the thread that binds and runs through all of the Research, Prevention/Intervention, Education, and Outreach projects.

GLCASH's target audience is employers, domestic workers, migrant workers, and families located within agricultural communities of the states served by the Center. To accomplish this, the Center has: (1) completed a comprehensive agricultural safety and health needs assessment in the GLCASH region; (2) established an Internal Advisory Committee of the senior individuals responsible for Project Areas who assist the Director in making scientific and administrative decisions for the Center; (3) assembled an External Advisory Committee composed of five experts to provide guidance, direction, and consultation to GLCASH, and to offer local, state, and/or national perspectives from their experience and expertise in agricultural safety and health; and (4) successfully administered 12 projects, nine completed and three on-going, which span seven states of the eight-state region. In summer 2005, GLCASH expanded its network by approaching Dr. John Shutske of the University of Minnesota for possible collaboration with GLCASH. Dr. Shutske agreed that Minnesota would become part of the Center's region.

The GLCASH Cores have synergy throughout. The Research Project Area intends to generate new knowledge about the causes of agricultural injuries and illnesses and how best to investigate them. Projects in the Prevention/Intervention Project Area apply this new knowledge to the development and evaluation of programs designed to reduce the incidence of injuries/illnesses and to reduce the overall morbidity among agricultural workers and their families. The Education and Translation Project Area has a two-fold mission— (1) to broadly disseminate agricultural health and safety programs that have proven effectiveness, and (2) translate knowledge into practices that meet the agricultural community's needs to strengthen the capacity of health and safety practices in the workplace. To assist in dissemination of knowledge and activities of the Center, the Center has a Web site located at http://www.ag.ohio-state.edu/~agsafety/glc/.

GLCASH has only a five-year history as a NIOSH Agricultural Center. GLCASH initially received approval for two years of funding in 2001 and then received an additional three years of funding in 2003. Despite the difficulties in reapplication, during the initial short 2-year period, GLCASH staff and Principal Investigators (PIs) of Center Projects have or are in the process of accomplishing the major core activities presented below. All but three of the Core Projects (Effectiveness of Sun Safety Intervention Approaches to Change Sun Safety Behavior of Agricultural Workers, Grain Engulfment Hazard Assessment Tool, and Audiovisual Approach to Train West Virginia Farmers on Prevention Effectiveness of ROPS in Reducing Traumatic Injury) are in the final phases of completion. Until all of the final reports are presented

significant findings for some of the projects cannot be reported at this time, thus the findings of these projects have not been translated to regional impacts. Those that are poised to have impact are presented further in this report in the section entitled *Translation of Findings*. Results of the Sun Safety Intervention are presented as part of the Program Area Overview.

Program Area Overview

The Great Lakes Center for Agricultural Safety and Health has assembled a cross-disciplinary, multi-institutional and geographically diverse group of principal investigators who are addressing some of the current issues in agricultural safety and health within its region. The broad goals of GLCASH are to: (1) conduct research related to the prevention of occupational agricultural diseases and injury among agricultural workers (2) develop, implement, and evaluate model programs for the prevention of illness and injury among agricultural workers and their families (3) develop, implement, and evaluate education and outreach for promoting health and safety for agricultural workers and their families (4) develop linkages and communication with other governmental and non-governmental bodies involved in agricultural health and safety programs including other NIOSH Centers (5) provide assistance and education to community-based groups (e.g. farm youth or adult associations, extension services, local and state government, medical clinic/hospitals, etc.). Objectives and aims are unique to individually funded projects (project is defined as research, intervention, prevention, education, or outreach) and are evaluated by the Center Director and staff based on the needs within the region and the broad goals of the center. For each funding cycle the programs selected for inclusion are adjusted to meet the need within the region based on the initial needs assessment, advisory committee input, and unmet needs of the broad goals of the Center. A brief snapshot of the program areas by NORA categories is presented below:

Research Tools and Approaches—Intervention Effectiveness Research

Adapting the ASHBMP for the Insurance Industry

Principal Investigator: Dennis J. Murphy, Distinguished Professor, Pennsylvania State University

Background: Hazard audits are a fundamental tool for identifying and correcting hazards of any type. Best Management Practices (BMPs) normally incorporate flexible and practical guidelines for addressing a specific topic or area of concern. The format of a Penn State developed hazard audit tool, formally known as Agricultural Safety and Health Best Management Practices (ASHBMP), used hazard gradation scales and other features to objectively and efficiently describe the condition of a particular hazard. Thus, the ASHBMP hazard audit tool conveys important intervention information to users by its very implementation (Legault & Murphy, 2000). The use of gradation scales in the ASHBMP provides a mechanism for an objective means of evaluating hazards and risks.

The aims for this GLCASH funded project are:

(1) Take an experimentally evaluated farm hazard audit tool and further develop it so that it is more useful to insurers of agricultural work sites, work activity, and farm residences.
(2) Evaluate specific loss control efforts by farmers when the specific effort is requested by their insurer and facilitated by the ASHBMP document.

(3) Provide a mechanism by which an insurance company can reliably correlate a farm hazard score to actual hazard reductions and claims costs.
Outcomes: This project is currently in its final year of funding.

Audiovisual Approach to Train WV Farmers on Prevention Effectiveness of ROPS in Reducing Traumatic Injury

Principal Investigator: Jim Helmkamp, Ph.D., Research Associate Professor, West Virginia University

Background: Tractor overturns and rollovers, without ROPS, caused 29 of 37 tractor-related deaths identified in West Virginia from 1997 to 2002. This resulted in the development of a safety intervention plan to inform West Virginia farmers about the risks associated with tractor rollovers and the effectiveness of ROPS in reducing injuries. The plan had three phases: (a) conduct a ROPS Use Prevalence Survey; (b) use survey results and farmer focus groups to create a tractor safety video; and (c) conduct a survey to determine if the video influenced farmer's safety attitudes and behaviors.

Activities: Mailed evaluation survey (ROPS Video Evaluation Survey – 2) with the video to this same group less the 155 who responded that they did not currently own a tractor, had retired, were deceased, or who submitted an incomplete baseline survey. Thus far, slightly over 12% responded after watching the video. We continue to receive completed ROPS Video Evaluation Surveys each day. Data will soon be analyzed.

Assisted 15 respondents who called the 1-800 # listed in the video asking for assistance in obtaining information on ROPS for their model tractor. ROPS had been located for 13 of the 15 who requested assistance.

Responded to 43 individual farmers seeking a copy of the video after learning of its existence via a news press release.GLCASH supported the last two phases of the plan.

Outputs: A 17-minute ROPS safety video, "A Tractor Accident Can Happen to Anyone". A summary article appeared in the November 2005 GLCASH Newsletter.

Outcomes: The video is being distributed globally. Several local and nationally-based corporations, organizations, governmental agencies including DuPont Corporation, Veterans' Administration, and Indiana State University have asked for multiple copies of the video for their internal training programs and lending library inclusion. A copy of the newsletter article and video were sent to the CDC/NCIPC Injury Control Research Center Program Manager (Tom Voglesonger).

Effectiveness of Sun Safety Intervention Approaches to Change Sun Safety Behavior of Agricultural Workers

Principal Investigator: Benita M. Jackson, The Ohio State University,

Co-PI: Dee Jepsen, Program Director, The Ohio State University

Activities: This completed project used an experimental design to evaluate the effectiveness of a skin cancer prevention program for agricultural workers and pesticide applicators; evaluated the effectiveness of sun safety training, the use of sun safe headgear, and the impact of the Dermascan® sun exposure screening equipment on changing sun safety practices of a selected population of agricultural workers and pesticide applicators; evaluated the acceptability of the design of sun safe headgear for use in agricultural work situations; and explored the influence of the affective domain and peer response to use sun safe headgear among a selected population of agricultural workers and pesticide applicators.

GLCASH translates results from sponsored projects into the agricultural workplace. Through the Ohio State University Extension Service, GLCASH Outreach Director, Dee Jepsen, developed a national train-the-trainer program for sun safety and skin cancer prevention.

Findings: Evaluation of the sun safe hat given to program participants was found to be acceptable and without safety concerns. The hat was reported as having good ventilation, good sun protection and made of light weight material. Some initial concern existed that the Supplex® nylon fabric used in the hat might be uncomfortable; however most respondents liked the lightweight fabric and comfort associated with it. Subjects noted that the brim of the hat offered sun protection and provided cooling shade when working in the sun. Despite desirable features of the hat, dissatisfactions were also expressed. These problems influenced use of the hat particularly in specific situations, such as windy days, using specific equipment, or wearing hearing protection. Major concerns focused on the wide brim of a sun safe hat and the chin strap. Participants found the brim to be annoying in wind. The brim would catch the wind creating a tendency for the hat to blow off or brim to flip back. The wider brim occasionally interfered with vision.

Outputs: The Sun Safety R2P effort includes a PowerPoint presentation, educational content, and the intervention device, the Dermascan® skin analyzer. The training materials for workshops are organized on a CD-ROM.

Outcomes: During the past year, these materials were presented at a workshop for 34 American Farm Bureau Safety Coordinators from across the nation.

Diseases and Injury—Asthma

Farm-Related Asthma

Principal Investigator: Kenneth D. Rosenman, Professor, College of Human Medicine, Michigan State University

Background: This project identifies and interviews all farmers and family members between the ages of 18 and 65 who were treated for asthma over a four-year period and obtain their health insurance through Blue Cross Blue Shield. There are approximately 1,200 adults with asthma among the members during this four-year period. All eligible subjects are interviewed with a standardized questionnaire. Individuals who do not have documented pulmonary function testing showing hyperactive airways are offered testing.

Activities: Using questionnaire data, subjects are classified as having or not having work-related asthma and their type of work-related asthma is documented. Dr. Kenneth Rosenman uses the current National Institute for Occupational Safety and Health (NIOSH) Sentinel Event Notification System for Occupational Risks (SENSOR) criteria for work-related asthma to perform this classification. All subjects who meet the NIOSH SENSOR criteria for work-related asthma are offered electronic peak flow and Forced Expiratory Volume in one second testing over a two-week period—this determines if there are changes on pulmonary function testing in relation to their farm work. Prevalence rates with 90% confidence limits are calculated for farm-related asthma. Additionally, Dr. Rosenman compares prevalence rates using individuals who meet the NIOSH SENSOR criteria, without objective documentation of asthma and pulmonary function changes associated with farm work, versus those individuals who meet the criteria because they have objective documentation of asthma and pulmonary function changes associated with farm work. The staff performing this project is experienced in the diagnosis, management and epidemiology of asthma and work-related asthma. Currently, Dr.

Rosenman directs the project and has 14 years of experience with the Michigan SENSOR asthma surveillance system.

Findings: Mailings have been sent to 1374 subscribers and 148 individuals heard about the project and contacted us. One Hundred and thirty-three of the 148 individuals who contacted us, signed up at the 2003, 2004 or 2005 Agricultural Exposition. Only a few of these individuals were on our original mailing. To determine this Blue Cross/Blue Shield checked their names against the original mailing. This is a prevalence of adults with asthma who received medical care in one year of 4.2%.

We were contacted by a total of 487 individuals. One hundred and ten were not eligible (outside age limits, not farmers or their dependents), 53 refused to be interviewed, 63 still need to be interviewed, and 307 individuals were interviewed.

Of the 307 individuals interviewed, 212 have had spirometry, 67 have had pre/post bronchodilator testing and 15 have had methacholine testing as part of their regular medical care. We have performed 15-pre/post bronchodilator, and 29 methacholine tests (1 individual had both). Seventeen individuals have completed the computerized spirometry/peak flow on their farm.

One hundred eleven individuals met the SENSOR criteria for work-related asthma related to farm exposures. Seventy-seven reported their symptoms were worse with exposure to a known workplace allergen, 17 reported their symptoms were worse with exposure to a substance not previously associated with work-related asthma, 3 had onset of symptoms consistent with RADs and 14 had symptoms consistent with work aggravated asthma.

Based on reports to the SENSOR system the prevalence of work-related asthma among farmers was 19/100,000. The prevalence among farmers from this current project using the same clinical history criteria used in the SENSOR program is 309/100,000. This difference, which indicates the SENSOR system is missing 94% of cases, is large but is consistent with our published estimate that SENSOR misses 82% of cases.

Among the 111 individuals with potential farm-related asthma, 90 (81.1%) have been tested as part of their medical care or by this project for hyperactivity. Forty of the 77 (51.9%) for whom we have reviewed their pulmonary function test results have evidence of hyperactivity. Seventeen individuals tested to date that met the SENSOR criteria for work-related asthma by history and had evidence of hyperactivity did not have evidence of pulmonary function changes on the computerized spirometry in relation to farm exposures. We are still evaluating the computerized spirometry results since farmers are not spending sufficient time away from their farm to obtain measurements during non-exposed periods that can be compared to measurements during periods when they are exposed.

Dr. Rosenman is also still testing additional individuals and reviewing additional pulmonary function test results. The percentage of individuals meeting the SENSOR criteria for farm work-related asthma is high (111 of 307, 36%). Dr. Rosenman has had a limited response rate and potentially individuals with farm-related problems were more likely to participate, although the contact letters did not indicate he was studying asthma in relationship to farm exposures. The percentage of individuals who met the SENSOR criteria for farm work–related asthma and who had tests of hyperactivity as part of their regular medical care was 34 of 111, 30.6%. This is less than the result of 65% having such testing in the overall SENSOR database. Among the 77 tested and reviewed who met the SENSOR criteria for work-related asthma, 37 (48.0%) had negative results for hyperactivity and the 17 individuals with tests done in relationship to work had negative results. This is consistent with data from Quebec indicating

the SENSOR criteria based on history are sensitive but not specific (37). The data from the Quebec study which compared a history of symptoms in relation to work with specific antigen testing reported the history of symptoms in relation to work had a specificity of only 33-45% using a positive specific antigen test as the "gold standard".

Outputs: Fact Sheet: MIFACE Hazard Alert #6, "Fatal Asthma Attack While Cleaning Bulk Milk Tank"

Outputs/Outcomes: This project is ongoing and accordingly, data collection and data analysis have not been finalized.

Research Tools and Approaches—Risk Management

Field Test of the Farm Grain Engulfment Hazard Assessment Tool

Principal Investigator: Douglas Michael Kingman, Assistant Professor, Illinois State University

Background: In a previous study by the Principal Investigator, a systems approach was used to complete a hazard analysis of on-farm metal grain storage bins in order to develop and test a farm grain hazard assessment tool that could predict the increased likelihood of an engulfment. The preliminary study was limited because most of the farms evaluated were located in Indiana and no commercial grain storage operations were assessed with the tool. The study broadens the application of the tool by applying it to commercial operations and farms in Illinois.

Grain storage is vital to agriculture throughout the Midwest. In many instances, grain storage may pose risks that producers are unaware of such as: falls from heights, entanglement in augers, electrocution, and toxic atmospheres. One specific hazard that is often disregarded is engulfment in grain. Identifying contributing factors to engulfment may play a key role in reducing the risks associated with the storage of grain. Previous studies indicate that a systems approach can be used to identify hazards associated with on-farm metal grain storage bins, and that the presence of those factors increased the likelihood of an incident occurring. The objective of this study is to further identify the practices of those in the grain handling and storage industry that lead to a greater risk of engulfment and to identify risk factors.

Activities: To achieve this goal, a modified version of the previously developed Farm Grain Hazard Assessment Tool (FGHAT) identified specific practices of farmers throughout the state of Illinois who store grain. The tool was distributed to 92 farm bureau offices throughout the state and data were collected on a voluntary basis. On-site visits were made to discuss grain-handling procedures directly with producers. Then the data were analyzed to determine those practices that increase the likelihood of an engulfment incident occurring.

Findings: To date, the PI collected and began to analyze more than 200 assessment responses from Illinois farm owners/operators and more than 20 responses from commercial grain-handling sites. The responses have been entered into an electronic database, summarized and compared to previous findings. A statistical consultant has been utilized on this project to coordinate the summary of the responses.

Outputs: To date, a web-based version of the assessment tool has been developed and some individuals involved with the storage and handling of grain have provided responses.

Outcomes: We have continued to facilitate the ASABE proposed grain bin safety standard, X523, Grain Bin Safety Standard.

Professional Development and Outreach

Evaluating for Impact GLCASH Fellows Program

Principal Investigator: Karen Bruns, Assistant Professor, The Ohio State University

Background: The objective of the GLCASH Fellows Program is to increase the evaluation for impact of the agricultural/rural safety and health outreach and educational programs. Evaluation for impact is the documentation of the effect that outreach and educational programs have on participants. This impact includes sustained and substantial change in agricultural health and safety behaviors and practices. These changes are documented through quantitative and qualitative research methods.

Activities: To achieve this objective, the project is developing a cadre of safety and health education practitioners (fellows) who will have the skills to conduct and analyze quantitative and qualitative research. These practitioners will use these skills to assess the impact of the outreach and education programs developed within their organizations and in selecting health and safety outreach and education programs to implement.

Through the program, 11 fellows from six states are participating in the 20-month GLCASH Fellows Program. The program started in February 2005 with a face-to-face conference between the fellows, their mentors (there are a total of seven mentors from five states involved with the program), and the program staff. Since the February meeting, the fellows and their mentors engaged in on-line activities focused on helping them expand their understanding and application of program evaluation skills. They also have been involved with their mentors who are available to help guide and support the development of the fellows' evaluation impact skills. As the fellows progress through the on-line course they also will conduct a research project to evaluate for impact the agricultural safety and health outreach or educational program. In summer 2006, the fellows, along with their mentors, will share the results of their evaluations with stakeholders and other health and safety professionals.

As a next phase of the project, the authors are taking the on-line content developed for the GLACSH Fellows and converting it to an on-line training program that can be accessed by anyone interested in expanding their evaluation skills (GLCASH Version 2). The GLCASH mentors and fellows will be able to use this version with colleagues. It also will allow agricultural and safety professionals from around the world to use the content at any time. The current format encourages a cohort to go through the course all at the same time. Version 2 will be more flexible, allowing people to start and end the course at any time.

Outputs: On line web-based course developed. 18 modules put on line. Continual monitoring and assessment of program has resulted in monthly live online chat sessions for fellows and mentors.

HOSTA Train-the-Trainer

Principal Investigator: Dee Jepsen, Interim State Safety Leader OSUE and Outreach Director, GLCASH

Activities: During FY 2005, the Center utilized funds from the outreach budget to support train-the-trainer programs for the Hazardous Occupations Safety Training in Agriculture (HOSTA) project in Ohio. GLCASH Outreach Director Dee Jepsen and Wayne Dellinger, from the OSU Extension Agricultural Safety and Health Program, conducted 10 sessions around the state between November 2004 and July 2005. More than 100 participants attended the training workshops. These educators now teach the tractor certification program to youth in their

communities. GLCASH funds supported the reproduction of notebook training materials. For more information please contact GLCASH at 1-800-678-6129 or e-mail greatlakescenter@osu.edu.

Translation of Findings

Findings of current studies have already begun to affect the GLCASH region. GLCASH has been able to translate results from sponsored projects into the agricultural workplace.

Many attendees at the AgExpo 2005 collected the available information: *Hazard Alert* describing 2005 farm asthma deaths; Asthma Fact Cards, prepared for AgExpo 2003; Project Information Brochures, also prepared for 2003; Bookmarks with information on the Asthma Initiative in Michigan (www.getasthmahelp.org); and pencils and pens with project hot-line phone numbers. One participant of the "Farm-Related Asthma" project visited the AgExpo 2005 booth to relay that he had benefited by this project in becoming better aware of farm triggers for his asthma. The extensive testing and consultation with Dr. Rosenman had helped him better manage his asthma.

Through the Ohio Extension Service, GLCASH Outreach Director, Dee Jepsen has developed a national train-the-trainer program for sun safety and skin cancer prevention. Jepsen presented a workshop for 34 American Farm Bureau Safety Coordinators from across the nation. The materials developed for this training were pilot tested in a past GLCASH research project. This Research to Practice (R2P) effort incorporated the PowerPoint presentation, educational content, and the intervention device, the Dermascan® skin analyzer. Training materials for the workshop were organized onto a CD-ROM and used for this program as well as future training sessions. Additional sun safety and skin cancer prevention workshops are planned for FY 2006. Collaborations with the American Farm Bureau Federation are also likely to continue.

The Center is marketing and distributing a national tractor safety video. The funded project "Audiovisual Approach to Train WV Farmers on Prevention Effectiveness of ROPS in Reducing Traumatic Injury" resulted in a locally developed video to inform West Virginia farmers about the risks associated with tractor rollovers and the effectiveness of ROPS in reducing traumatic injuries. The PI has taken the video and adapted it to a national audience. Currently, GLCASH has developed a flyer to market the video to agricultural safety and health professionals. This flyer includes a toll free number where videos can be requested at no cost and farmers can inquire about installing ROPS and seatbelts on their tractors. To date, over 400 videos have been distributed. This effort will also support the goals of the NIOSH Agricultural Safety and Health Centers' National Agricultural Tractor Safety Initiative.

Emerging Problems, New and Future Directions

Emerging problems the Center has encountered and foresees in the future include the issues of high-speed tractors on highways, use of auto-guidance systems in tractors, and potential for the use of driverless tractors. These provide new directions for future research when funding becomes available. Currently, the Center has redirected some of its efforts toward the tractor initiative that is beginning within all of the Centers.

Southwest Center for Agricultural Health, Injury Prevention, and Education

Table of Contents

Introduction & History

The Southwest Center for Agricultural Health, Injury Prevention and Education (SW Center) was established in October 1995 on the campus of the University of Texas Health Center at Tyler (UTHCT) to initiate a program of agricultural safety and health activities in U.S. Public Health Service Region VI. This center is located in an agricultural region of northeast Texas that contains 46% of the rural Texas population. The early focus on responsiveness to regional issues has resulted in a broad range of partners for the development of agricultural safety and health activities throughout the five state region represented. Housed initially in the Department of Medical Education, the SW Center drew upon the strong and expanding occupational and environmental medicine strengths of the host institution. When Center Director, Arthur L. Frank, M.D., Ph.D. left the host institution in 2002, Jeffrey L. Levin, M.D., M.S.P.H., a physician board certified in occupational medicine and previous member of the SW Center's external advisory board, ably assumed the leadership role for the Center and formally aligned it within the Department of Occupational and Environmental Health Sciences.

From the beginning, the SW Center has benefited from the guidance of an actively engaged external advisory board that, despite changes in membership over the years, has provided consistent leadership to benefit the Center's growth and scope of work. The Advisory Board met independently early in the Center's formation to draft a mission statement along with guiding and action principles against which to establish programmatic activities.

Mission Statement

The mission of the SW Center is to foster, disseminate, and evaluate activities related to health, injury prevention and education among agricultural interest groups in order to promote health and safety practices among agricultural workers and their families.

Guiding Principle

To support justified (theory-based, preliminary data, etc.) research that leads to action to improve the health and safety of the agricultural community.

Action Principles

The SW Center represents a unique geographic region that can maximize its contribution to agricultural safety and health practices by supporting work that incorporates:

- Worker population concerns that have regional or national significance
- A particular problem that has significance to a state in the region
- Specific, understudied population in the region
- A multiplier effect to generate additional resources
- The ability to reach additional audiences through collaboration
- Sustainable interventions

Continuity of SW Center administrative staff has facilitated the expansion of collaborative relationships, project partners, and outreach activities. In addition, a commitment was made to implement program evaluation from the outset. This enabled the SW Center to make a significant contribution to the inter- Center Evaluation Team when it was implemented in 1997. Forms and procedures developed by the SW Center have been used, with modification, by eight of the nine Centers as a result of that interaction. When the cross-center evaluation project evolved into a database design, the SW Center maintained a collaborative role assisting with the

identification and definition of program indicators and more recently, providing a database consultant to assist the leadership group with modifications, short-cuts and data management tips to facilitate responsiveness to new requests and uses of the information maintained in the database format.

Scope of Work

The modest initial funding level provided support for three (3) projects, each funded at levels below the amount requested; and minimal Center-based activities. Subsequent and consistent increases in funding over the years enabled the SW Center to develop a robust portfolio of programs, projects, and activities characterized by region-wide partnerships, research to practice (r2p) emphasis, multi-disciplinary interactivity, and attention to special populations. As the three original projects matured, each represented a significant contribution to the original aims of the NIOSH Agricultural Research Center Initiative. The project with Oklahoma State University to reduce injuries related to cattle-handling became the SW Center's premiere demonstration of r2p. The project initially surveyed cow-calf operators throughout the state about their work injury experience and assessment of causation. Contrary to expectations, the cause of injury was overwhelmingly cited as human error – lack of concentration, ignoring known animal behavior, fatigue – rather than the expected reason of corral and equipment design. The findings gave rise to the need for an intervention that could be easily disseminated and frequently used. Temple Grandin, DVM, the noted animal behaviorist at Colorado State University, was recruited to assist with the project. Her expertise was captured in the production of a short educational tape on animal behavior. Cowboy poet Baxter Black volunteered to narrate the video that was awarded the Outstanding Educational Tool in 1999 by the American Society of Agricultural Engineers (ASAE). As a result of the quality and distribution of the videotape, Dr. Ray Huhnke, project PI, was contacted by the Oklahoma Veterinary Medicine Foundation (OVMF) to create an educational videotape addressing livestock handling safety for children. The OVMF provided partial funding for the development of the video and funded the production of sufficient copies for distribution to every elementary school in the state. A statistically significant sample of teachers and students completed evaluations of the video and teacher guide for information, knowledge retention, and enjoyment value. The material was overwhelmingly rated as a successful educational tool. The American Society of Agricultural Engineers bestowed the Outstanding Educational Tool award to this product in 2001. The video was subsequently dubbed in Spanish for broader distribution. Today, the Center receives frequent requests and continues regular distribution of this popular tool within and beyond the Health Service Region.

The second project, a collaboration with the University of Kentucky (UK), hypothesized that farmwomen could serve as effective change agents for safety and health behaviors on family farms. The project demonstrated the value of collaboration for capacity -building. In this case the research team established a formal partnership with the Division of Nursing at West Texas A & M (WTAMU), a regional university serving the targeted geographic region for the research. By project year 3, the WTAMU team named a PI for the project and the research team from UK assumed a consultative role. Lengthy telephone interviews were conducted with 657 farmwomen, self-sustaining coalitions of farmwomen (the intervention to empower safety and health behavior changes) have been organized in three counties in the target region, and follow-up data has been collected in telephone interviews with the original cohort. As a result of this

project, WTAMU has established an Office for Rural Research in the Division of Nursing, and integrated agricultural health and safety into the nursing curriculum offering both research and practical experiences in agricultural health and safety for undergraduate and graduate nursing students.

With a significant portion of the migrant farm labor force moving through this region, the third project, a partnership with the National Center for Farmworker Health (NCFH), a national resource for Migrant and Community Health Centers, was a natural alliance. A series of focus groups with migrant/seasonal farm workers emphasized the issue of lower back pain. Using its excellent in-house development team, a bi-lingual brochure of tips to prevent lower back pain and a companion poster for display in health centers was created, field tested, and disseminated nationally; it is included in the NIOSH publication, *Simple Solutions*.

Recognizing the lack of information about migrant/seasonal farm workers in the professional literature, NCFH solicited input from both clinic staff and their academic partners to identify barriers to the conduct of scientifically sound research with this hard to reach population. Feedback gave rise to the initiation in 1998 of a Research Track at the Midwest Migrant Stream Forum.An intensive training workshop was added to facilitate understanding, respect, and the mutual benefit of collaborative arrangements between community/migrant health clinics and researchers as a strategy to improve services for farm laborers. NIOSH immediately made additional funding available to the organizers of the East and West coast Migrant Stream Forums to add a research track to the program. Based on evaluations completed by conference participants, the research track has proven to be an effective mechanism for sharing pertinent research findings with clinicians who can implement the information in the delivery of services. The Research Track continues to be a conference component in each of the three Migrant Stream Forums.

With its competitive renewal in 2001, the Center has maintained a dynamic scope of work with projects and activities that emphasize research, intervention, and outreach/education in a number of agricultural program areas such as injury prevention, understudied populations, and emerging technologies. Administration of the Center has resulted in building a transdisciplinary integration of regional capacity in agricultural occupational health research, torespond to important agriculture workforce issues. For example, included among projects that address migrant and seasonal farmworkers is an epidemiologic study of work injuries in migrant farmworker youth. This study capitalizes on previous work that demonstrated the “home based” nature of migrant farmworkers from the Lower Rio Grande Valley as well as the ability to collect data from the population over a period of time. Building trusting relationships with key community leaders made it possible for this project to broaden the scope of data collection and compare injury rates between non-working youth, non-farmworking youth, and youths working as farm laborers. An educational project to prevent injuries among migrant farmworkers resulted in the development of a bi-lingual curriculum addressing safety and health behaviors for students enrolled in a High School Equivalency Program in South Texas. Finally, an outreach strategy being tested with feasibility project funds, aims to reduce the stress experienced by migrant farmworkers when they are separated from family. This innovative program teaches migrant farmworker families how to locate and use free internet services in order to stay in communication with family members during the season.

A review of death certificates in New Mexico highlighted an over-representation of agricultural fatalities among the Navajo. Excellent relationships have been forged with this Native American community resulting in tractor safety and cattle-handling safety educational programs throughout the Nation. Chapter House leaders were taught to use logic models to select, implement and evaluate safety and health interventions. This guided strategy has been embedded in the community planning process to address priority issues. In recent years, the Navajo have shifted from sheep herding to raising cattle. Lacking the experience of working with the larger animals increased risks for injuries. As subsistence farmers and ranchers, the Navajo individually, do not have the means to purchase standard cattle handling equipment. The project purchased a set of gates and chutes as a pilot equipment loan program. The designated Chapter House is responsible for managing the loan schedule and maintaining the equipment in good working order. Use of the equipment is contingent on completing a safety training program. The Cattle Handling Safety video created by Oklahoma State University (OSU) has been dubbed in Navajo and is used widely during spring and fall agricultural training days. The project recently purchased three additional sets of equipment that will be distributed strategically to maximize access and use among the Chapter Houses.

Cutting edge technology has supplanted the originally proposed strategy to analyze the endocrine disruptive effects of common, ubiquitous agricultural chemicals. Leveraging funds from the SW Center, a genetic research team persuaded its host institution to purchase a micro-array analyzer thereby greatly accelerating the scope of investigation as proposed using methods standard at the time. This has resulted in a prolific generation of information and peer-reviewed publications examining implications for gene regulation of various disease states and the impact of endocrine disruptive chemicals used in agricultural settings.

The SW Center was awarded a conference grant to develop an interactive televideo workshop to assist communities with the inclusion of agroterrorism in their emergency preparedness plans. Speakers were linked from 5 locations and nine sites were connected to participate in didactic and small group discussion exercises. A CD was produced and has been disseminated across the nation. It is a standard curriculum component for a regional Animal and Plant Health Inspection Service (APHIS) office, an arm of the USDA. The program included a six month follow-up to assess the impact of this workshop; results have been published in a peer-reviewed forum.

In addition to various collaborations with the other NIOSH agriculture research centers, the SW Center designed, publishes, distributes, and maintains the distribution list for AgConnections, the newsletter for the NIOSH Agriculture Research Center Initiative.

Key Accomplishments

Nearly fifty peer-reviewed publications have been generated in the current funding cycle of the Center.

Enduring Materials

- First Aid Farm Quest, an interactive CD for pre-adolescent youth

- First Aid for Rural Emergencies, a curriculum for rural providers and First Responders
- Cotton Picker Safety, CD with machinery safety tips for cotton farmers and their families
- "Lost Youth" videos addressing occupational risks for immigrant youth, translated to Spanish
- Bi-lingual (English/Spanish) Curriculum of Occupational Safety and Health for Farmworkers
- Agroterrorism Workshop CD to assist communities with including agriculture in their emergency preparedness plans
- Cattle Handling Safety, 13 minute video and DVD, winner of the ASAE Outstanding Educational Tool (also available in Navajo)
- Livestock Safety for Kids, 11 minute video and DVD, English and Spanish, also won the ASAE Outstanding Education Tool

In-Kind and Leveraged Funds

a) Through the collaboration with many partners and outreach activities at the project level, the SW Center is able to report in-kind contributions to agricultural safety and health in the amount of $523,400.

b) NIOSH funds awarded to the SW Center served as a catalyst to leverage $323,000 in additional financial support as well as a successful bid for a conference grant totaling $20,644.

Feasibility/Pilot Projects

PI	Institution	Study Title	Outcome
Rager, R., Ph.D. Doyle, E., Ph.D.	TWU Baylor	Health & Safety Needs Assessment: Farmworkers in East Texas	2 juried pub, 6 Professional Presentations
Hurley, A., M.S. CCC-A	LSU, Communication Dis.	Establishing Exposure Risk for Noise & Organic Solvents in Soybean Farmers	2 Professional Presentations
Banks, L., DVM	UNM IPRE	Syndromic Surveillance to Detect Naturally Occurring/Intentional Zoonotic Diseases in Agricultural Workers	Successful application to Homeland Security, $125,000
St.Hill, S., M.D., M.S.	UTHCT-OccMed Resident	A Study of Commercial Fishing Fatalities in US Coast Guard District 8	Successful R21 $125K/yr for 2 years; 2 Professional Presentations
Ball, C., D.O., M.S.	UTHCT-OccMed Resident	Work Injury Reporting in US Citizens vs. Non-citizens	Occ Injury History Survey, Eng & Spanish; 2 Professional Presentations
Acosta, M., M.D., Ph.D.	UTH-SPH-Brownsville	Occupational Health Curriculum for Farmworkers in TX	Successful R21, $75K/yr for 2 years
Spencer, Tara	Millers Grove ISD, TX		
Hebert, Michael		Ag Safety Outreach	

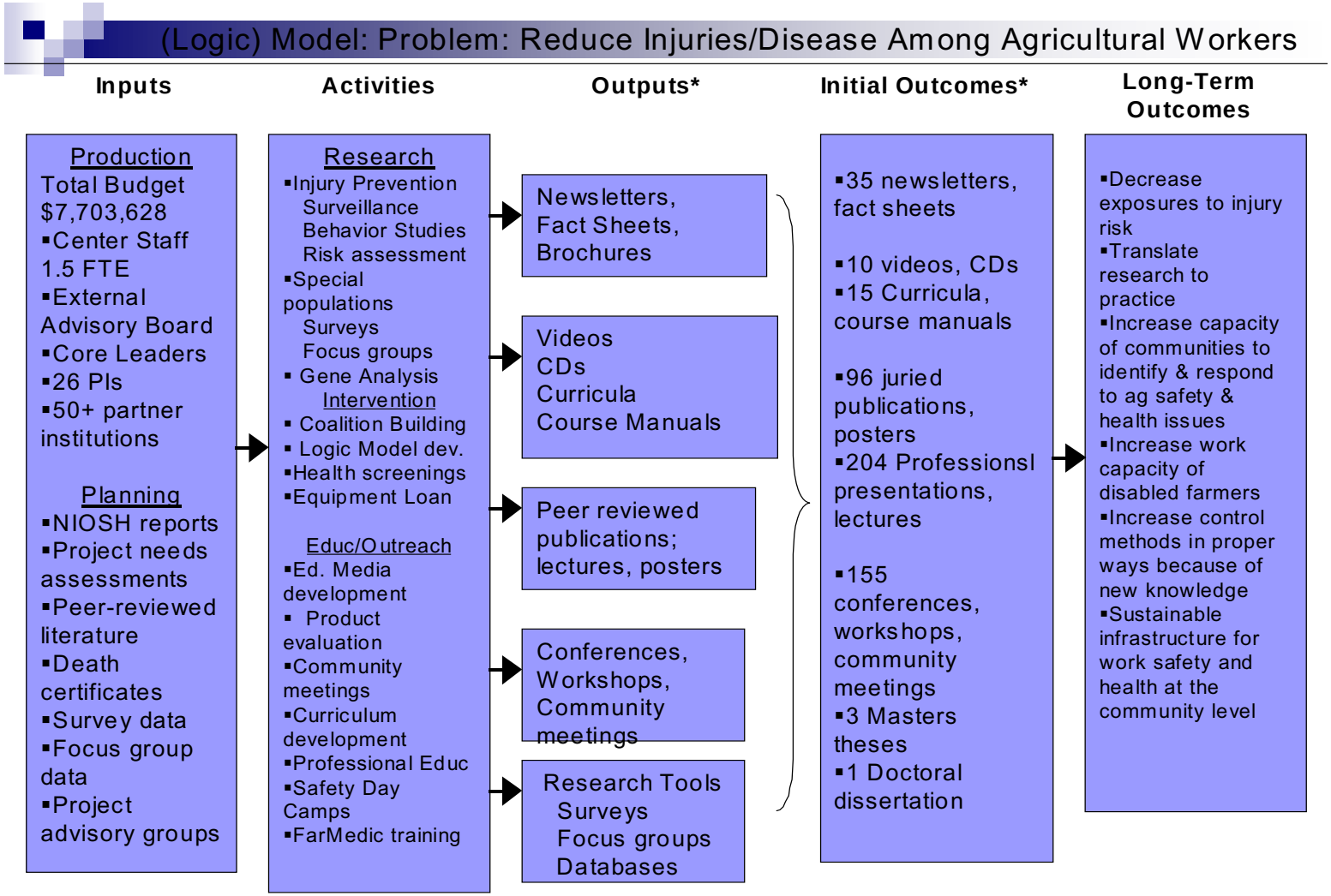
Williams, Robert, Ph.D.	Texas A&M U.-Commerce	Certified Tractor Safety Training	
Reyna, Ricardo	PeopleFirst, TX	Cybervoices From the Field	

Research to Practice (r2p)

Several examples demonstrate the value of r2p in project development.

- A feasibility study in the previous cycle allowed researchers in Oklahoma to quantify the number of farmers in the state who were either not farming, limiting their farming, or continuing to farm despite a serious disability. The data was used to apply for an AgrAbility project. The application was successful and OK now has a model AgrAbility program to help injured workers continue farming and ranching.
- As a result of the dockside survey with Vietnamese shrimpers, one of the captains called the US Coast Guard and requested a vessel safety examination.
- A student who participated in the pilot test of First Aid Farm Quest accurately assessed a farm injury as involving an arterial bleed, called 911 and rendered first aid.
- A Navajo rancher, who is raising cattle instead of sheep, recognized the importance of using chutes to control cattle while giving inoculations; he attends the annual cattle handling safety program and participates in the project equipment loan program.

Logic Model



* For Projects in Selected Program Area

Program Areas

Tools and Approaches

As technologically has advanced researchers affiliated with the SW Center have provided leadership by applying new technologies in a way that accelerates results, expands access to and participation by target populations, demonstrates efficiencies and accuracy of data collection, and facilitates communication among groups at locations remote from each other.

When Dr. Busbee began his project to determine the endocrine disruptive properties of agricultural chemicals, the state of the art was to use reporter gene systems as a surrogate measure of impact. In the course of the project, micro-array analysis was validated as an effective assessment tool to measure gene regulation of endocrine response to chemicals. Using funding from the SW Center as leverage, Dr. Busbee was able to secure funds to purchase micro-array analysis equipment. This technology has substantially accelerated the scope and breadth of his work resulting in massive amounts of data and analysis that move our understanding of this process forward and which have been shared through the peer-reviewed literature.

With little published information about work injuries among farmworker children, Dr. Cooper borrowed an anthropology research tool, participatory rural appraisal techniques to develop the definition of injury among Hispanic farm worker families and to ascertain injuries in a population of farmworker children. This definition, generated by the target population was a crucial step for developing a meaningful survey tool. Capitalizing on developments in web-based information management, the validated instrument was programmed as a web-based survey to collect information from high school students on demographics, health status, health behaviors, work patterns, work exposures (hazards) and injury experience of adolescents (with focus on back injuries). The relative economy of this data collection strategy, compared with hiring interviewers, made it possible to gather three years of data on a cohort (10/03-10/05) of all students attending high school in Starr County, TX. All students were eligible to participate. The survey was administered during English class because all students must be enrolled in at least one English class. In addition, there were make-up days for students not able to take the survey during their assigned time. Use of the web-based technology resulted in a greatly expanded data pool allowing for comparison among groups and accelerated data analysis since the students entered their own responses which were captured electronically. It also eliminated the discomfort the student might have experienced if the data had been collected by personal interview.

The National Center for Farmworker Health used another application of web-based data collection to evaluate the effectiveness of the research track in achieving the objectives of promoting an understanding of the research process, learning about clinical practice from reported research results, and fostering of collaborations for the conduct of research to benefit MSFWs. NCFH used a web-based tool, SurveyMonkey to distribute a targeted survey via email to everyone who registered for the research track since it was first included in the Midwest Migrant Stream Forum program. The response rate was much higher than expected with mailed surveys, it was very economical, and the data were readily available for analysis.

Both SW Center projects addressing farm women and children utilized Computer Assisted Telephone Interviewing (CATI) to collect demographic, health and safety behavior information, and injury experience data. This technology requires computer programming that handles complex skip patterns, minimizes interviewer bias, and enhances complete and accurate data collection. Since all responses are electronic, data cleaning and analysis is efficient. Application of this technology also enabled each project to obtain a statistically significant sample size that would have been more difficult with other types of survey administration.

The SW Center also utilized Interactive Televideo Network technology to deliver a conference, "Agroterrorism Workshop: Engaging Community Preparedness". Use of this technology, while potentially challenging, made it possible for 158 people to participate from five separate locations without the travel expense usually associated with conference participation. It also made it possible for more substantial community participation, an important element among agricultural populations.

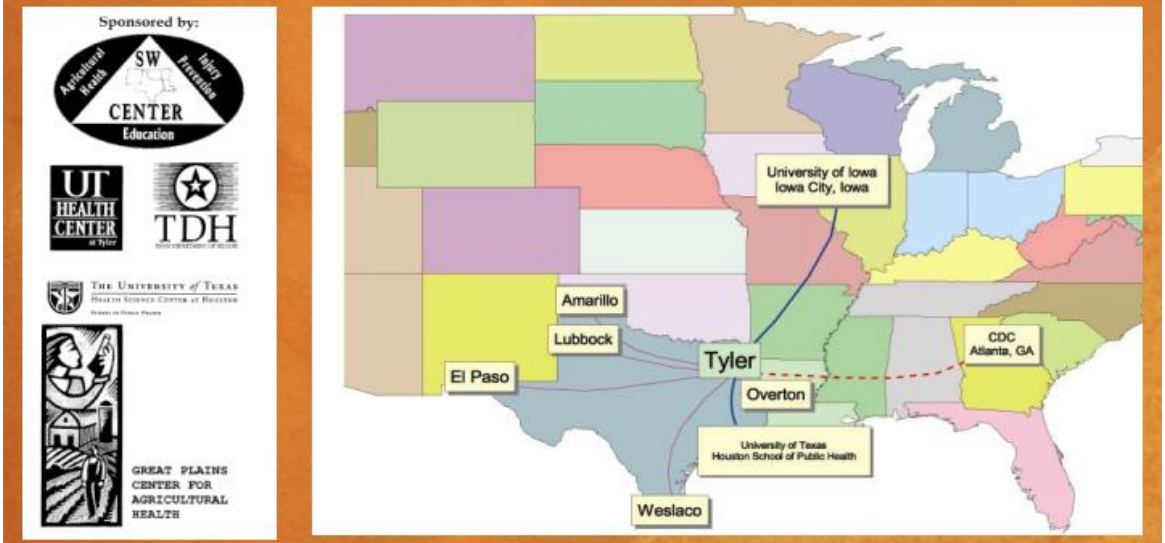


Figure 2. Agroterrorism Workshop (February 12, 2004) brochure and connectivity map illustrating the collaborative and innovative nature of the conference.

It is incumbent upon any research center to be not only current but on the cutting edge of technology. The SW Center has responded to this challenge with the adoption and enhancement of emerging technology, applying tools from one discipline to another, and evaluating the effectiveness of using technologies in new or unproven approaches.

Injury Prevention

Injury Prevention was a designated program area in the original scope of work proposed by the SW Center. It was anticipated that all projects and activities would include injury prevention as an intended outcome regardless of the strategies, target audience, or specific topic. Program efforts include both primary and secondary injury prevention considerations. Projects including injury prevention as a focus include animal handling, farmers and ranchers working with disabilities, and children living and working on farms.

Cattle Handling

The five state region served by the SW Center included 289,919 individual cow-calf operations according to the U.S. Department of Agriculture's Census, 1997. Biosystems and agricultural engineers with Oklahoma State University (OSU) cited the 1993 NIOSH survey that reported livestock as the leading cause of lost-time injuries in Oklahoma in their proposal to reduce injuries associated with cattle handling. Nearly 90% of the total farms in the state included cattle as part of their enterprise; cattle operations tend to have the lowest net farm income and the highest off-farm income compared with other agricultural commodities, and cow-calf operations use minimal hired labor despite the limited on-farm work time. In Oklahoma, 82 % of the cow-calf operations had an inventory of fewer than 100 head and 62% had fewer than 50 head of cattle. This is an issue of particular regional relevance since there are still more than a quarter of a million independently owned cattle raising operations in the region. On average, over half of the farms/ranches have less than 50 head of cattle per operation.

The research team at OSU established a partnership with the cattle specialists of the Cooperative Extension Service for the design and administration of a survey to cow-calf owner/operators across the state. The survey sought to determine size of the enterprise, off-farm work hours, farm work hours, work injury experience (using the lost work time definition), and the operator's perception of the cause of the injury. Contrary to the expectation that faulty equipment or corral design would be the leading contributor to injury experience, the responses indicated human error as the primary, underlying cause of injuries. This included fatigue, not paying attention, mis-judging animal behavior, and rushing to finish a task. Small group discussions with the Cooperative Extension agents with a graduate student in agricultural education pointed to the need for an educational intervention that could be easily disseminated, used repeatedly, have an enduring and lasting shelf life, and impart important safety information in an entertaining format. The OSU media services department was enlisted to create a brief video including footage of Temple Grandin, DVM, and narrated by Baxter Black, nationally recognized as the cowboy poet. The video received the Association of Agricultural Engineers Award for outstanding educational tool.

The Oklahoma Veterinary Medicine Foundation (OVMF) subsequently contacted the research team with a request to produce an educational video for children addressing safety issues when visiting or working on farms, petting zoos, or fairs. The resulting product was an eleven-minute video, "Livestock Safety for Kids". This video was tested with teachers and students for educational value, content retention, and acceptability. The responses on pre-/post-test comparisons, long-term follow-up and teacher evaluations rated the video and teacher's guide as effective educational materials. This product also received the Association of Agricultural Engineers Award for outstanding educational tool. The OVMF provided funds to

place the video and teacher's guide in every elementary school in Oklahoma. The video is also available in Spanish. Both versions continue to be widely distributed.

Farmers with Disabilities

According to the U.S. Department of Labor 2000 census report on the percent of individuals who experience a disability, approximately 288,000 individuals engaged in production agriculture experience physical, sensory or cognitive disabilities that affect performing one or more essential work tasks. The Wellness Center based at Oklahoma State University provides health education, preventive health care and therapeutic health services within the OSU service area and through a statewide network of agencies. It was observed that a substantial number of clients were farmers and ranchers recovering from debilitating injuries and avenues were explored to participate in the AgrAbility Project, a national program collaborative between the USDA and the National Easter Seal organization. The key requirement for a successful application is the partnership between the Cooperative Extension Service (CES) and a rehabilitation service provider. The CES leadership in Oklahoma was not convinced of the need or interest in this program among the state's farmers and ranchers. With pilot project funds from the SW Center, the Wellness Center staff developed and pilot tested a survey to validate the number of the state's farmers and ranchers who had a disability that affected performing one or more essential work tasks and whether they would use services to develop compensatory strategies in order to continue their agricultural work. The Oklahoma Agricultural Statistical Service selected the sampling frame and administered the survey. Staff from both the Wellness Center and the CES were surprised at the number with self-reported disabilities and the request for services. The application for AgrAbility project designation and funds was successful. Five years later, the Oklahoma AgrAbility project is considered a model program.

Childhood Agricultural Injury Prevention

According to reports published by NIOSH (2001) and the USDA National Agricultural Statistics Service (1999), about 1.5 million youth under 20 years of age lived or worked on a farm, roughly 666,500 youth not living on farms were employed to work on farms, and over 400,000 youth under age 20 lived, visited or worked on one of the estimated 60,000 racial minority operated farms in the U.S. With regard to injury experience:

- Children who live, work, or visit a farm have an agricultural-related injury rate of 12.7 per 1000 youth.
- Most injuries occur to youth who are part of the farm household (rate of 15.7 injuries per 1000 youth).
- Over 50% of the children injured on farms were not working at the time of injury.
- More than 100 children die each year as a result of injuries sustained in an agricultural environment.

SW Center sponsored projects have responded to this need to reduce risks for children, working or bystanders, in agricultural settings through a combination of research, intervention, and outreach/education efforts. Several projects have developed strategic community partnerships to conduct Progressive Farmer Safety Day Camps that have delivered important

safety messages to thousands of youth and adults. Topics of regional importance have included, recognition and appropriate field first aid for poisonous snake bites, railroad crossing safety, and outdoor electrical safety. All-terrain vehicles (ATVs) are a leading cause of fatal injuries for youth in Arkansas; one study documented use of ATVs in farm work, youth behaviors with ATVs, , and disseminated safety recommendations to health care providers throughout the state through a peer-reviewed article. Projects have fostered the formation of coalitions of farm women who identified health and safety concerns for their children and facilitated strategies the women could use to influence behavior changes to reduce injury risk for children on family farms in their own communities.

As a whole, the work of the SW Center has raised awareness of agricultural safety and health in the region, established a network of partners for injury prevention research, intervention, and education.

Special Populations

The work of the SW Center could be characterized by two foci 1) work with special populations and 2) leadership in the research to practice continuum. The strategy of developing partnerships and projects to increase awareness of agricultural risks as well as safety and health needs has served as a catalyst for seminal work with farm women and children, migrant and seasonal farm laborers of all ages, the Navajo Nation, and farm women and children.

Farm Women & Children

Historically, farm safety programs have been developed and delivered by agricultural engineers and other production agriculture specialists with the Cooperative Extension Service and have targeted the male farm owner/operator. Roughly a third of the more than 300,000 farms in the five-state region are classified as part-time operations. Economic necessity has influenced trends towards the need for off-farm employment and increased mechanization of agricultural operations. Additionally, the changing role of women's responsibilities in farming/ranching enterprises has given rise to an innovative approach to influence farm safety behavior. The premise underpinning two significant projects is that farm women, working through a coalition of peers, can be empowered to influence work health and safety issues on the family farm as a strategy for injury risk reduction.

The Division of Nursing at West Texas A & M University in the Texas Panhandle, administered a telephone survey to 657 women living and working on farms in five counties. Data included commodities, women's farm tasks, injury experience, and utilization of primary health care. If children were in the household, additional data were collected about farm tasks, at what age, health and injury experience. Women were also asked if they would participate in a coalition for agricultural safety and health promotion. With initial project support, three self-sustaining coalitions have been organized. The coalitions have rallied around farm safety day camps as a strategy to reach all rural children and parents with important safety messages. The number, attendance, and venues of these camps have continued to grow each year of the project. A repeat survey of the original cohort has been completed and the data are being analyzed to determine the extent to which the coalition has been an effective strategy to empower women to

influence safety and health behaviors on their farms, the extent to which their own knowledge base has increased, and their perception of their ability to function effectively as the family safety officer.

The research component of the project described above was replicated by a team at Southeastern Louisiana University, a regional campus serving a large agricultural area. This study group of farm women preferred to organize around specific events rather than establish a formal organization. Groups in two parishes (counties) decided to use the farm safety day camps as their priority project and those have become self-sustaining, community-wide events. This research team also recruited student nurses to organize health fairs, provide health screening services at already established fairs and festivals. They were also engaged to prepare and deliver agricultural safety programs in elementary schools, Migrant Head Start programs, and for community-based clubs and organizations. In addition, one focus group of farm women identified the need for pre-adolescents to know how to administer first aid for common farm injuries since they would likely be first on the scene. The women and an ongoing focus group of farm youth worked with the research team to develop and test an interactive CD, "First Aid Farm Quest". A teacher's guide was developed with a Master teacher, emergency response personnel and agricultural education specialists. Pilot testing has been completed and the data are being analyzed. Feedback from children and adults who have used the material have responded very positively. An expanded distribution is being planned as well as a Spanish version.

Building on the focus group data, the Principal Investigator used farming communities as the target for nursing students enrolled in the Health Community Assessment Course. Compilation of the findings highlighted an urgent need for First Responders to be trained in the appropriate handling of farm emergencies, particularly given the long response times for ambulance to get to the scene, poorly marked roads, and difficulty providing adequate directions in rural areas. Graduate student nurse teams in a subsequent course were each tasked with researching and developing a teaching module to address eleven rural/farm emergency topics. The target audience for such a curriculum is undergraduate nurses, rural health care providers, and first responders. The course, "First Aid for Rural Medical Emergencies, or FARME" has been added to the nursing school curriculum as an elective. It is a self-directed, on-line course augmented with three lectures. The evaluation of the course included pre- and post-test administration and a focus group. The response was very positive and students commented that they had not previously considered rural issues in health care practice. Several students indicated a desire to pursue rural health upon completion of their training as a result of the course.

Migrant and Seasonal Farmworkers

Texas and New Mexico represent the gateway for migration of farm laborers for the SW Center. An enumeration study conducted by the HRSA Bureau of Primary Care in 2000 estimated 362,724 migrant and seasonal farmworkers (MSFW) in Texas, over 75,000 of whom are children. Many of these farm laborers maintain permanent households in southern areas of the state and migrate from there throughout the U.S. An additional 30,000 MSFWs perform farm labor in Oklahoma, Louisiana, and Arkansas. Unfortunately, New Mexico was not included in this study.

SW Center project focus on this special population includes a long-standing relationship with the National Center for Farmworker Health (NCFH), a national resource center for migrant

and community health clinics. Initially, interviews were conducted at the Hope Migrant Center in Hope, AR to ascertain work-related health issues of concern to the population. A subsequent series of focus groups confirmed a uniform complaint about lower back pain, concerns about pesticide exposures, and access to medical services when needed. Two issues arose in analyzing the data, the lack of low-literacy material addressing back care, and a relative dearth of information about MSFWs in the peer reviewed literature. In response, NCFH assembled a team of bi-lingual educators, occupational medicine physician and graphic artist to develop a bi-lingual brochure and poster with tips for preventing and treating lower back pain, for distribution through the network of migrant and community health clinics. The material is also highlighted in the NIOSH publication, "Simple Solutions".

The second issue was more challenging. NCFH staff solicited input from clinic staff and community-based advocacy groups (as gatekeepers to the population) about their experience with researchers. Information was also gathered from researchers who had reported on their work with MSFWs. Gatekeepers reported feelings of distrust for researchers and a sense of being used because once the data was collected, the researchers didn't come back, or share their findings, or provide assistance to remedy problems documented in the research process. Sometimes they were made to feel inadequate because they didn't understand the terms being used, and they were not treated as partners in the process. The researchers found it challenging to get the level of cooperation they wanted from the clinics/communities, study participants didn't match the criteria set by the researchers, ability to contact a study participant multiple times proved difficult, and funding only covered the "research" project, not ongoing interaction or response to the findings. In addition, given the mobility of the MSFWs, the study population size tended to be too small for findings to be accepted by the major journals. In an attempt to bridge the concerns and needs for both groups, the NCFH decided to add a Research Track to the program of the Midwest Migrant Stream forum, an annual conference attended by clinic staff, outreach workers, advocates, government agencies, and MSFWs. A pre-conference, intensive workshop was added to teach non-researchers some basic terminology, principles, and requirements to facilitate communication between researchers and gatekeepers. This strategy, initiated in 1998, also provided a venue for researchers interested in MSFW issues to present their work and establish collaborative relationships for future work. This has been extremely successful, based on evaluation feedback from conference participants. NIOSH immediately made funds available to support the addition of a research track in both the East and West Coast Stream Forums. This format continues as part of the annual conference in each of the three Migrant Stream Forums.

Despite the service and successes of the Migrant Education Program, many children of migrant farmworker families are not able to complete the requirements for a high school diploma. In South Texas, public school systems have instituted High school Equivalency Programs (HEP) specifically to meet the needs of this population. What the curriculum lacks is agricultural health and safety content and information on worker's rights to protect this vulnerable population. The SW Center provided pilot funding for the assimilation and translation of two published curricula, one from MN and one from CA, that could be added to the HEP curriculum in south TX schools. Additional support was provided by NIOSH through a competitive review process, to implement and test the effectiveness of the curriculum with a cohort of migrant farmworkers. That two-year study is in its final year and data collection is on -going.

Public policy and economics have changed the nature of migration for farm laborers. Under the guest worker program established in the 1950s it was common for entire families to migrate together in an established geographic pattern. Often a grandmother or aunt would accompany the family to care for young children while parents and older siblings worked in the fields. It is now much more common for groups of emancipated males to travel together to do farm labor. Without the presence and support of their families, alcohol and substance abuse, violence, and other manifestations of stress and a sense of isolation, are increasingly reported. A feasibility study called "Cyber Voices from the Field" has been undertaken with SW Center support to help migrant farm workers stay connected with their families. The program teaches migrant families how to use the internet, how migrating workers can find free internet access as they travel, and e-mail etiquette.

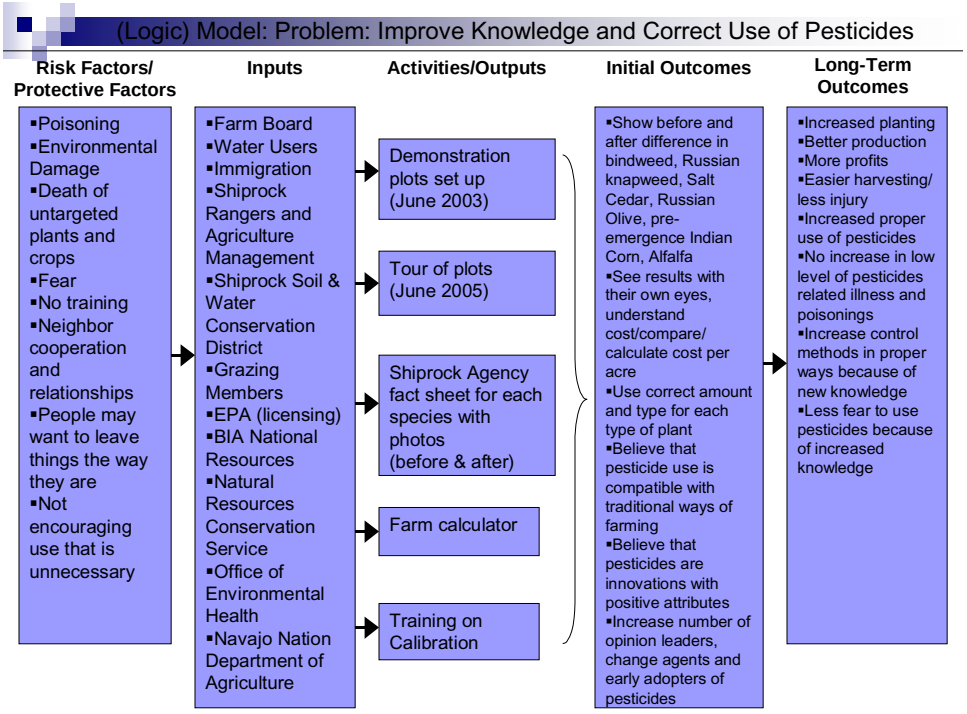
A pilot research project was undertaken by Occupational Medicine resident, Cynthia Ball, DO, M.S. to explore her hypothesis that new farm labor immigrants are less likely to report work-related injuries or seek treatment compared to longer term immigrant or resident workers. Dr. Ball first adapted an occupational and injury history survey, then had it translated and validated in Spanish. To control for economic variability among workers and to include a representative mix of the target population, Dr. Ball worked with a Migrant Head Start program and a regular Head Start program to administer and collect the low literacy level surveys. The preliminary results of this small sample tended to support her hypothesis. She presented her findings at a professional conference as part of her residency requirement.

<u>Understudied/Under-Represented Populations</u>

- Navajo

Little attention has been paid to Native American workers by the agricultural safety and health community. A review of death certificates in New Mexico documented a much higher than expected work fatality rate for Navajo engaged in agriculture. The Navajo Nation located in northwestern New Mexico and northeastern Arizona, have a history of sheep-herding and subsistence farming for their livelihood. In recent years, seeking to improve their economic position, they have transitioned to cattle raising. Limited experience working with the larger, more dangerous animals, created serious injury risk situations. The research team enlisted the participation of the Cooperative Extension Service (CES) assigned to the Navajo Nation.With stakeholder input, they developed modules on cattle handling safety, animal flight zone and appropriate use of chutes and gates to manage the animals. The module included the video, "Cattle Handling Safety" (developed by another SW Center project), that was delivered as part of the CES spring and fall "Farm Days" organized by the CES. The program was offered at least once in each of the 30 Chapter House areas. In the process of conducting the training, staff learned the Navajo worked together in cooperatives within the Chapter House (a geographic) designation. Even the cooperatives did not have the financial means to purchase the cattle chutes and gates for proper cattle handling. As a pilot, arrangements were made for the project to purchase one set of equipment to be loaned within and among the Chapter Houses. The Chapter House was responsible for managing the loan program in an equitable fashion, while the CES assumed responsibility for equipment maintenance and repair. The ability to borrow the equipment was contingent upon participating in the cattle safety training program.

Building on this preliminary work, the currently funded project with the Navajo took a more structured approach to designing and evaluating the effectiveness of stakeholder-selected interventions. Using historical land ownership records, Navajo farmers/ranchers were identified and recruited to participate in a needs assessment survey conducted in Navajo (an oral, "non-written" language). A statistically significant sample was achieved. The data were then used with a group of stakeholders, recruited by Chapter House leaders and the trusted CES agent, as they were guided to select three intervention priority areas and develop a logic model for the intervention to address each priority. This process was a significant capacity-building effort. One of the CES agents Jeanny Benally, a Navajo, used the process and intervention implementation to earn her Masters thesis. She is now a resource as leaders identify other priority issues for which they will develop intervention logic models. In response to continued concerns about working with cattle, the Navajo requested to have the video available in Navajo, and dubbing was accomplished. Multiple copies have been made and widely distributed to Navajo CES and Chapter Houses. Though arid most of the time, when it rains the land quickly gives way to rushing water forming dangerous arroyos and flash flooding. Children are especially susceptible to drowning during this storm so an educational video "Ditch Witches", in the Navajo language, has been acquired and distributed throughout the Navajo Nation. The third area of concern was introduction of pesticides onto the Nation. The logic model developed and implemented by the stakeholder group is shown.



- Vietnamese Shrimpers

The Texas Gulf Coast is home to 3 of the top 20 most valuable fishing ports in the country. Shrimp, oyster, blue crab, lobster, and other food fish harvested in Texas and Louisiana coastal waters represent a significant portion of the industry's landed value in the U.S. A literature search revealed very limited information about the shrimp fishermen in the Galveston

Bay area. Occupational Medicine resident, Sacha St. Hill, M.D. chose to explore the occupational safety and health risks for this work group in a pilot study undertaken as part of her residency training program in 2003-2004. The U.S. Coast Guard District 8 office in New Orleans, LA collects data on all reported commercial fishing incidents. Parameters studied included fatalities, cause of incident, persons overboard, number of fatalities per incident, use of safety equipment, completion of voluntary dockside exam, and vessel loss. District 8 has the second highest fatality rate for commercial fishing vessel (CFV) workers. While the data supported relationships between use of safety equipment and non-fatal incidents, other measures did not demonstrate clear relationships between safety interventions and reduced fatalities as in other parts of the country.

The data analysis from this pilot study and ongoing work with the U.S. Coast Guard CFV Safety Officer, resulted in the development of a competitively funded research project under the direction of Center Director, Jeffrey L. Levin, to explore and develop a culturally sensitive safety training program for Vietnamese shrimpers. Stakeholder involvement has been key to project implementation. It started with a community meeting organized by the CFV Safety Officer and Vietnamese community advocate to present the project concept and intent. A stakeholder advisory board was chosen. Based on their recommendations, a survey, translated and administered in Vietnamese, gathered information from captains and crew about their perceptions of work risk, work behavior, injury experience, knowledge of safety equipment, and attitude about safety behaviors. A series of focus groups (in Vietnamese as appropriate) comprised of owner/operators, family members, and industry representatives provided additional insights about perceptions of work risk, behaviors they believed put the worker at risk, and what type of information or training would reduce injuries, fatalities, and vessel loss. A community meeting was held (with 72 Vietnamese shrimpers and family members in attendance) to share results of the survey and focus groups. Nearly a dozen captains have volunteered to participate in the pilot of the safety training program when it is ready later this year.

- Migrant Farmworker Youth

An outstanding epidemiologic study conducted by Sharon Cooper, Ph.D. demonstrated that many MSFWs do in fact maintain a permanent residence in a “home state” and that researchers may access a consistent study population over time by building relationships with key leaders in the community, timing data collection to coincide with non-farm work periods, and providing study findings to the community. This seminal work led to the successful funding of a project under her direction entitled, “A Study of Work Injuries in Farmworker Children”. Key community informants assisted the research team in community mapping, identifying the area where the maximum number of residents would meet the study criteria, and facilitated developing a relationship with all of the high schools in the county to participate in the study. The logistics of managing a research site from a remote location and the trusting relationship that developed between the research team and the community made it possible to utilize new technology for data collection and to expand the population to include all high school students in the county instead of the original target of only those who performed migrant farm labor. This project provided critical research experience and dissertation material for one of Dr. Cooper’s graduate students, Ms. Eva Shipp, who was awarded her doctoral degree in December 2005. Five papers have been published or accepted for publication thereby contributing substantially to the body of knowledge about injury experience among migrant farmworker youth.

PACIFIC NORTHWEST AGRICULTURAL SAFETY AND HEALTH CENTER
1990 – 2006

Report for National Academy of Sciences Review

Pacific Northwest Agricultural Safety and Health Center
http://depts.washington.edu/pnash/

School of Public Health and Community Medicine
University of Washington
Seattle, Washington

June 13, 2006

PACIFIC NORTHWEST AGRICULTURAL SAFETY AND HEALTH CENTER
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CENTER OVERVIEW

INTRODUCTION

The Pacific Northwest Agricultural Safety and Health (PNASH) Center is one of ten agricultural safety and health centers created by the National Institute for Occupational Safety and Health. We are part of the Department of Environmental and Occupational Health Sciences at the University of Washington, housed within the School of Public Health and Community Medicine. The School was recently ranked by *US News & World Report* as the fourth best in the nation, and is the only school of public health in the four-state region that we serve.

The PNASH Center provides a truly regional focus by addressing the three major agricultural sectors in the Northwest -- farming, forestry, and fishing -- and serving the Northwest states of Alaska, Idaho, Oregon and Washington. We have worked to build a network of health and safety researchers, educators, health care providers, industry and community partners in the field of agricultural safety and health. We have also created opportunities for stakeholder inputs, research partnerships, and research dissemination. The PNASH Center has sponsored a formal Pilot Project Program since 1996 to encourage novel research and education projects.

The PNASH center's focus is primarily on populations not well represented in current research, including hired laborers, migrant/seasonal workers, women and children. The Center's overall aims are to:

- Conduct research related to the prevention of occupational disease and injury among agricultural workers and their families;
- Develop, implement and evaluate educational and outreach programs that promote health and safety for agricultural workers and their families;
- Develop, implement and evaluate model programs for the prevention of illness and injury among agricultural workers and their families; and
- Develop linkages and communication with other organizations involved in agricultural health and safety with special emphasis on communication with other agricultural health and safety programs.

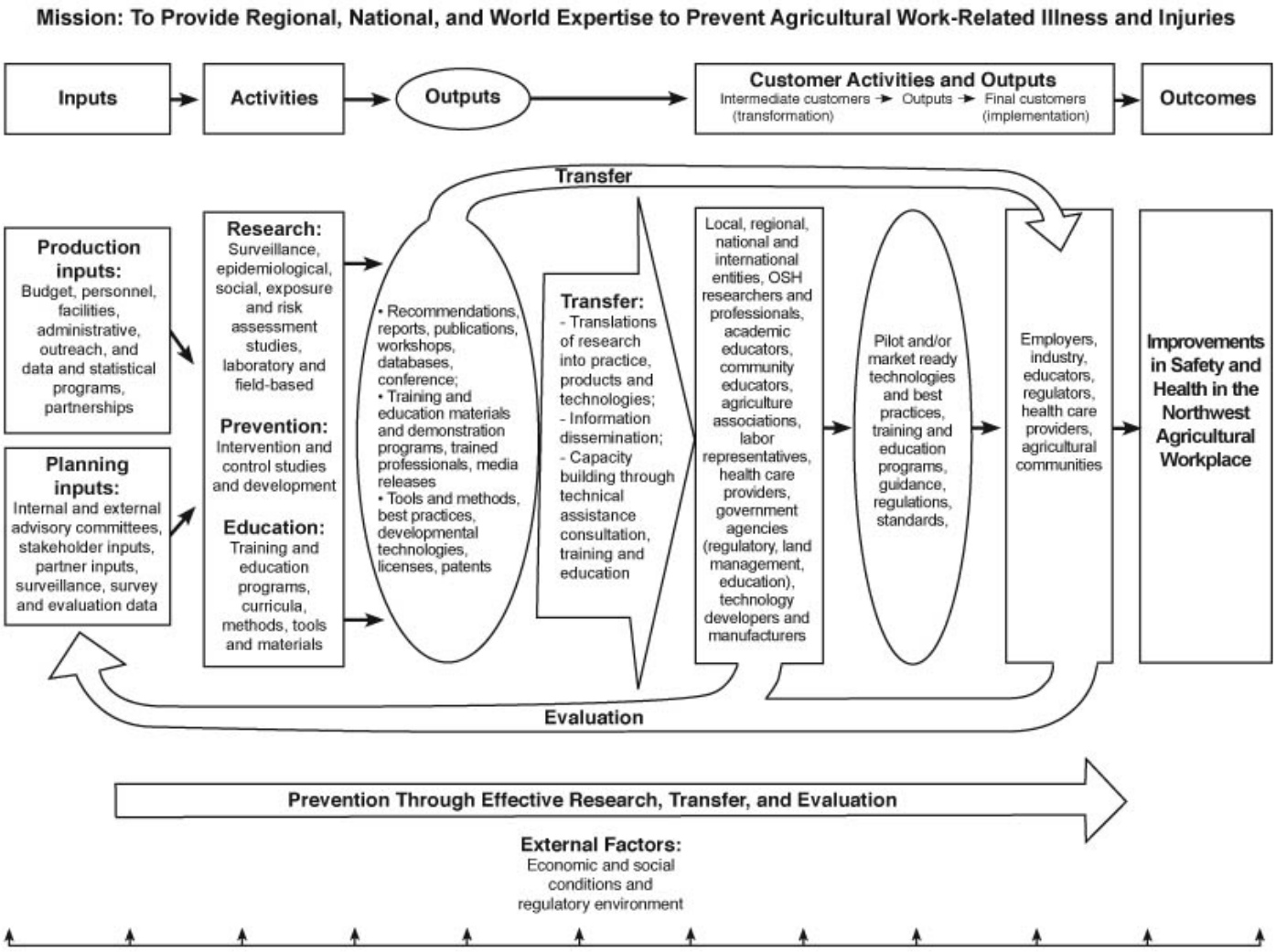
The PNASH Center is part of a vital national infrastructure dedicated to the prevention of illness and injury among agricultural producers, workers and their families. In addition to our regional partnerships, we work collaboratively with other regional centers to formulate national programs and policies in agricultural health and safety. The PNASH Center reflects a cross-disciplinary, multi-institutional, and geographically diverse set of initiatives.

The PNASH Center's principal funding is from the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention under Cooperative Agreement #5U50OH07544 and from the Washington State Medical Aid and Accident Funds. Other significant grant sponsors include the Environmental Protection Agency and the National Institutes of Health.

PNASH CENTER OVERVIEW

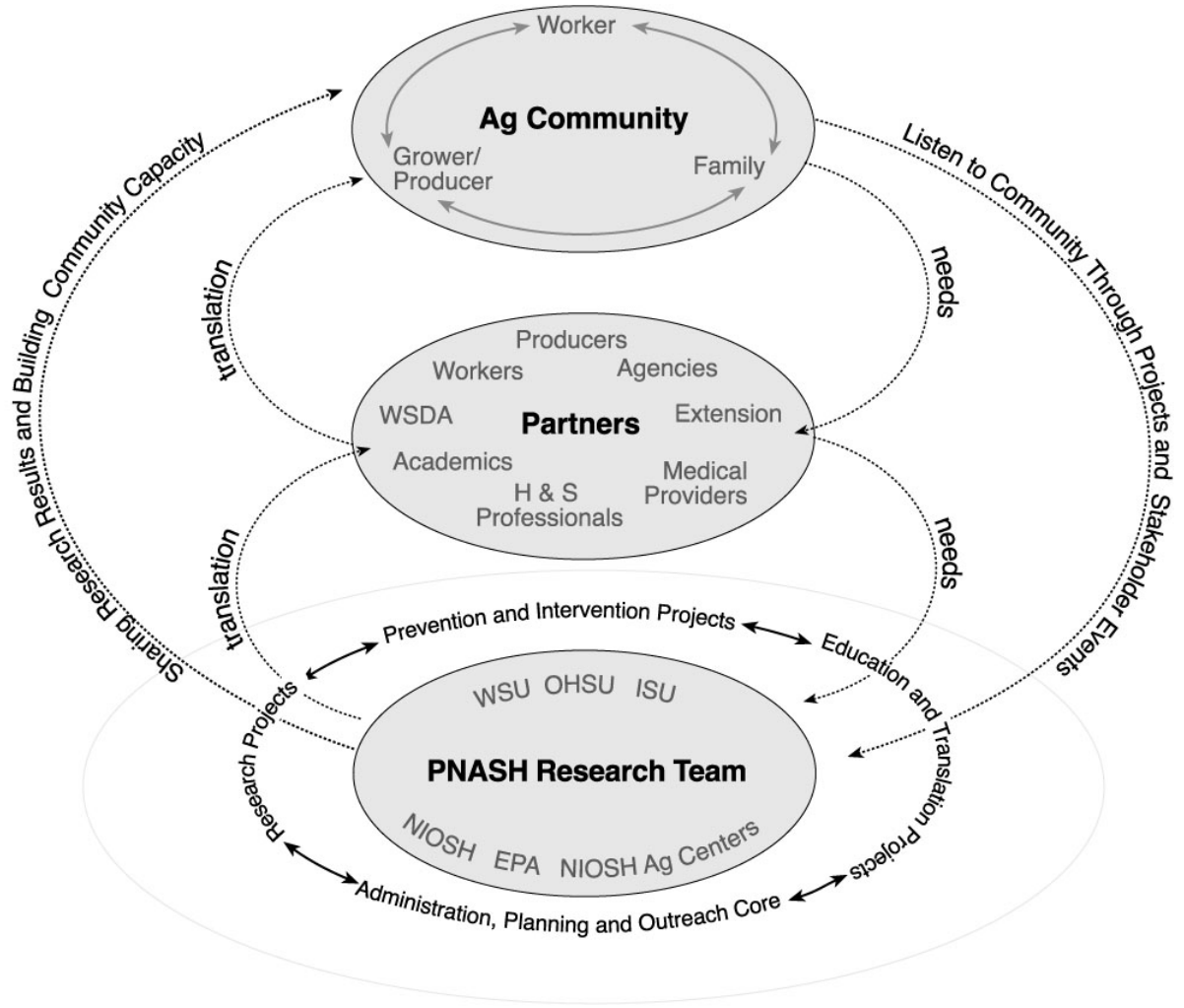
The activities of the PNASH Center can be described within an operational model that charts inputs, activities, outputs, and outcomes, as illustrated in Figure 1. The overall goal of the Center's activities is to produce practical outcomes that prevent or reduce injuries and illnesses in agriculture.

Figure 1. The PNASH Center Operational Model



The PNASH Center's activities can also be seen within the context of a regional model that places an emphasis on interactions with our regional partners, as illustrated in Figure 2. We work to reach the agricultural community – employers, workers, and the rural communities that support agricultural production – through an iterative process. The research products of the center are translated to practical findings that can be implemented within the agricultural community.

Figure 2: The PNASH Center Partnership Model



BACKGROUND AND SIGNIFICANCE

The agricultural industry (production farming, fishing and forestry) consistently ranks among the highest for worker injury and illness. Acute traumatic injury and death are among the most striking outcomes. According to the Bureau of Labor Statistics, approximately 31 deaths per 100,000 workers occurred in the agricultural sector in 2003, compared to an average of 4 deaths for the general working population. Washington and Alaska have seen some of the highest rates of agricultural injuries in the country, and nearly double the national average in the last decade.

Agriculture is a cornerstone of the Northwest's economy and the main source of livelihood for many families. The Northwest is the nation's leading producer of tree fruit, potatoes, certain vegetables (wrinkled seed peas and processing carrots), field and grass seed crops, grapes, hops, aromatic oils (spearmint and peppermint), tulips, raspberries, Christmas trees, lumber, and a variety of fished and farmed sea foods (National Agriculture Statistics Service, 2006).

Washington State agriculture directly employs from 160,000-180,000 workers annually and deciduous fruit tree work employs an estimated 47% of the agricultural workforce. Employment in agriculture has increased 12.6% between 1990 and 1998 and expansion in the production of tree fruits (apples, cherries, and pears) has been the major source of this expanding workforce.

While agriculture adds about $5 billion a year to the state's economy, it also adds a measure of injury and illness. The cost averages more than $8 million a year in workers' compensation claims in just the tree fruit industry in central Washington – plus untold costs to the workers and their families.

The theme of the PNASH center is ***Promoting Safe and Sustainable Agricultural Workplaces and Communities***, which frames our aim to integrate the health and safety of workers within the concept of sustainable agriculture and to develop a measuring scale for a sustainable agricultural workplace. Center Director, Richard Fenske, has stated, "In our view, the need for sustainable agricultural workplaces extends beyond the boundaries of the farm, and into the rural communities that are themselves the sustenance of the agricultural economy…. Thus, our theme encompasses a broad, public health view of sustainability and includes the next generation within these communities."

Workers

Management, harvesting, and processing rely on intensive seasonal labor, conducted mostly by Hispanic resident or migrant workers. In Washington state 69% of the agricultural workforce is Hispanic, the majority of whom are employed in tree fruit production (Washington State Employment Security 2005). These workers and their families are at special risk due to the nature of their tasks, as well as language and literacy barriers. A common health issue is musculoskeletal complaints; 40% leave or change jobs because of chronic back or neck pain, and the bulk of worker's compensation claims involve falls from ladders. Through Washington farmworker community surveys and a town meeting, we have heard that their top concerns in 2006 are pesticides and chemicals, work-related injuries and illnesses, and abusive workplace conditions.

Children

Another special population at risk for injury and illness is children who live in farm communities or work on their family farm. Young children are more vulnerable to agricultural chemicals by virtue of their higher metabolic rates, smaller body size, immature biological systems and behaviors. Teenagers working on family farms have higher injury rates than those working in agribusinesses not owned by their family. Hispanic youth working in agriculture report higher injury rates than their non-Hispanic counterparts. The PNASH Center conducts prevention-oriented, research, and intervention development to reduce agricultural injuries and illnesses among children of agricultural workers in the Northwest. Priority issues are identified through research and community surveys.

Setting Priorities

The more than 50 projects undertaken by the PNASH Center span a variety of subjects and research disciplines. As a NIOSH Agricultural Center, the majority of our projects focus on farming. However, recognizing the importance of the fishing and forestry industries to the Northwest, some projects address their needs.

In the development of projects, we select topics that

- Address hazards that are the most serious, affect the greatest number of workers, and where research will make a difference.
- Meet the needs of Northwest employers, workers, and service providers. We have established a process that engages various constituencies familiar with agricultural health and safety throughout our region to help us establish PNASH Research Priorities.

The Center's Agricultural Community, Outreach, and Education Program (ACOEP) is the Center's foundation for building relationships and sharing information with producers, farmworkers, health care providers, extension specialists, government workers, and other researchers and educators. Outreach links the Center to its stakeholders in the agricultural community, forging the partnerships that are essential to the success of all of our activities.

Agricultural Occupational Research Agendas

A key strategic element in our approach has been the development of a stakeholder-based hazard priority ranking process for each of the three major industries. First, in 1998 we gathered producers, labor representatives, health care providers, and key government agency figures to discuss health and safety priorities in Northwest farming. This "Farm Summit" produced an occupational research agenda modeled after the National Occupational Research Agenda (NORA) process pioneered by NIOSH. Second, in the area of forestry, we convened a Technical Advisory Committee of forestry health and safety experts from across the region to help plan a Forestry Safety Workshop. The Workshop was held in February 2000, and included leaders from industry, labor, tribal nations, and government agencies. The research agenda generated from this meeting presents many exciting challenges, and has led to the center's formal inclusion in forestry industry conferences and activities. Third, in the area of commercial fishing we established a Technical Advisory Board of industry leaders to help establish research priorities. The board recommended several directions for our center's activities, but did not believe that a formal priority ranking process was needed for that industry. As a result, no priority-ranking workshop was organized for the fishing industry. In sum, we believe that our center has articulated a new role for health and safety research and education in each of these industries, and has established credibility among industry and labor leaders in the region. The priorities identified by our farming and forestry stakeholders are presented in Table 1.

Additional information regarding the Farm Summit and the Forestry Safety Workshop can be found in the following documents: *Occupational Research Agenda for Northwest Farming* and *Occupational Research Agenda for Northwest Forestlands*. Downloadable PDF reports of these events are available at the PNASH Center website:

http://depts.washington.edu/pnash/research_summaries.php#haz_three

Table 1. Northwest Priority Research Areas – Findings of the PNASH Center's AgNORA Process

FARMING	FORESTRY
DISEASE AND INJURY	**DISEASE AND INJURY**
Musculoskeletal Disorders	Hearing Loss
Respiratory Disease	Heat and Cold Stress
Skin Disease	Musculoskeletal Disorders
Traumatic Injuries	Skin Disorders
	Traumatic Injuries
WORK ENVIRONMENT & WORKFORCE	**WORK ENVIRONMENT & WORKFORCE**
Chemical Exposures	Work Organization
Special Populations at Risk	Environmental Hazards
Social/Economic Foundations of Workplace Safety	Hazardous Operations
Risk Communication Barriers	Training
	Workplace Behaviors
RESEARCH TOOLS & APPROACHES	**RESEARCH TOOLS & APPROACHES**
Hazard Control Technology	Hazard Control Technology
Intervention Effectiveness	Intervention Effectiveness
Surveillance Research Methods	Surveillance, Data Collection & Reporting
Diagnostic Approaches	Medical Services
	ECONOMIC & POLICY FACTORS
	Government Policy
	Industry Trends
	Top Level Commitment

In 2003 personal interviews with health care providers of farm workers yielded new insight into the needs of this important constituency. The PNASH Center identified the following priorities for health care providers: health effects due to the quality of farm worker housing, skin diseases, depression, and evaluation of programs that enlist community health workers, or *Promotoras*. All of the medical directors of the clinics contacted believed that the main farm worker illnesses were poor nutrition, diabetes, substance abuse, depression, asthma, and domestic violence. The most common noted occupational illnesses were related to musculoskeletal disorders and allergies.

El Proyecto Bienestar Hispanic Agricultural Community Health Concerns

The PNASH Center's community-based participatory research project (*El Proyecto Bienstar*, the Well Being Project) in the Yakima Valley of Washington State (Dr. Matthew Keifer, Principal Investigator) has conducted key informant interviews and two years of community surveys, culminating in a Town Hall meeting in April 2006. This project has also identified key health concerns in this important agricultural community, as indicated in Table 2.

Table 2. El Proyecto Bienestar Health Priorities

CATEGORY	PRIORITY
Exposures	Pesticides and chemicals Water contamination Extreme workplace temperatures Air contamination
Outcomes	Work-related illnesses and conditions Work-related injuries Cancer Dehydration or heat illness
Contextual Factors	Abusive workplace conditions Low wages or job instability Lack of documentation of immigration status Lack of access to medical care Problems with workers' compensation claims

NIOSH Agricultural Sector Town Hall Meeting

On Jan. 17, 2006, the PNASH Center served as a site-host and planner for NIOSH's agricultural sector NORA Town Hall meeting in Seattle. Through our networking in the region and with the assistance of the other agricultural centers, more than 120 people attended the Town Hall, and 51 speakers presented their ideas for research. We were happy to contribute to the development of the speaker docket, and look forward to the next decade of NORA to refresh our understanding of agricultural research priorities.

SIGNIFICANT FINDINGS

The PNASH Center has succeeded in developing a substantial presence and working relationship with the Northwest farming industry, and in particular, with the tree fruit industry. The Center has had an excellent experience working with a variety of partners, gaining industry support, and in conducting farmworker community-based research.

We summarize six major accomplishments by program area:

- Pesticide Exposure Assessment Methods
- Interventions to Reduce Pesticide Exposures among Agricultural Workers and their Families
- Traumatic Injuries
- Musculoskeletal Disorders
- Noise and Vibration Exposures
- Special Populations – Hired Farmworkers and their Families

TRANSLATION OF FINDINGS

The PNASH Center's activities have made demonstrable impacts in Northwest agricultural safety and health. While we are not able to document that our activities have led to the end goal of reducing injury and illnesses, the following intermediate outcomes are closely linked to our study results and expertise.

Washington State Cholinesterase Monitoring Rule

In 1995, a Technical Advisory Group (TAG) formed by the Washington State Department of Labor and Industries (L&I) found that a cholinesterase monitoring program was technically feasible and necessary to protect worker health. Both PNASH director Richard Fenske and co-director Matthew Keifer served on the TAG. The recommendations outlined in the TAG report, *Cholinesterase Monitoring in Washington State*, were used by the Washington State Supreme Court to decide if a monitoring system was feasible and their recommendations greatly informed the resulting program. The TAG report recommended:

- Medical supervision for workers who mix, load, or handle Class I or II OPs or carbamates
- Testing for workers who handle pesticides more than 3 consecutive days, or more than a total of 6 days in a 30-day period.
- A single pre-exposure baseline measurement taken from workers each year prior to exposure.
- Follow-up testing every three to four weeks (depending on spray cycle) until spray activities are completed for the season.
- Removal of workers whose red blood cell cholinesterase is at or below 70% of baseline levels or plasma cholinesterase is at or below 60% of baseline. Workers would not be exposed to OP or carbamate pesticides until their cholinesterase levels return to 80% or more of their baseline.

In 2000, the Washington State Supreme Court mandated that the L&I develop a Cholinesterase Monitoring Program for workers handling acutely toxic pesticides. The new rule was implemented in February 2004, requiring agricultural employers to provide blood testing to workers who handle organophosphorus and carbamate pesticides. PNASH Center investigators have been instrumental in the development and implemention of the new Washington State rule. Initially, L&I organized an expert committee as it implemented the rule. Dr. Matthew Keifer and Dr. Patricia Boiko, both from the PNASH Center, served on this committee. Subsequently, the PNASH Center developed a training program for clinicians who planned to participate in the monitoring, and published this program as a clinical guide (available through the PNASH Center website). The PNASH Center also contracted with Dr. Karl Weyrauch to develop and test an appropriate informed consent document for pesticide handlers that could be used by clinicians in the testing program (available through the PNASH Center website).

The University of Washington's Department of Environmental and Occupational Health Sciences (DEOHS) has also assisted the state in the evaluation of findings from this mandatory monitoring program. Specifically, several faculty members have been active on the Scientific Advisory Committee formed to oversee data collection and analysis. Dr. David Kalman (the DEOHS department chair) has chaired the program's Scientific Advisory Committee; Dr. Matthew Keifer of the PNASH Center, Professor Gerald van Belle, and Clinical Instructor Dr. David Bonauto have served as members. Dr. Kalman, who for 19 years directed the Environmental Health Laboratory, called this an example of "taking science out of the lab and into the regulatory world." The idea behind the monitoring, he said, is to identify potential poisoning before symptoms develop, providing a margin of safety. Dr. Kalman's committee is reviewing monitoring results to allow the state to determine whether the monitoring program is, in fact, protecting a significant number of workers. Dr. Keifer described the goals of the monitoring program as preventing poisonings, identifying hazardous conditions and practices, increasing hazard awareness among workers and employers, and helping to determine a safe time frame for returning to work after a poisoning event. The PNASH center is currently

conducting follow-up studies to investigate the causes for cholinesterase depression and is also evaluating a field test kit that clinics can use.

Washington State Department of Agriculture Pesticide Applicator Hands-on Training

The PNASH project team, under the leadership of Dr. Fenske, has developed a reciprocal relationship with our partners to enhance the Washington State Department of Agriculture's (WSDA) Hands-on Pesticide Handler Training. This was accomplished by the incorporation of PNASH developed fluorescent tracer demonstrations into the standardized WSDA pesticide-training curriculum. One hundred and fourteen handlers have been trained using this method. Based on the results of this training the WSDA has adopted the use of the FT training on permanent and ongoing basis. The response from educators, orchard managers, and students to the FT hands-on training has been very positive. In addition to the Washington state training program, a FT Manual for educators and others who train pesticide handlers, is being produced. The manual will provide users with specific 'how to' instructions for different training environments, and will be produced in Spanish and English. This manual will be available for distribution locally and nationally.

Washington Tree Fruit Industry Technology Roadmap

The PNASH Center's research on injuries in the tree fruit industry, led by Dr. Matthew Keifer, has found that falls from ladders are the most common injury reported by orchard workers in Washington. The results from these studies have contributed to a plan by the tree fruit industry in the United States to incorporate new technologies in agricultural production. For example, mobile platforms for workers have been introduced into several orchards, obviating the need for ladders. In 2003, the industry developed a "Technology Roadmap" with the goal of improving the sustainability, efficiency, and quality of fruit production in the United States. The Technology Roadmap seeks not only to improve the operational efficiency of tree fruit harvesting, but also seeks to create a more prosperous, skilled year-round work force that works under safer conditions. The tree fruit industry acknowledges that a past practice of merely increasing workload in order to increase productivity is outmoded, yet pure reliance on technology is likely to fail unless it also improves the lives, social conditions, and economics of the industry. PNASH Center investigators are currently working in partnership with the Washington Tree Fruit Research Commission and Washington State University to incorporate sound ergonomic practices into the use of mobile platform technologies in order to prevent musculo-skeletal disorders in the agricultural workplace.

Capacity Building in Farmworker Hispanic Communities

PNASH Center investigators, through the leadership of Dr. Matthew Keifer, have worked to enhance the center's involvement with Northwest farmworker communities. The project, El Proyecto Bienestar, a community-based participatory research project, has been instrumental in capacity-building through various aspects of its work. El Proyecto Bienestar has joined forces with ConneX, a program for economically or educationally disadvantaged students from the Yakima Valley who are interested in pursuing health careers. The University of Washington (UW) accredited curriculum for undergraduates involves classroom work on environmental and occupational health, environmental justice, community-based participatory research, and the scientific method. The course ends with an intensive fieldwork experience, during which students carry out a community survey, complete data analysis and present their findings to the project's Community Advisory Board for inclusion in the project's dataset. Each year, the ConneX students have received scholarships to present their work at the Western Migrant Stream Forum, where they are exposed to a wide range of academic research and intervention activities. El Proyecto Bienestar has also raised general awareness among farm workers about

the scientific process. A recent "Town Hall" meeting in Yakima was a clear example of this effort, and provided a way to share and receive input about environmental and occupational health research. The meeting was one step in a process that has been important in building the capacity of individuals to understand both the potential uses and the limitations of scientific research. Finally, El Proyecto Bienestar has increased the participation of community members in graduate student research. This year, we had an individual from the community act as a committee member for a public health graduate student. This type of partnership increases the knowledge of community members about the processes of academic work, and makes the academic process more transparent for the general community.

Capacity Building of Agricultural Employers

The PNASH Center has focused substantial effort on building partnerships with agricultural employers. We have sponsored numerous short courses that have been attended by farmers. For example, our 2004 "Pesticide Issues" conference, co-sponsored by Washington State University, included special breakout sessions for employers. The PNASH Center director has also given presentations at meetings of employer organizations such as the Washington Growers League.

Most recently, the PNASH Center has played an active role in the development of a new forum for education and outreach, the annual Governor's Agricultural Health and Safety Conference, or Ag Safety Day. The first Ag Safety Day was held in the late winter of 2004 in Yakima, Washington, and was attended by over 300 agricultural employers and their lead supervisors. PNASH Center investigators served on the Planning Committee. In 2005 we were again active on the Planning Committee, and PNASH Center staff made several of the educational presentations at the conference on such topics as cholinesterase monitoring, heat stress, and reducing children's exposure to pesticides. Ag Safety Day is an extraordinarily important new development in our region. The conference is held with both English and Spanish language sessions, thereby reaching the primarily Hispanic supervisors who direct the day-to-day activities of workers at the worksite. Ag Safety Day is an ideal venue to transfer PNASH Center research findings to an audience that can implement our educational and prevention strategies.

Capacity Building of Health Care Providers and Occupational Health Professionals

Over the past ten years, the PNASH Center has informed and guided professionals and graduate students engaged in agricultural health and safety. The Center has hosted 14 professional education courses. In our efforts to ensure participation from professions working in rural, agricultural settings, we offered most of the courses in farming communities. We also designed the courses to incorporate breakout and Spanish language sessions to be inclusive of diverse audiences.

The PNASH Center has been pleased to educate and provide research opportunities for graduate and undergraduate students. Students have played an important role in many of the research projects in the Center. We are able to support their research efforts and tuition through funds allocated through the NIOSH-funded Education and Research Center (ERC) and UW departments such as the Department of Environmental and Occupational Health Sciences. Most recently, an EPA grant has allowed PNASH to develop curricula that will be inserted into health care provider higher education for both advanced and mid-level practitioners. PNASH faculty and staff through education and mentoring are improving the capability of future health and safety practitioners.

National Policies and Programs for Agricultural Worker Safety and Health

The work conducted by PNASH Center faculty has led to invitations to participate in national

policymaking, particularly in the area of pesticide health risks. In 2002-2003 the U.S. Environmental Protection Agency completed its national evaluation of the federal Worker Protection Standard. Both Dr. Fenske and Dr. Keifer were invited to present their views at the U.S. EPA's "Worker Risk Seminar", a conference that reviewed the strengths and limitations of this important rule that protects agricultural workers from overexposure to pesticides. Fenske and Keifer were the only academic researchers invited to speak at this conference.

Other examples of national service are as follows: Dr. Keifer chaired a national panel to develop diagnostic strategies for pesticide-related illness, and edited a widely cited issue of *Occupational Medicine State of the Art Reviews* on the health effects of pesticides; Dr. Fenske served for eleven years on the advisory panel of the NCI/NIEHS/EPA Agricultural Health Study; Dr. Keifer served on a NAS panel to evaluate the health risks of methyl bromide as a soil fumigant; Dr. Fenske currently serves on the National Academy of Sciences/Institute of Medicine committee that reviews the health effects of Agent Orange and other herbicides used in Vietnam; also, Dr. Fenske is currently a member of the U.S. EPA's Science Advisory Board, the Agency's lead scientific advisory group; he was also appointed recently to the EPA Human Studies Review Board (HSRB), which is responsible for evaluating the scientific and ethical quality of intentional dosing and human exposure studies. The HSRB's activities include the review of scientific protocols for worker exposure studies during pesticide applications and field reentry. Dr. Keifer was recently appointed to the EPA's Pesticide Program Dialogue Committee, a key advisory group to EPA on pesticide policy.

Most recently, Dr. Keifer received a 5-year award from U.S. EPA through a competitive grant process to develop new curricular materials related to pesticides for health care providers ("Pesticide Effects: Integration into Health Care Provider Curricula"). This newly funded project's goal is the only one of its kind in the country. Its purpose is to improve the training of clinicians in the diagnosis, treatment, and prevention of pesticide poisonings. It will develop modules of pesticide related content into pre-med, nursing, mid-level practitioner (physicians' assistants and nurse practitioners) and physician training through the collaborative efforts of faculty from Heritage College, Seattle Pacific University, Medex Northwest, and the UW Schools of Nursing and Medicine. The content in these courses will be tested, and the results disseminated to educational institutions around the nation.

International Programs and Activities

The work of PNASH Center has extended beyond the Northwest region, and has made an impact internationally. Our center works very closely with the University of Washington's NIH-sponsored Fogarty International Center, "International Training in Environmental and Occupational Health". Dr. Matthew Keifer, our co-director, serves as director of this international center. Work conducted through the PNASH Center has informed practices in both Central America and Southeast Asia. PNASH Center investigators have trained health and safety professionals from Costa Rica, Nicaragua, Vietnam and Thailand. In addition, specific research methods and intervention strategies have been introduced in these and other countries: Dr. Fenske's fluorescent tracer technique for evaluating pesticide exposures has been transferred to scientists and educators in Ecuador, Nicaragua, and Vietnam; our center's work with saliva biomonitoring has been transferred to researchers in Thailand and Nicaragua; and Dr. Keifer's work with cholinesterase monitoring has been transferred to both Vietnam and Thailand.

EMERGING PROBLEMS

Commercial Fishing Emerged Hazards and Barriers to Participation in Research

In the late 1990's, the Center assembled a 13-member Technical Advisory Board to guide our

engagement with the Northwest commercial fishing industry. This board informed the development of two projects, each with unexpected impacts on the Center's future work with the fishing industry. These PNASH Center projects were "Respiratory Health in the Seafood Processing Industry" and "The Implications of the Jones Act on Health and Safety in the Commercial Fishing Industry."

The project, "Respiratory Health in the Seafood Processing Industry," focused on potential respiratory illnesses associated with crab processing among commercial fishers in the Northwest. This project developed into an extraordinary network of collaborators during the most recent project period, including NIOSH's HETA group, OSHA Region X, and the Dutch Harbor Clinic in Alaska, whose partnership in the project, "Crab Related Respiratory Illness in Dutch Harbor, Alaska," resulted in an Honorable Mention for the 2001 NORA Partnering Award. Results of this project were published both by NIOSH investigators and PNASH Center investigators.

The project, "The Implications of the Jones Act on Health and Safety in the Commercial Fishing Industry," demonstrated that there are significant policy and liability barriers to fishing industry cooperation in hazard and risk assessment projects. The injury compensation system available to seamen is unique in that it provides guaranteed benefits similar to workers' compensation (i.e., maintenance and cure) and also allows them to sue their employers to obtain a tort recovery for negligence under the Jones Act or for unseaworthiness. A seaman's burden of proof is significantly less than in an ordinary injury case. Moreover, the recoveries a seaman can obtain typically are higher than what would otherwise be received by a shoreside worker who would fall under a workers compensation system. For these reasons, employers are often reluctant to participate in identifying health and safety risks that could form the basis of establishing their liability. This, in turn, has limited our further work in investigating fishing industry hazards.

The National Agricultural Tractor Safety Initiative

While tractor injuries and fatalities present a long-standing problem, this area of research was a new area of work for the PNASH Center. The PNASH Center was brought into this national initiative early in its conception as the developers and writers of the National Agricultural Tractor Safety Initiative publication. The launch of the publication to interested parties took place at the National Symposium on Agricultural Health and Safety in June 2004. This project brought together all the NIOSH Agricultural Centers in their first joint project to address a known problem area. The Centers are now working together to develop an informed solution to the high fatality and injury rates from tractors. PNASH continues to develop communication materials, including a website, for the national initiative and serve as a regional resource.

NEW AND FUTURE DIRECTIONS

Past Redirections

We have recognized our limitations in trying to serve three agricultural sectors in a four-state region. Many of our resource needs lie in fiscal support, but we also need qualified principal investigators who can address identified stakeholder needs. Over the past 10 years, the Center has been successful in gaining additional project grants in our areas of expertise from Washington State, NIOSH/CDC, US EPA, and NIH. In the past, we broadened our field of research by engaging regional investigators in Northwest priority research through our Pilot Project program. The Pilot Project program also enabled us to respond quickly to emerging problems and stakeholder needs. In the past four years, without the Pilot Project program, we have struggled to respond to needs and bring in new investigators. In the current competitive renewal process, NIOSH reinstated the Pilot Project program, which will greatly aid our ability to respond to regional needs.

Forestry was the main casualty of our scaled-back fiscal and investigator resources. The development of the *Occupational Research Agenda for Northwest Forestlands* offered the Center industry support, partners, and a compelling need, but without an investigator to lead this effort, we have done little more than maintain our relationship with industry leaders and disseminate general safety and health educational information. Unfortunately, in the last cycle of funding, one of the key projects not funded addressed a forestry need investigating noise and vibration exposures. Without a substantial project in forestry, little progress was made. Nonetheless, we continued to embrace the three-industry scope because of the importance of these industries to the Northwest.

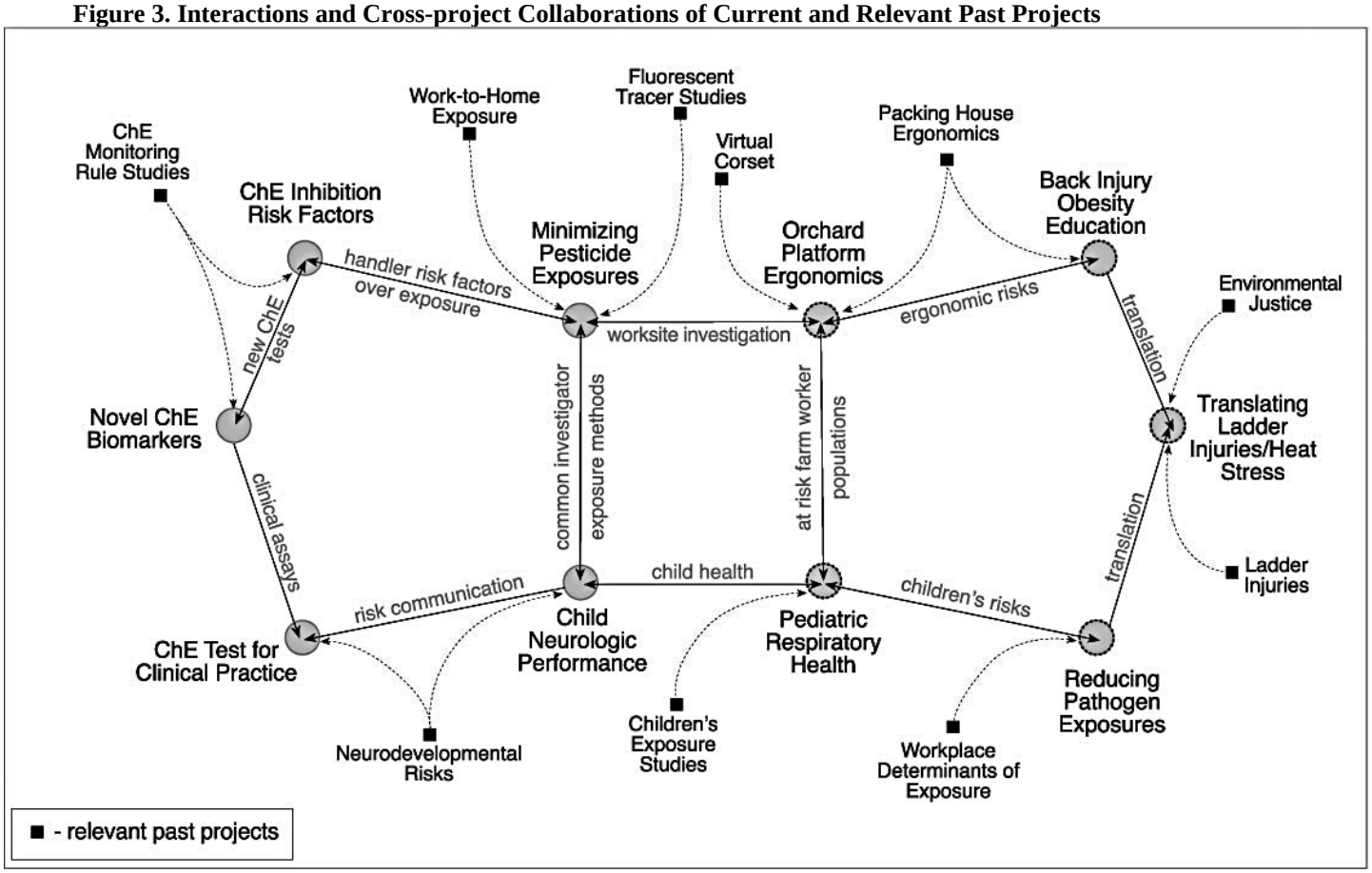
New Directions

For the coming years, the PNASH Center has adopted the theme ***"Promoting safe and sustainable agricultural workplaces and communities."*** This theme grew out of our successful September 2004 conference, "Cultivating a Sustainable Agricultural Workplace." The conference attracted participants from across the nation because it brought occupational health and safety researchers and educators face-to-face with sustainable agriculture practitioners. Our goal was to highlight the need to explicitly recognize the health and safety of workers within the concept of sustainable agriculture, and to develop metrics for a sustainable agricultural workplace. We noted that neither the 1990 farm bill (Food, Agriculture, Conservation, and Trade Act), nor the President's 1997 Sustainable Agriculture Task Force Report acknowledged the need to include occupational health and safety as a part of sustainable agricultural production processes. In our view, the need for sustainable agricultural workplaces extends beyond the boundaries of the farm, and into the rural communities that are themselves the sustenance of the agricultural economy. Thus, our theme encompasses a broad, public health view of sustainability, and includes the next generation within these communities.

PNASH is also looking to a future assemblage of projects that link multiple institutions within our region, are multi-disciplinary, and result in synergies from information exchanges and interactions. Figure 3 illustrates the multiple connections among the ten proposed Center projects. On the left side of the figure we see five projects with a common thematic focus: **preventing pesticide-related injury and illness**. This issue is a very high priority in our state; the WA State Supreme Court recently mandated cholinesterase (ChE) testing for pesticide handlers, and overexposures have now been documented. The five projects on the right side of Figure 3 also have a common thematic focus**: promoting safe workplaces and communities.**

Another important development for the PNASH Center has been the appointment of Dr. Fenske (Center P.I.) as a Washington State University Visiting Scientist. He will spend a part of each year at the WSU Center for Precision Agriculture in Prosser, WA, working directly with WSU researchers to better integrate health and safety into new agricultural production processes.

Figure 3. Interactions and Cross-project Collaborations of Current and Relevant Past Projects



Trends

In conducting our future work and developing new projects, we are also keeping abreast of trends in Northwest agricultural workforce and practices. Some of these include:

- ***Hispanic Workforce Upward Mobility.*** The resident Hispanic workforce is increasingly moving into other occupations or taking leadership roles in the agricultural industry as supervisors, managers, and farm owners/employers.
- ***Hired Workforce from Central American Indigenous Communities and Thailand.*** The hired temporary workers doing hard labor are increasingly indigenous to Mexico and Central America, and recently guest workers from Thailand.
- ***Aging Experienced Workforce.*** The experienced agriculture workforce is aging; younger workers are not staying in the field.
- ***Tree Fruit Industry "Technology Roadmap."*** The technology roadmap outlines the industry's goals of improving the sustainability, efficiency, and quality of fruit production in the United States. Major goals of the Technology Roadmap are to use technology to improve the operational efficiency of tree fruit harvesting and to create a more prosperous, skilled year-round work force that works under safer conditions.

PESTICIDE EXPOSURE ASSESSMENT METHODS

INTRODUCTION

The risks faced by agricultural workers and their families through contact with pesticides have not been well characterized. The PNASH Center has conducted a series of field investigations in the Northwest over the past 15 years to better understand pesticide exposure. In so doing, we have developed novel techniques for pesticide exposure assessment that have been adopted by researchers throughout the United States. As a result, the PNASH Center has developed a reputation as a leader in pesticide exposure assessment methodology.

GOALS

The overall objective of this program area has been to develop accurate and practical methods for assessing pesticide exposures in agricultural communities, with particular emphasis on agricultural workers and their children. Specifically, we have worked to:

- develop environmental, personal and biological monitoring techniques, and
- improve methods of exposure assessment (i.e., questionnaires, exposure opportunity models, and spray drift models).

BACKGROUND AND SIGNIFICANCE

The health risks of pesticides remain an area of great scientific uncertainty and public discussion. Recent toxicologic and epidemiologic studies have suggested that relatively low levels of pesticide exposure can have significant impacts on neurologic functioning. Washington state's recent Cholinesterase Monitoring Program requires that pesticide handlers who mix, load, or apply highly toxic pesticides be offered baseline and periodic blood monitoring to evaluate exposure. This program has heightened concerns among employers and workers.

The quality of both epidemiologic studies and human health risk assessments relies on accurate and reproducible exposure assessment methods. When we began our studies of pesticide exposures among children of agricultural families, there were virtually no standard methods available, since this population had never been the subject of systematic study.

Children are considered a vulnerable population in regard to pesticide exposures. The Food Quality and Protection Act of 1996 requires that pesticide risk assessments for children take into account all pathways and routes of exposure, and simultaneous or sequential exposure to compounds with similar toxicologic properties. Children of agricultural workers are a special sub-population for pesticide exposure, since they are exposed not only through diet and residential use, but may also receive exposures due to work-to-home transmission of pesticides and via pesticide drift. The PNASH Center has focused much its work on improving exposure assessment methods for this population, including housedust sampling, urine sampling, and time-location analysis.

The measurement of pesticides in the urine of workers and their children provides an estimate of internal dose and risk. The PNASH Center has developed new methods for such biomonitoring in children. Our group has also explored the novel method of saliva biomonitoring. Saliva biomonitoring permits measurement of the parent compound rather than a metabolite, thus providing a more accurate estimate of internal dose. Finally, the measurement of cholinesterase enzymes found in the blood has been used to monitor occupational exposures to

organophosphorus (OP) and carbamate (CB) pesticides for over 50 years. The depression of these blood enzymes is considered to be a surrogate measure of possible depression of a similar enzyme that is vital to function of the nervous system. Pre-exposure (baseline) and post-exposure sampling is required to determine an individual's drop in cholinesterase activity. The PNASH Center has worked actively to improve the methods and protocols involved in cholinesterase monitoring. Our work has provided a foundation for Washington state's Cholinesterase Monitoring Program. Most recently, we have worked to validate a portable test kit -- the EQM™ Test-Mate™kit – for field use. This kit can provide immediate cholinesterase readings, permitting a more rapid response to cases of overexposure, and on-the-spot retesting to check for false positive readings. However, it is not yet clear that the kit can provide ChE measurements with accuracy and precision that has been achieved with laboratory methods.

The primary route of pesticide exposure for most agricultural workers is via skin absorption. Measurement of skin exposure in agricultural workplaces, and quantitative modeling of dermal absorption of pesticides have proven to be complex technical problems. The PNASH Center has worked to improve methods in this area, leading to more accurate estimates of exposure, dose, and risk. In the case of epidemiologic studies, tools are needed to estimate worker exposures over extended periods of time. Traditional work history questionnaires have not demonstrated high reliability or accuracy among agricultural worker populations. The PNASH Center has focused its efforts on the development of icon-based methods that can be effective with low literacy populations.

Agricultural worker exposure to pesticide drift is a major public health concern in the Northwest. Workers may be exposed to drift when adjacent fields are treated. Or they may live in close proximity to farmland that is treated with pesticides on a regular basis. Concern with pesticide drift extends to the families of agricultural workers, and particularly to young children who may be exposed through their normal play activities. The PNASH Center has worked to develop new modeling approaches to pesticide drift that are directly relevant to Northwest agriculture. We have also developed a novel LIDAR method to characterize drift patterns in real time.

ACTIVITIES

Dust Sampling of Pesticide Residues in the Homes of Agricultural Workers

We have conducted house dust sampling for pesticide residues in the homes of agricultural workers since 1992. Our first study involved about 50 worker homes and a reference population. A 1995 study focused on a population of about 100 workers, and a 1999 study involved over 200 workers. We developed a standard procedures for use of a vacuum sampler known as the HVS3, including instructions for sample collection, instrument cleaning between samples, and quality assurance procedures. We also developed an analytical method capable of measuring multiple OP pesticide compounds in dust samples. We validated this method and published it in 2002 (Moate et al. 2002).

Urinary Metabolite Monitoring of Children's Exposure to Pesticides

We adapted existing methods for the measurement of OP pesticide metabolites in workers to the assessment of exposures in children. This work involved improving sensitivity to quantify the relatively low levels of metabolites in children's urine samples. We validated and published this method (Moate et al. 1999). We have used this method in numerous studies of children's exposure (see products section).

Global Positioning System (GPS) Methods for Children's Time-Location Studies

One of our doctoral students, Kai Elgethun, focused his dissertation research on the development and use of a novel global positioning system suitable for research with children. This device was developed in conjunction with a private manufacturer. We have used it in several field studies, including a study that characterized the activities of children of agricultural workers before, during, and after an aerial pesticide application (Elgethun et al. 2003; Weppner et al. 2005). As a result of his work, Dr. Elgethun was invited to meet with federal scientists in Denmark to discuss the application of the method to studies in that country. This method holds tremendous potential for improving the accuracy of children's exposure studies.

Saliva Biomonitoring

PNASH Center researchers, led by Dr. Alex Lu, conducted several years of laboratory studies with animal models in the 1990's to validate the use of saliva as a matrix for pesticide exposure sampling (see Products section). These studies were the first to systematically address this issue, and are the foundation for all of the research that is being done in this field presently. We have also demonstrated the feasibility of saliva biomonitoring in several population studies, including a collaborative study with NIOSH scientists of herbicide applicators (Denovan et al. 2000, Hines et al. 2006), studies of farmers and their children in Nicaragua (Rodriguez et al. 2006), and agricultural workers in Thailand.

Advances in Cholinesterase Monitoring

The PNASH Center has worked directly with the manufacturer of the EQM Test-Mate™ Kit to improve its accuracy and precision. We have tested this kit in both laboratory and field settings, and provided recommendations to the manufacturer that have been incorporated into new models of the instrument. Most recently we have performed rigorous testing of the kit in conjunction with the Washington State Cholinesterase Rule. Phase 1 of this work has involved measurement of ChE levels with the portable test kit, side-by-side with measurements conducted by the Washington State Department of Health Public Health Laboratory. One of our research scientists, Dr. Angela Carden, conducted these analyses in the summer of 2005 at the Public Health Laboratory (PHL) in Shoreline, WA. Dr. Carden ran each of 50 blood samples in triplicate using the test kit. These results were then compared with those generated by PHL for the same samples. We found excellent correspondence between PHL and test kit measurements for both serum (plasma) ChE and RBC ChE. We also conducted a pilot study in the summer of 2005 with a major Yakima Valley clinic that collects blood samples for the state program. Sixteen blood samples were analyzed with the test kit in the clinical setting. The serum ChE results indicated a good correspondence with PHL values; the RBC ChE results were more variable. Phase 2 of this project is ongoing (spring and summer of 2006), and involves a larger study of test kit measurements conducted in the clinical setting. We hope to complete 100 measurements, and compare these with PHL values to determine whether the test kit can be used as a valuable screening tool, and/or as a substitute for samples shipped to a central laboratory.

Farmworker Exposures to Pesticide Residues during Hand Labor Activities

This project examined the mechanisms by which farmworkers are exposed to pesticide residues following orchard applications, and assessed doses and risks associated with such exposures. This work led to an analysis of factors that can reduce skin absorption and dose in these workers. As a result of this project, new funding has been secured to explore novel methods for exposure assessment in agricultural worker populations. This work formed the foundation for the Center's 2002 Awarded Research Project: Workplace Determinants of Take Home Pesticide Exposure.

Icon-Based Exposure History Questionnaires for Low Literacy Populations

PNASH Center investigators, led by Dr. Larry Engel, have developed a novel icon-based exposure history questionnaire (Engel et al. 2001a, 2001b). In their central study, 89 farmworkers and non-farmworkers were interviewed twice, 8-10 months apart, about their lifetime employment. In the first interview, subjects were asked to recount their entire work history, starting from the interview date and moving backwards in time ("traditional questionnaire"). In the second interview, subjects were first asked about important life events, which were recorded with icons on a calendar. They were then asked to recount their work history, which was recorded, job-by-job, on the calendar with icons ("icon-calendar questionnaire"). This study found that the number of jobs and amount of work time accounted for since first employment were significantly greater using the icon-calendar questionnaire than the traditional questionnaire, the disparity increasing with time from the date of interview. The ratio of number of jobs in the traditional questionnaire to number of jobs in the icon-calendar questionnaire decreased from 100.0% in the most recent time period to 0.0% in the earliest time period. While the percentage of time explained by employment remained relatively constant across time periods in the icon-calendar questionnaire, ranging from 86.3 to 98.9%, it rapidly decreased with time in the traditional questionnaire, from 77.9% in the most recent time period to 0.0% in the earliest time period. The work of the PNASH Center has been included in the efforts of the National Cancer Institute to develop new epidemiologic methods for agricultural worker populations (Zahm et al. 2001). The PNASH Center has since developed a computerized, icon-based instrument for the collection of exposure history information from pesticide handlers in Washington State. This method was pilot-tested in the summer of 2005. A total of 66 pesticide handlers have been recruited to date in 2006, and we will continue to recruit study participants throughout the remainder of the 2006 spray season.

Light detection and ranging (LIDAR) Technology for Pesticide Spray Drift Studies

Optical remote sensing allows one to sample multiple volumes of space remotely using the properties of electromagnetic radiation. In the case of pesticide monitoring, traditional sampling techniques provide only point sample measurements. Furthermore, each sample is collected over a relatively long period of time (minimum 1/2-1 hour), which means that it can only provide a time-averaged concentration measurement. Optical remote sensing measurements can provide near real-time measurements (seconds per sample) over a large area. This rapid measurement feature can provide insight into spray drift movement/evolution over the spray period. LIDAR systems were developed by the military for the purpose of detecting the use of chemical agents in warfare. Since the 1960's they have been increasingly used to study the atmosphere. It is now possible to use such mobile lasar systems for environmental monitoring. The PNASH Center, under the leadership of Dr. Michael Yost and doctoral student Ming Tsai, have developed and field-tested a LIDAR instrument appropriate for pesticide drift studies. The LIDAR instrument has now been used in two studies of orchard airblast applications. The results of this work are forthcoming (August 2006) as part of the Ming Tsai's doctoral dissertation.

SIGNIFICANT FINDINGS

Dust Sampling of Pesticide Residues in the Homes of Agricultural Workers

The systematic collection of house dust with state-of-the-art sampling procedures has produced a stable and reproducible metric for children's exposure opportunity in agricultural communities. It has allowed accurate resolution of high and low-exposed populations, and has provided evidence that proximity to pesticide-treated farmland results in home contamination. House dust sampling has thus become a new method for classification of populations for epidemiologic studies, and a useful tool for intervention studies. Our published method for the analysis of OP pesticide in house dust (Moate et al. 2002) provides other laboratories with valuable guidance regarding extraction, detection, and quality assurance procedures. Our initial field study report of house dust levels in farmer and farm worker homes (Simcox et al. 1995) has served as a model for subsequent studies by a variety of research groups (UC Berkeley, Oregon Health & Sciences University, Wake Forest University, Rutgers University, NIOSH).

Urinary Metabolite Monitoring of Children's Exposure to Pesticides

The measurement of the dialkylphosphate (DAP) metabolites in children's urine has proven to be an important tool for both researchers and educators. This method provides an integrated estimate of exposure to the OP pesticides, and permits identification of high risk populations. Our published analytical method for these metabolites (Moate et al. 1999) serves as a valuable guide for other laboratories conducting these analyses. After our initial publication of OP pesticide metabolite levels in children (Loewenherz et al. 1997), the Centers for Disease Control and Prevention elected to include analysis of DAP compounds in the ongoing National Health and Nutrition Examination Survey (NHANES). DAP concentrations for the U.S. population were first reported by CDC in 2001 in the *National Report on Human Exposure to Environmental Chemicals.*

Global Positioning System (GPS) Methods for Children's Time-Location Studies

The PNASH Center has pioneered the use of GPS for children's exposure studies (Elgethun et al. 2003), and for children of agricultural workers in particular (Elgethun 2004; Weppner et al. 2005). Portable GPS instruments have revolutionized the ability of researchers to determine the temporal and spatial patterns of individuals as they related to exposure sources. The specificity of this methodology (5-second time intervals, 3 meter spatial resolution) allows highly accurate characterization of exposure opportunity, and decreases uncertainties in exposure estimates. We are now seeing the rapid adoption of our instruments and methods by other researchers in the field of exposure science.

Saliva Biomonitoring

The PNASH Center has been at the forefront of developing methods for the sampling and analysis of pesticides in saliva. Dr. Alex Lu (now at Emory University) conducted the key laboratory studies in this area as a scientist within the PNASH Center (Lu et al. 1997a, 1997b, 1998, 2003). We have also demonstrated the feasibility of this method through collaborative studies with NIOSH (Denovan et al. 2000, Hines et al. 2006). Most recently we have used saliva biomonitoring in collaborative studies with investigators in Nicaragua (Rodriquez et al. 2006) and Thailand. In so doing we have helped to build research capacity at the National Autonomous University of Nicaragua, Division of Preventive Medicine, and at the Department of Occupational Health, Buripha University, Thailand. Saliva biomonitoring is now being included routinely in epidemiologic investigations (A. Bradman, UC Berkeley, personal communication).

Farmworker Exposures to Pesticide Residues during Hand Labor Activities

The work of the PNASH Center has led to improved methods of dermal exposure assessment

for agricultural workers (Lu and Fenske 1994, Fenske et al. 1999), and more accurate models for dermal absorption of pesticides (Kissel and Fenske 2000, Doran et al. 2003). Our work with the direct-reading ATR-FTIR method (Carden et al. 2005) shows promise as a rapid and inexpensive method for determining pesticide concentrations on the skin and uptake rates.

Advances in Cholinesterase Monitoring

The PNASH Center's validation work with the EQM Test-Mate™ Kit for cholinesterase monitoring has been critical in making this instrument available to clinical providers and researchers both nationally and internationally. The kit is now being used in the clinic of one of the major health care providers in eastern Washington State as a supplementary tool for the Washington Cholinesterase Monitoring Rule. It is also being used with increasing frequency in other parts of the world (Delgado et al. 2004, Thetkathuek et al. 2005).

Icon-Based Exposure History Questionnaires for Low Literacy Populations

Our studies have demonstrated that the icon-calendar questionnaire is more effective than traditional questionnaires for obtaining complex work histories during interviews with agricultural workers. This method produces a more accurate and complete picture of a person's work history.

LIDAR Technology for Pesticide Spray Drift Studies

Our studies with LIDAR technology have demonstrated that pesticide drift occurs for much greater distances than those documented with current sampling methods. We believe this finding will have important ramifications for current drift models, such as AgDrift, the model used by the Environmental Protection Agency for regulatory purposes. LIDAR technology will permit a much more accurate characterization of the temporal and spatial patterns of pesticide drift in agricultural communities.

PRODUCTS/OUTPUTS

Further products are reported in the companion database.

1. Review Papers on Pesticide Exposure Assessment Methods

Fenske RA [1997]. Pesticide exposure assessment of workers and their families. Occup Med State of the Art Reviews, *12(2):*221-237.

Keifer M [1998]. The clinical laboratory in the diagnosis of overexposure to agrochemicals. Laboratory Medicine *29(11):*689-695.

Fenske RA, Lu C, Simcox NJ, Loewenherz C, Touchstone J, Moate TF, Allen EH, Kissel JC [2000]. Strategies for assessing children's organophosphorus pesticide exposures in agricultural communities. J Exp Anal Environ Epid *10*:662-671.

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Questionnaires and Surveys

Worker and Children's Exposure to Pesticides: bi-lingual interview instruments to determine hygienic behaviors of workers, hygienic behavior in worker residences, and residential pesticide use.

Sampling and Analytical Methods

Children's Pesticide Exposure: Improved laboratory methods for the analysis of pesticide metabolites in urine.

Children's Pesticide Exposure. New laboratory methods for the analysis of pesticides in house dust and vehicle dust samples.

Children's Pesticide Exposure: New global positioning system instrument for collection of time-location data of children.

PDA Survey and Field Database: Recording method using PDAs and specialized software to administer health effects and work history questionnaires, and link to exposure data. The PDAs allow us to digitally capture data in the field, to collect data in harsh environments, link exposure data to survey subject, and administer easy to use cascading surveys.

Farmworker Exposure to Pesticide Residues: A new model for assessing dermal absorption of pesticide residues that incorporates information on the time course of dermal uptake.

Saliva Biomonitoring: New field methods for collection of saliva samples; new laboratory methods for analysis of pesticides in saliva.

Methods for Accessing Pesticide/Nitrate Environmental Exposure Databases: Methods to use Global Positioning System (GPS) to obtain coordinates to link to environmental exposure data.

LIDAR: a new technology for characterizing pesticide spray drift in agricultural communities.

Tools for Education and Prevention:

Cholinesterase Field Test Kit: Testing of a field test kit, EQM Testmate Kit™, that shows good performance for measuring cholinesterase depression under field conditions as compared to the laboratory.

OUTCOMES

Our work in the area of children's exposure to pesticides in agricultural communities has spawned numerous studies by other research groups. A recent example is a published report of pesticide exposures among preschool children in an agricultural community in Thailand (Petchuay et al. 2006). This study cites 8 of our publications, and uses the urine sampling and dialkylphosphate analysis approaches that our group documented in the 1990's to characterize children's exposures.

House dust sampling has become a new method for classification of populations for epidemiologic studies, and a useful tool for intervention studies. Our published method for the analysis of OP pesticide in house dust (Moate et al. 2002) provides other laboratories with valuable guidance regarding extraction, detection, and quality assurance procedures. Our initial field study report of house dust levels in farmer and farm worker homes (Simcox et al. 1995) has served as a model for subsequent studies by a variety of research groups (UC Berkeley, Oregon Health & Sciences University, Wake Forest University, Rutgers University, NIOSH).

After our initial publication of OP pesticide metabolite levels in children (Loewenherz et al. 1997), the Centers for Disease Control and Prevention elected to include analysis of DAP compounds in the ongoing National Health and Nutrition Examination Survey (NHANES). DAP concentrations for the U.S. population were first reported by CDC in 2001 in the *National Report on Human Exposure to Environmental Chemicals.*

We are now seeing the rapid adoption of global positioning system instruments by other researchers in the field of exposure, with our methods serving as templates for these investigations.

We have used saliva biomonitoring in collaborative studies with investigators in Nicaragua (Rodriquez et al. 2006) and Thailand. In so doing we have helped to build research capacity at the National Autonomous University of Nicaragua, Division of Preventive Medicine, and at the Department of Occupational Health, Buripha University, Thailand. Saliva biomonitoring is now being included routinely in epidemiologic investigations (A. Bradman, UC Berkeley, personal communication).

The portable cholinesterase test kit is now being used in the clinic of one of the major health care providers in eastern Washington State as a supplementary tool for the Washington Cholinesterase Monitoring Rule. It is also being used with increasing frequency in other parts of the world, such as Costa Rica and Thailand (Delgado et al. 2004, Thetkathuek et al. 2005).

LIDAR technology is now being adapted to the study of airblast applications in Northwest orchards, and is providing new insights into the extent to which pesticide drift results from these applications.

INTERVENTIONS TO REDUCE PESTICIDE EXPOSURES AMONG AGRICULTURAL WORKERS AND THEIR FAMILIES

INTRODUCTION

The PNASH Center has worked with employers and employees to better understand how to reduce exposures among pesticide handlers, and to reduce the transmission of workplace chemicals to the home environment. We have worked primarily with the Washington State Department of Agriculture, the Washington State University Extension Service, and major orchardists in Washington State as a part of this program area. We have also conducted studies in Florida to evaluate the performance of chemical protective clothing and other factors affecting exposures during pesticide applications.

GOALS

The overall objective of this program area is to reduce pesticide exposures among agricultural workers and their families. Specifically, these projects have aimed to reduce exposures through worker education, development of new control technologies, and promotion of safe behaviors.

BACKGROUND AND SIGNIFICANCE

Pesticide handler exposure is an important public health concern nationally, and particularly so in the Northwest region. The U.S. EPA's Worker Protection Standard mandates pesticide handler training, and use of certain forms of personal protective equipment during the mixing, loading, and application of pesticides. The Washington State Department of Agriculture is responsible for the implementation and enforcement of this federal standard in Washington State. In 2004 the Washington Department of Labor & Industries promulgated a new mandatory Cholinesterase Monitoring Rule. This rule requires that pesticide handlers who work with high toxicity pesticides have blood testing for cholinesterase conducted prior to exposure, and then on a periodic basis throughout the spraying season. This monitoring program has demonstrated that a substantial fraction of pesticide handlers in Washington State are exposed at levels that trigger regulatory action. Thus, there is great interest in reducing such exposures.

Our group has used the fluorescent tracer technique in pesticide safety education to demonstrate the possible failure of chemical protective clothing, as well as the importance of applicator training. We have also examined how contamination can inadvertently spread when a contaminated object is handled. The visual experience produced with fluorescent tracer methods – allowing workers to see their own exposures -- has an immediate impact and can increase awareness of how dermal pesticide exposure can occur.

The potential health risks associated with exposure of children to pesticides have received increased attention with passage of the Food Quality Protection Act of 1996 and with new federal emphasis on children's health. Current efforts to characterize such exposures within a risk assessment framework involve the integration of scientific knowledge from several fields. The result is a very complex picture of risk, characterized by substantial uncertainty. Our current understanding of pesticide health effects is at a relatively early stage of development, and if our experience with childhood lead exposure is viewed as a model for this field, then we can expect that new science will lead to a deepening understanding of health risks in children. As the science in this field continues to mature, it seems prudent to reduce children's pesticide exposures where possible. In particular, children of agricultural workers can be exposed to workplace chemicals that are brought home by their parents. The prevention of this work-to-home transmission of chemicals can significantly reduce total pesticide body burden for these children.

ACTIVITIES

Greenhouse Ventilation Studies to Reduce Applicator Exposures

Pesticide handlers in greenhouses commonly use hand-held spray guns to treat ornamentals or other plants on benchtops. Greenhouses have either natural or forced air ventilation systems to maintain temperature control. We evaluated workers who conducted benchtop hand spraying in commercial greenhouses with the ventilation system either on or off. When operating, the greenhouse ventilation system produced a strong uni-directional air movement. We tested both workers with pesticide application experience, and workers who were new to this task. Applications were conducted for one hour with a fluorescent tracer substituted for pesticides in an aqueous mixture. We used qualitative and quantitative methods to assess the deposition of the fluorescent tracer on the skin and clothing of these workers.

Protective Clothing Performance during Greenhouse Applications

Pesticide handlers in greenhouses employ chemical protective clothing as protection against skin contact with pesticides. CPC is designed to prevent exposure to spills, splashes and spray deposition. However, greenhouse applicators very often are presented with the additional hazard of contact with wet foliage that overhangs the walking spaces between the benches. In this work we evaluated protective clothing performance during handspray applications. A fluorescent tracer compound was added to the applicator's tank prior to work, and served as a surrogate for the pesticides being sprayed. Qualitative and quantitative methods were used to evaluate chemical breakthrough of four garments thought to be protective.

Protective Clothing Performance during AirblastApplications

Chemical protective clothing is often recommended as a method of exposure mitigation among pesticide applicators in orchards and citrus groves. CPC is normally evaluated in the laboratory through permeation studies. That is, the CPC material is challenged with a pesticide formulation, and breakthrough time is measured. Only rarely are follow-up studies conducted to determine if the CPC performs as expected under realistic field conditions. Our work evaluated four CPC regimens (cotton work shirts and work pants, cotton/polyester coveralls, and two non-woven garments) during airblast applications of the organophosphorus insecticide ethion in central Florida citrus groves. The two non-woven garments were provided by the U.S. Environmental Protection Agency as a part of their protective clothing evaluation program. CPC performance was determined by measurement of fluorescent tracer deposition on skin surfaces beneath garments with a video imaging analysis instrument (VITAE system), and by alpha-cellulose patches placed outside and beneath the garments.

Pesticide Safety Classroom Demonstrations of Fluorescent Tracer Exposure

Training is recognized as an effective tool for behavior modification and promoting self-protection. State pesticide applicator training programs promote judicious and safe use of pesticides through outreach education recertification courses that cover a wide range of topics in addition to pesticide safety. These large-audience classes typically are not conducive to interactive learning methods. In addition, applicators may have change-resistant attitudes for a variety of reasons. This study evaluated the impact of different training delivery styles on simulated dermal exposure for pesticide applicators. A fluorescent tracer dye demonstration was incorporated into two of the three delivery styles. The goal was to determine how to conduct more compelling, effective training to motivate applicators to protect their skin from pesticide exposure. A questionnaire was administered at each training site to evaluate training style and impact. Response information was collected from applicator attendees and compared in the context of an intervention effectiveness evaluation. This study was designed to evaluate the educational impact of three different training delivery styles, with and without the demonstration

of fluorescent tracers, with all presentations aimed at promoting self-protection from dermal exposure among pesticide applicators. Each of the three delivery styles -- live fluorescent tracer demonstration, video-tape of the live tracer demonstration, and a conventional instructional video -- was tested at three large-group pesticide license recertification courses in Washington state in 2000 and 2001 for a total of nine locations. Each presentation was a 50-minute segment of a two-day Washington State University Pesticide Education Program recertification training. The nine pesticide applicator courses included 1431 applicators: 80% participated in the questionnaire evaluation of the courses.

Fluorescent Tracer Use in Hands-on Pesticide Handler Training

The Washington State Department of Agriculture (WSDA) and the Washington State University Agricultural Extension Service have developed a novel "hands-on" training method to reach a primarily Hispanic and low-literacy audiences of pesticide handlers. This training course has received favorable reviews from employers and workers alike, but has never been formally evaluated. PNASH Center investigators joined this effort in 2004. Our goals were to introduce the fluorescent tracer (FT) technique into the existing training program, and to conduct an evaluation of the impact of hands-on training program. The PNASH Center has developed an FT training module designed specifically for use in the hands-on training program. Pesticide handlers immediately see potential pesticide contamination by viewing results of proper and improper handling techniques. The effectiveness of the hands-on training and the FT module were evaluated through pre-test and post-test questionnaires, as well as through interviews of a subset of workers.

Workplace Determinants of Take-Home Pesticide Exposure

The PNASH Center has identified and characterized children's pesticide exposure pathways through a series of studies over the past 10 years. Our early studies in the agricultural region of Washington State demonstrated that agricultural pesticides measured in housedust were elevated in the homes of agricultural workers when compared to other homes in the same community. Follow-up studies collected urine samples from pre-school children, and found that children of pesticide applicators had higher levels of pesticide metabolites than did children of non-agricultural workers. These studies led us to hypothesize a significant para-occupational or "take home" pathway for children of agricultural producers and workers. Our 1999 study of this pathway involved pesticide residue analysis of dust samples collected from the commuter vehicles and residences of more than 200 farm workers. We found a strong association between agricultural pesticide levels in home and vehicle dust, providing further support for the take-home exposure pathway.

Our current efforts have focused on interventions to improve hygienic practices at the workplace to reduce pesticide residue levels in homes. This approach differs from earlier community education efforts to change worker behaviors outside of the workplace (e.g., take shoes off before entering the home), and is based on the industrial hygiene principle of controlling exposures at the source. In this case, we consider the source to be the workplace, and we are working to prevent agricultural chemicals from leaving the workplace. The PNASH Center is partnering with employers and employees to test practical, workplace-based interventions to reduce pesticide levels in the homes of agricultural workers.

We began by sampling vehicle and household dust to determine the extent of take-home pathway contribution to home pesticide residue levels. Three interventions were then developed to reduce this type of pesticide exposure. The first intervention focused on pesticide handlers, and involved a change from a single locker to a double locker system for each worker, so that regular clothing and chemical protective clothing could be kept separate. We also asked the employer to have the

pesticide handler locker room cleaned on a regular basis throughout the pesticide spraying season. The second intervention focused on treating work boots used in the field as protective clothing not suitable for home use. We provided workers with what we have termed a plastic "boot bin" that can be kept in the trunk of the car. Workers were asked to change out of their work boots at the end of the day, and wear different footware home. The third intervention focused on vacuuming of commuter vehicles before leaving the worksite. We installed a shop-vac style HEPA vacuum at the worksite entrance/exit, and encouraged workers to make use of it at least once a week. We used vehicle and house dust sampling for pesticide residues as our measure of intervention effectiveness. We have now concluded three years of fieldwork, and are currently analyzing the data from these studies to evaluate these interventions.

SIGNIFICANT FINDINGS

Greenhouse Ventilation Studies to Reduce Applicator Exposures

We found that when the ventilation system was in operation experienced applicators had only minimal dermal exposures, while inexperienced applicators had very high exposures. When the ventilation system was turned off the exposures of experienced and inexperienced applicators was similar. These findings indicated that the air movement created by ventilation can present a hazard to workers during application, but can also be used to a worker's advantage to avoid dermal contact with pesticides. The findings also underscore the importance of greenhouse applicator training. We provided recommendations based on these findings to individual greenhouse owners, and to the industry through the leading greenhouse trade publication, *Greenhouse Manager*.

Protective Clothing Performance during Greenhouse Applications

The four garments tested in these studies all exhibited chemical breakthrough after a 1-hour application period. Follow-up studies indicated that two of these garments had breakthrough times of between 5 and 15 minutes. Interviews with applicators and management indicated that these garments were normally used for a full day (8 hours), and often for multiple days. We ascertained that because these garments caused substantial sweating the workers could not sense that breakthrough had occurred. We concluded that none of these garments could be considered protective under realistic field use conditions, and that contact with treated foliage represented a special hazard during greenhouse applications. As a result of this study, the manager of the greenhouses at the study site discarded the existing clothing, and purchased new clothing based on our recommendations. Our results were disseminated to the industry through the leading greenhouse trade publication, *Greenhouse Manager*.

Protective Clothing Performance during AirblastApplications

We found that the non-woven coveralls tested in these studies allowed significantly greater exposure than did traditional woven garments, primarily because of design factors (e.g., large sleeve and neck openings). The greatest exposure occurred on the forearms beneath the non-woven garments. These exposures were only evident with the fluorescent tracer technique. Many previous studies using the traditional patch technique had failed to measure such exposures. We concluded that the clothing materials tested were not chemically resistant under these field conditions, since fabric penetration was detected for all test garments, As a result of these studies, the U.S. EPA abandoned further testing of the non-woven garments and adopted our recommendations regarding garment design.

Pesticide Safety Classroom Demonstrations of Fluorescent Tracer Exposure

Results from these studies showed that the live demonstration with fluorescent tracer produced

significantly more favorable results than the other two treatments for seven of eight outcome measures, including both process and impact evaluation measures. In addition, the videotape of the live skit produced significantly more favorable results than the instructional video for four out of eight outcome measures. For the four strongly-agree outcomes, the evidence suggests that the interventions produced significantly different responses: that the live tracer demonstration produced significantly more favorable responses than the other treatments, and that the videotape of the live demonstration produced significantly more favorable responses than the instructional video. This work was published in the on-line *Journal of Pesticide Safety Education*, a primary information source for pesticide safety education practitioners.

Fluorescent Tracer Use in Hands-on Pesticide Handler Training

We found that the hands-on training program had a positive impact on knowledge acquisition based on pre- and post-tests. For certain information, the FT module improved knowledge scores, but not in all cases. The dramatic visualization of exposure and contamination provided by the fluorescent tracer method was remarked upon by many of the study participants in the post-training interview, and was strongly endorsed by the trainers. The FT training curriculum (Spanish) has now been incorporated as a standard component of the WSDA Hands-on Pesticide Handler Training program. This program trains approximately 200 Hispanic pesticide handlers each year. In addition, elements of the training (i.e., PPE decontamination) are used in other educational presentations such as at pesticide recertification classes and industry events. We are producing a new FT training manual that will give pesticide safety educators the tools they need to integrate FT training into their own programs. The final print and Web-based model FT training materials will be available in September 2006, and will be distributed nationally and internationally.

Workplace Determinants of Take-Home Pesticide Exposure

Our baseline study in 2003 investigated the concentrations of organophosphorus pesticide residues in the commuter vehicles and homes of three groups of agricultural workers: pesticide handlers, apple thinners, and agricultural workers at an organic orchard (reference group). Pesticide levels in the homes of handlers were the highest among the three groups. Both the handler and thinner groups had significantly more pesticide residues in house dust than the controls. Vehicle dust was found to be a significant predictor of house dust concentrations for all three pesticides studied, and leaving the vehicle window rolled down was found to be a significant predictor of vehicle pesticide concentrations for two of the pesticides.

Our 2004 study pilot-tested two practical interventions: storage bins for work boots, and availability of a high efficiency vacuum at the worksite for cleaning commuter vehicles. We found that work patterns and the use of the interventions were highly variable within this study group. We also learned that a careful analysis of work records would permit a proper assignment to intervention and control groups. Our intervention with pesticide applicators is still under analysis.

In 2005 we implemented a larger-scale intervention study that focused on vehicle vacuuming among agricultural workers who were picking cherries. At the end of the study period, each subject was interviewed and a vehicle and house dust sample was collected. We found that those workers who used the workplace vacuum to clean their vehicles had lower levels of pesticides in both their vehicles and homes than did those workers who did not vacuum. In future studies, we would like to further evaluate this intervention. We plan to develop new strategies to encourage employers to make vacuums available to their workers, and to persuade employers to let workers use the vacuums during work time. We also plan to develop new strategies for motivating workers to vacuum their vehicles on a regular basis.

PRODUCTS/OUTPUTS
Further products are reported in the companion database.

Publications

1. Publications -- Applicator-focused Interventions

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Tools for Education and Prevention

Use of Theater to Introduce Health and Safety Information in Hispanic Communities Play Script Packet (Spanish): Plays which provide health education and farm safety training for Hispanic agricultural workers. Topics covered: Pesticide Safety, Preventing Hepatitis A, Tuberculosis Awareness, Alcohol Education, Pregnancy/Prenatal Concerns, Ergonomics.

Fluorescent Tracer Pesticide Exposure Demonstration: Uses the fluorescent tracer technique to demonstrate to pesticide applicators their potential dermal exposure. Actors are exposed to a fluorescent tracer and water mixture that simulates pesticides under various work conditions. After application of the solution, exposures are demonstrated by standing under a black light. The demonstration is followed by audience discussion of the technique and methods to avoid pesticide exposure at work.

Spanish Language Safety Plays: VHS and DVD format Pesticide Safety (with English subtitles) also streamed on the Farm Center Web page.

Courses and Workshops

- Pesticide Health Risks session at Future of Rural Peoples: Rural Economy, Health People, Environment, Rural Communities conference in Saskatoon, Canada on October 12-23, 2003.
- Pesticide Medicine Short Course. These courses bring together local and national experts on pesticide use, pesticide exposure and pesticide health effects. Washington [2000, 2001, 2003].
- Pesticide Issues Short Course. These courses offered local regulators, employers, health care providers, and workers with the latest pesticide health issues. Washington [2002, 2003].
- Educational Seminars in partnership with Washington Department of Health. Providing education to farmworker health care providers on pesticide education and the use of the mental health diagnostic tool. Washington [2003].
- Train-the-Trainer, 2-day courses taught in Washington (PNASH staff and stakeholders participated). New Jersey, Florida and Puerto Rico [2003].
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OUTCOMES

The state of knowledge and transfer of that knowledge on pesticide exposure and health effects is not yet complete. Studies are published regularly, slowly developing the picture of what the problems and solutions to pesticides might be. The uncertainty among scientists and the lack of safer alternative products makes for difficult decisions within the agricultural industry, From a PNASH Center survey of 66 Washington state producers in 2005, we learned that 63% of these wanted further information on pesticides and their health effects. From a farmworker at El Proyecto Bienestar's Town Hall in 2006 it was expressed that what was needed was "Information; about what to do coming home from work. Like after working with pesticides, keep away from the home, like remove the clothes before entering home."

Interventions to Reduce Pesticide Applicator Exposures

Our work to characterize applicator exposures under realistic field conditions remains unique in the scientific literature, and contains numerous recommendations for reducing exposures. These recommendations have been disseminated through state cooperative extension services (e.g., distribution of a fluorescent tracer slide presentation to pesticide safety educators), presentations at meetings of health and safety practitioners (e.g. the American Industrial Hygiene Conference), and trade publications (e.g., *Greenhouse Manager).* Our studies have directly contributed to the protective clothing requirements developed by the U.S. Environmental Protection Agency, and incorporated in the federal Worker Protection Standard.

Pesticide Safety Education

Our work with fluorescent tracers has been a great asset to pesticide safety educators throughout the United States. Our publication in the Journal of Pesticide Safety Education was aimed at practitioners who regularly teach pesticide safety to applicators renewing their applicator licenses. Our more recent work with the WSDA Hands-On Pesticide Handler Training Program has focused on the transfer of the fluorescent tracer (FT) technique to pesticide safety educators. The dramatic visualization of the fluorescent tracer demonstrates 'contamination' during training

and gives handlers insight as to where and how pesticide contamination occurs. At the end of FY 2005, a draft of the FT training curricula (Spanish) was in-use with the WSDA program. This program trains approximately 200 Hispanic pesticide handlers each year. In addition, elements of the training (i.e., PPE decontamination) are used in other educational presentations such as at pesticide recertification classes and industry events.

From a masters student project that interviewed pesticide educators who used PNASH's FT training we learned that FT aids pesticide safety educators by:

1. instantly impressing upon participants their messages.
2. providing relevant lessons that trigger participants to instantly connect to real-life exposure situations.
3. creating a fun peer group dynamic to instantly engage participants.

From this same evaluation project, here are a few of many similar testimonials provided by agricultural pesticide safety educators.

"it has been very effective because it tells more (than a) dozen words. Because I can spend hours, two, hours, talking but until the people actually see what I'm talking about, says 'Man, now we know what you are talking about' …. This is one of the more powerful training tool that I have encountered because the message is clear and it is shocking."

"It makes a big impression on everybody that sees it, it's like 'oh my god, I had no idea… Well, ya, it's an eye opener for everyone."

"The reactions (of participants were) 'How can we do to reduce exposure?' At first, they were a little bit shocked, but then immediate reaction: 'what can we do to reduce exposure?' Ya, it was very, very, very good. They look that they are in risk, they are exposed, 'What will we do to reduce? We use this cloth, or this mask, how can we, what is the doctor recommendations?"

"And it made them think about their, you know, protecting themselves. So it did raise their level of awareness."

Demonstrating the lasting power of the training,

"(The research) was, remember, 7 years ago. But what I remember, remember from participants is some of them were contaminated and said the hands was the most contaminated, and they thought that was the only thing that could be contaminated, or the back of the legs. One month ago, I went to visit two farmers because they were two who were in this study and they still remember that, and they said the guy demonstrated (with FT) to them how difficult it is to escape from the pesticide. So it creates an impact."

Workplace Determinants of Take Home Pesticide Exposure

Work in this area predated the PNASH Center, but was funded by NIOSH. Center support over the past ten years has allowed this research to proceed at a rapid pace. A series of field studies have been completed that permit assessment of exposure pathways for children of agricultural workers, and allow an estimate of doses received by these children. This work resulted in numerous peer-reviewed journal articles. It received widespread attention in the media, and has informed policy makers at the state and federal levels. This work has also provided a foundation for our current work on interventions to reduce pesticide exposures.

Three interventions have been developed and adopted by a major fruit orchardist over the past two years. Using the results of the baseline study as a starting point, three interventions were evaluated for their ability to reduce work-to-home transmission of agricultural pesticides.

- Thinners were given a work boot storage box ('boot bin') and sandals so that they had an alternative to wearing their boots into their home.
- Thinners vacuumed their cars once a week using vacuums (equipped with high efficiency particulate air filters) located at a central location.
- Applicators used a locker room that was cleaned daily and had separate lockers for PPE and work clothes.

We are still in the process of analyzing the results of these studies, but preliminary findings indicate that the vacuuming of commuter vehicles at the workplace decreases pesticide levels in workers' homes. We plan to publish our work in 2006, and provide a practical guide regarding these interventions for both employers and workers.

PREVENTING TRAUMATIC INJURIES

INTRODUCTION

Traumatic injuries are a known problem for many occupations in the agricultural industry. Over the last eight years PNASH's major effort, under the leadership of Dr. Matthew Keifer, has been a systematic investigation of injuries in the tree fruit industry in Washington state. Overall, PNASH researchers have tackled traumatic injuries through survey, research, prevention and education in four important areas:

- Orchard Injuries
- Tractor Injuries
- Children's Farm Injuries
- Forestry and Fishing Injuries

GOALS

The goal of the PNASH Center's Prevention of Traumatic Injuries program is to reduce occupational injuries among workers in agricultural industries, in particular the tree fruit industry. The sub-goals are to:

- Explore and characterize the array of factors that contribute to injury
- Prioritize the injuries and risk conditions among orchard workers
- Use this information to develop targeted interventions aimed at reducing the frequency of risk conditions that lead to injury
- Evaluate the effectiveness and the cost-benefit ratio of interventions

BACKGROUND AND SIGNIFICANCE

Estimates of agriculturally related deaths from the National Safety Council and statistics from the National Census of Fatal Occupational Injuries converge putting annual agricultural deaths between 780 and 700. The death rate in agriculture of 22.1 per 100,000 is exceeded only by mining and quarrying among major industries in the U.S. U.S. agriculture is not unique in this respect. Canadian data shows that farming there is the fourth most dangerous industry. Nonfatal injuries are also very high in agriculture. The NSC estimated 150,000 disabling agricultural injuries in 1999 and other sources such as the U.S. Department of Labor, the workers' compensation system in California (the largest agricultural producer in the country), and the Department of Labor and Industries of Washington State confirm this high rate of injury. A study of agricultural injuries in Washington state, using Washington workers' compensation data, demonstrated an elevated risk for injuries (2.3 overall) for agricultural workers as compared with the general worker population.

The tree fruit industry, in particular, is a large employer but a dangerous industry. Apples alone employ up to 45,000 workers during peak activity and cherries and pears employ 16,000 and 7000 respectively. The tree fruit industry accounts for some 45-58% of the injuries in agriculture. According to the Washington State Department of Labor and Industry data, the tree fruit industry has the highest rate of injury per full time equivalent of any agricultural sector. Injuries include various musculoskeletal injuries, including back, eye injuries, fractures, amputations, cuts, bruises, and burns. High rates of occupational injury among orchard workers demonstrate a need for further research to study common, preventable risk factors and conditions.

Ladder injuries appear to be a major contributor to these high rates. Based on a PNASH Center

review of data from the three-county agricultural area of eastern Washington, ladder injuries account for 67% of the cost of all fall-related workers' compensation expenditures. Orchard workers are particularly at risk for ladder injuries because of the nature of their work. It seems clear that traditional individualized approaches are not working. The multiple factors and conditions that contribute to ladder injuries demand innovative and creative solutions that emphasize engineering and administrative techniques.

The forest resources industry is also one of the most hazardous in the United States. The fatality rate of loggers in 1997 was approximately 27 times the national average (128 vs. 5 per 100,000). Nationally, nonfatal injuries between 1992 and 1996 declined from 4,537 injuries per year to 2,136 injuries per year, yet rates are still high and injuries severe, resulting in a median number of 11 days away from work. A study of logging fatalities in Washington state indicated that employees of smaller logging firms had a higher risk for mortality. This trend for small businesses is apparent on a national level, with logging in the top five of all small businesses with high risk for injury or death. Based on Washington state workers' compensation claims data, the rate of nonfatal lost time injuries for loggers (13.5 per 100 full time equivalents [FTE]) is more than 3.5 times that of all industries combined (3.8 per 100 FTE). In Oregon, the average fatality rate by industry for 1993 through 1997 finds agriculture, forestry, and fishing as having one of the highest fatality rates (19.0 per 100,000, just below construction at 19.4 per 100,000). In a review of the Alaska Trauma Registry for 1991 through 1995, logging had the highest average annual injury rate (2.5 for every 100 workers) of all occupations in Alaska. The types of injuries sustained by individuals working in forestlands range from frequent minor injuries to very severe incidents. Oregon's disabling claims data indicated loggers most frequently experienced sprains and strains, struck-bys, and back injuries. Likewise, in a review of nonfatal injuries in Alaska, struck-bys and falls led in causes of all severe injuries with fractured bone being the most common injury and most injuries impacting the lower extremities.

ACTIVITIES

Orchard Injuries

To reduce the high rates of occupational injuries among tree fruit industry workers, PNASH conducted a series of projects in the Yakima Valley aimed at identifying and preventing the most common injuries and their causes. This was accomplished through a review of workers' compensation claims data, interviews with key informants and workers, and evaluation of a prevention program. Data revealed a clear problem was ladder injuries. This was reinforced by workers' compensation data review, key informant interviews, and worker interviews. This led to a focus on the development of an engineering intervention: a new ladder with built-in sensors that can, as a training tool, both warn workers and monitor risk conditions. Specific activities included:

1997 Farmworker Survey at community soccer league games. In a first step to characterizing the workforce, injury experience, and use of the workers' compensation system, an interview survey was conducted in the Yakima Valley. The survey used a specific venue for accessing hard-to-reach workers. Among migrant workers, it is common to neither have a fixed address, a permanent phone number, nor a permanent employment location. As a result, this study explored the use of summer soccer tournaments as a location where farm workers, who would otherwise be hard to find and interview, could be found. In a short summer project, a survey

conducted by a medical student, netted more than 300 workers during the Yakima Valley summer soccer league games, using the game locations for survey administration.

1999 Community Random Digit Telephone Survey. Seasonal workers, unlike migrant workers, generally have permanent residences and permanent telephone lines. This project used a random digit dialing approach to access workers in the Sunnyside, Washington area where, according to the 1990 census, 57% of residents were Hispanic and the vast majority of economic activity is agricultural. A 66% participation rate among 2363 households found 514 households with at least one adult agricultural worker. 440 workers participated in the survey.

2001 Review of Washington State Workers Compensation Data. All workers' compensation claims data for deciduous tree fruit workers in Region 5 of Washington state between 1996 and 2001 were reviewed and categorized according to cause of injury. Claims data were analyzed by cause of injury in terms of frequency, severity, and cost. While the worker compensation database is an administrative database aimed primarily for addressing billing issues, it can be used to a limited degree for epidemiological purposes. The weakness is that data fields on injury mechanism are filled in by non-epidemiologically trained workers. Its clear advantage is its reach. Almost all hired agricultural workers in the state are covered by the system.

2002 Key Informant Interviews. Aware of the limitations of data collected by an administrative database, we also sought information from persons who would be familiar with the health and safety issues in orchard agriculture. These 25 individuals included government workplace inspectors, worker representatives, private health and safety consultants and medical personnel in the region.

2002 Evaluation of Labor and Industries Eyes and Fall Prevention Program.
Responding to a request from the Washington Department of Labor and Industries, the PNASH researchers attempted to determine if a safety consultation program offered by L&I was effective in reducing injuries from ladders and eye injuries. The program in its early stages, did not have sufficient reach to statistically detect an effect on the injury rate in the covered area. Based on this information, the program switched to focus on the effectiveness of the consultation program from the perspective of the growers who participated. A project was undertaken to evaluate the experience of growers who had received consultation vs. growers who had not in terms of changes in behavior and attitudes about safety on the farm.

2002 Ladder Injury Interviews. In order to delve more deeply into the mechanism of ladder injuries, we conducted interviews with workers who had sustained injuries in orchards on ladders. Cases were identified by collecting data on all ladder-related injuries reported to the workers' compensation system. We sought to identify cases within two weeks of the index injury. Workers who could be located were interviewed using an open-ended interview format to determine the mechanism of ladder injury.

2003 Worker Interviews / 2004 Worker Survey. The purpose of this study was to gather information about Hispanic orchard workers' perceptions and experiences related to the risks and hazards related to their work. The study consisted of two phases of data collection: 1) open-ended, personal interviews of 25 Hispanic workers from two agricultural communities in central Washington, and 2) a written survey based on the interviews of 184 orchard workers.

The primary goal of the first phase of the study was to gain insight into the workers' perceptions about occupational health and safety of orchard work. Areas of inquiry included participants' day-to-day experiences as orchard workers, injury experiences, and perceptions of factors contributing to injury

2005 Sensing Ladders as a Training and Hazard Assessment Tool. These studies provided the impetus to develop a tool that could reduce the injury rate for orchard ladders. Specifics about mechanisms of injury by ladder users were derived principally from interviews with injured workers and workers who had witnessed injuries of others. The "smart ladder" was designed to both monitor the occurrence of risk conditions and to warn workers of the conditions that are associated with a high risk of injury. The ladder is equipped with sensors that can detect the workers' position on the ladder, determine his or her center of gravity, and alert the worker when the stability of the ladder is threatened. A single prototype has been developed, equipped with accelerometers and load cells; its reliability has been tested and verified.

Tractor Injuries

This project brought together all the NIOSH Agricultural Centers in their first joint project to address a known problem area. The Centers worked together to develop an informed solution to the high fatality and injury rates from tractors. Specific activities to date include the production of a joint report to outline the problem and recommended solutions. A launching meeting with stakeholders was held during June in 2004. Currently, a two-year grant from NIOSH is allowing us to build partnerships, finalize the evidence package, and conduct audience research. While this initiative is still underway, the development and launching of the initiative with national partners is a first step to implementing a strategic social marketing campaign that will reduce farmer injuries and deaths.

Children's Farm Injuries

A number of projects characterized children's farm injuries and evaluated prevention programs. A community phone survey in Sunnyside, Washington, characterized problem areas, injury rates, and patterns of work and treatment outcomes for teenaged hired farm workers. One pilot study investigated family supervision of farm children. Two existing educational prevention programs were evaluated: one teen tractor safety program in Washington and one children's farm safety day camp in Idaho. Currently, PNASH is engaged in evaluating and disseminating an agricultural safety curriculum to Washington state Ag-in-the-Classroom programs.

Forestry Injuries

Like farming, forestry occupations face high rates of fatal and disabling injuries. While PNASH lacks the resources to pursue a thorough investigation into these areas of work, some pilot studies have addressed aspects of these industries. The Forestry Summit pointed out many concerns in logging and forestry work. In 2002, two small projects characterized injuries in wildland firefighters.

SIGNIFICANT FINDINGS

Orchard Injuries

1997 Farmworker Survey at community soccer league games. We found that among 316 subjects interviewed, 97.7% identified Spanish as their preferred language and 85% worked in agriculture. Respondents earned an average of $12,222 per year, of which an average of $9974 was earned in 8.7 months of agricultural work. Among the workers interviewed, 46 reported having sustained work-related injuries, 44 occurring in agricultural work. Of these, 40 received medical attention. Half (22) reported that their employers paid their medical expenses and 12 of the injured workers paid these expenses themselves. When asked about their knowledge of the worker's compensation (WC) system in Washington state, only 26.5% had knowledge of such a system. When asked how they would cover the expenses of a workplace injury, the majority of workers (51.3%) said that they would themselves pay. Only 12.3% reported that they would file a WC claim for a work related injury. This study demonstrated that work related injuries were common, that workers appeared to know little about the WC system (which covers all workers in Washington state), and that the use of what we termed the "soccer survey" was an effective means to contact workers inexpensively and with good cooperation.

1999 Community Random Digit Telephone Survey. This study also demonstrated that injuries are common among agricultural workers (47 total and 39 medically treated injuries among 440 workers; 10.6% and 9% per year respectively). It also demonstrates that workers often do not use the worker's compensation system and that incidence rates based on WC data may underestimate the injury rate in this population. Only 29 of 39 medically treated injuries resulted in the filing of claims by this population. The relative lack of ladder injuries in this population may reflect the manner in which a subject could report injuries or the fact that many of these workers also spent large percentages of their time in non-orchard industries.

2001 Review of Washington State Workers Compensation Data. Claims related to ladders were not only the most frequent, but were also the most expensive as a group in terms of medical aid, time loss, and other costs. On a per claim basis, ladder-related injuries were among the most severe and costly reported injuries. Other common causes of injury among claims were branches and vegetation, structure and material, and ground-related injuries.

We found that when we focused on deciduous tree fruit as an industry, of the 13,068 claims that were classifiable by us in the dataset, 4,020 (30.8%) were determined to have been ladder-related. Ladder-related claims accounted for nearly half (48%) of all compensable claims (claims involving time loss, disability, or loss of earning power in addition to medical expenses). Ladder related injuries represented the single most important cause of injuries both in numbers and in cost within the workers' compensation system. On a per-claim basis, ladder-related injuries were among the most severe and costly reported injuries as well.

2002 Key informant interviews. Key informant interviews highlighted musculoskeletal and eye injuries, ladders, and the following risk factors: worker responsibility, employer obligations, priorities and responsibilities, governmental oversight, and the difficult nature of the work. The 25 qualitative, open-ended interviews revealed themes that indicate that knowledge and experience, physical and psychological aspects, and external influences all affect the occurrence of injuries in orchards. Reports from these informants again strongly endorsed ladders as being the primary source of injuries in the orchard environment.

2002 Evaluation of Labor and Industries Eyes and Fall Prevention Program.
Program participants (PP) versus employers not participating (NP)in the program were much more likely to report the implementation of safety changes: OR=16.87 (95% CI 6.96-40.9)). The difference remained significant after controlling for hours and business years, with OR=15.47, (CI 3.57-67.0). The changes most commonly reported by PP included the use of site-specific hazard communication and accident prevention programs. Among the changes most commonly reported by NP were the distribution of glasses to workers, the use of an accident prevention program, and ladder safety instruction. Of the 19 PP who implemented only some of the recommendations, 47% reported that the other change(s) were already in place before the consultation. Of the 52 NP who made no safety changes in the last three years, 90% believed that there was no need for it. Implementation difficulties were experienced by 32 (44%) of PP and 20 (59%) of NP. When only partial implementation was achieved by program participants, it was mostly (63%) because the grower believed that there was no need for more to be done, or because he/she considered the remaining suggestions unworkable. A fourth of the 23 PP reported difficulties with the installation of eye wash and shower facilities in the field; time constraints were a barrier to implementation in 19% of the cases and expense was mentioned by 16%.

Among the interviewed program participants 35 (41%) reported not having received recommendations to minimize the risk and cost of injuries. Fourteen could not tell whether they have received such risk management consultation. All the 34 PP who received risk management (RM) consultation reported partial (44%) or full (53%) implementation. Management of workers' claims was the most common change mentioned (20%), followed by the addition of policies for corrective action (16%) and changes in hiring practices (14%). Unlike the implementation of safety changes, no difficulty was reported by 69% of the participants who implemented RM changes.

Most (77%) of the interviewees did not have any program modification suggestions. More (36) of the interviewed growers made suggestions regarding ways that L&I could help them maintain the safety changes. Specifically, 16% expressed an interest in being informed about rules and 14% would like to receive safety material. The wish to be left alone was expressed several times by 4-10 participants in response to both of these open-ended questions. Fewer than 50% of the interviewed program participants provided feedback about the program and L&I staff. The feedback regarding the L&I staff was generally positive.

2002 Ladder Injury Interviews Over a nine-month study period, 37 injured workers were interviewed. These workers provided insight into how workers are hurt on ladders. This information helped formulate approaches to enhancing ladder safety. The study found that 25% of the injured workers had less than a year's experience working in orchards; 44% of cases took place on the upper third of ladder; ladder movement was the main cause in 47% of cases; the worker slipped in 27%. Back injuries and ankle sprains were the most common injuries. Several injuries occurred when a picker missed the last rung while coming down the ladder with a full bag of apples. The heavy bag can obscure vision and throw the worker off-balance. Missing the last step on descent, loss of balance while reaching, sliding of the third (mobile) leg, slipping on slippery ladder rungs, rolling on branches trapped between the foot and the rung all were scenarios identified by workers as mechanisms of ladder injury.

2003 Worker Interviews/ Worker Survey. The most common injury event, reported by nearly 60 percent of the injuried workers, was a fall from a ladder; and the most common types of

injury were sprains and strains, broken bones, and eye injuries. Factors contributing to injury fell into three major categories: personal attributes: (limited occupational choices, experience, risk-taking behavior, carelessness), work-related issues: (relationship with 'boss,' workplace treatment, employer demands, communication styles, training, resource availability, equipment and external factors: (weather, terrain, regulations, economic conditions).

A major goal of the second phase was to determine the importance of factors identified in phase one. A written survey was developed that included the factors identified in the first phase. Subjects were asked to indicate the importance of these factors using a five-point Likert scale. More than a quarter of these 184 subjects (n=49) reported having had an injury while working in the orchards, and nearly 75% reported that this injury involved a ladder. The factors that subjects identified as most likely to contribute to an injury included limited experience, being older, being female, (lack of) permission to make decisions, and employer demands. When data were compared using these factors, it was determined that, consistent with the workers' perceptions, experienced workers were more likely to be injured than less experienced workers (p=.012). However, gender did not affect injury rate and contrary to workers' perceptions, older workers were more likely to be injured than were younger workers (p=.017). Subjects also commented that regulations were not enforced and that weather and the terrain affected safety. About half of the workers (n=98) indicated that they had some training; about half of these were trained by their co-workers or through the use of written materials. Thus, only about one quarter of these subjects had any type of 'formal' training. Other contributing factors included 'poor equipment' (such as ladders), careless behavior, and lack of skills.

This study provided an interesting glimpse into the world of Hispanic orchard workers. While personal attributes (i.e., age, gender) were ranked as the most important contributors to injury, factors in the work organization (i.e., employer demands, workers' decision latitude, poor equipment) may be major contributors to workplace safety; and these work-related factors are most amenable to interventions. Further studies are needed to determine the extent of worker training, to learn about the contribution of other factors such as piece rate payment, workplace climate, use of personal protective equipment and the enforcement of rules and regulations. In order to be most effective, interventions should be aimed at workplace modifications; the development of effective, appropriate training methods; and the development of methods to promote compliance with rules and regulations.

2005 Sensor Ladders as a Training and Hazard Assessment Tool. The next steps in the development of the smart ladder are to develop a protocol for using sensor input to identify the risk conditions that warrant warning a worker. Further engineering needs to be done to simplify the sensor array and field harden the sensor package.

Once fully developed, the smart ladder will be a useful training tool for providing real-time feedback, through sensor triggered alarms, to workers being trained on orchard ladders. The smart ladder will also be usable for monitoring the effectiveness of training. By silencing the alarms and allowing workers to use the smart ladders in the fields under true work conditions, data on the frequency of the occurrence of worker induced risk conditions among trained ladder users can be collected. This can assist in evaluating the effectiveness of training and can provide feedback to instructors on improving training.

Tractor Injuries

The Agricultural Centers' years of study of tractor related injuries and deaths have led to several conclusions on the problems and solutions. Research has demonstrated that the following key recommendations would drastically reduce tractor injuries and deaths:

- Establishing a range of incentives to retire older tractors or retrofit them with ROPS
- Increasing the use and maintenance of preventative and protective technologies
- Mounting a social marketing campaign aimed at safe tractor use
- Building private and public sector (especially legislative) support for the initiative

Children's Farm Injuries

Injuries in teens working in agriculture. A study that used random digit dialing of the Sunnyside Washington area identified and interviewed parents or guardians of teens in order to assess the teen's agricultural injury experience. The study found 439 households with a teenager in the house. Two hundred were identified as doing agricultural work. Among these, 8 teenagers were identified as having suffered an injury while at work. A total of ten injuries were reported in the survey among teens. Three of the injuries were reported to the WC system. Only two of ten injuries were cared for in a hospital. The study found an injury rate among surveyed teens of 5.0 % or 19.2/100 full time equivalents (FTE). The rate was higher for Hispanic teens at 7.2 % and 27.2/100 FTE respectively. However, this rate did not reach statistical significance.

Forestry Injuries

Through our stakeholder engagement of the forestry industry we learned that traumatic injuries are a major concern in logging and forestry work. Project participants identified traumatic injuries as one of the top priorities for research. Concerns included both fatal and nonfatal injuries, with an emphasis on eye injuries. Traumatic incidents were attributed to struck-by injuries, slips, trips, and falls. Overexertion and fatigue were also noted as predispositions to forestry-related incidents.

In wildland firefighting we found an elevated injury frequency rate for the T-1 "Hotshot" crews assigned to the Clear Creek fire. There were a significant number of injuries in the fire camp setting, which offer opportunities to reduce injuries on future fires. The report includes recommendations to improve firefighter safety and reduce injuries, both on the fireline and among fire support personnel in the fire camp setting. It also proposes future research needs to better define the types of injuries, the resources affected, and the need to look at fire illnesses as another component of the wildland fire health and safety program.

PRODUCTS/OUTPUTS

Further products are reported in the companion database.

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Questionnaires and Surveys

Agricultural Work and Injuries in Teenagers Survey (English/Spanish): A Community-based telephone survey to estimate the one-year cumulative incidence of work-related injuries and characterize work patterns.

Tractor Safety for Teens Questionnaire: Includes a self-assessment behavioral checklist, teen knowledge and attitude assessment tool, and parent attitude assessment tool.

Questionnaire on Ladder Injury Experience (English/Spanish): A questionnaire to be delivered in a personal interview to determine the characteristics of orchard ladder injuries.

Farm Families and the Employment, Training, and Supervision of Children Survey: A personal interview survey using open-ended questions to assess the types of farmwork done by children; the conditions under which children perform tasks, and the extent and nature of parental training an supervision of children.

Older Farmers: Factors Influencing their Retirement Decisions Survey: A personal interview survey using open-ended questions to assess circumstances that affect older farmer's retirement decisions and potential risk factors for injuries.

Tools for Education and Prevention

Orchard Injury Project's "Smart Ladder." The Orchard Injury project has developed an engineering intervention to prevent the most common causes of injuries in the orchard, ladders. The "smart ladder," senses the position, weight, center of gravity and weight shift of the worker. PNASH is applying to license a working model of the invention. Patenting the ladder will open it to commercial development, which could facilitate its use in other industries, beyond its primary purpose for orchard worker training.

Design for Sensor-based Devices and Modifications to the Ladders. To facilitate training methodologies for improved ladder safety in orchards.

Safety and Health Research Agenda for Northwest Wildland Firefighting:. Describes health and safety research priorities for wildland firefighting, as identified through literature review and key informant interviews.

OUTCOMES

Orchard Injuries

Improving the practice of the Washington State Department of Labor and Industries.
Reuel Paradis, a regional administrator for the Washington Department of Labor and Industries sums up the impact of PNASH with:

> *"our frequent interface with PNASH researchers and their feedback added great value to our understanding of the relationship of regulatory authority and the regulated community and assisted in our developing insight to methods for improving work place safety. In addition, PNASH provided us with two unpublished papers that, in my opinion, are illuminating.*
>
> *A short list of insights I've gained, and I believe staff involved with the implementation of 'eyes and falls' gained, from the 'eyes and falls' project and from our association with PNASH researchers.*
>
> - *The department of labor and industries administrates public policy for the government of Washington state. The government of Washington state is the registered voters of the state. The department of labor and industries can not compel compliance with safety and health public policies or with the principles of loss control management.*
> - *Industries, employers and workers, need to own their safety and health issues.*
> - *The department of labor and industries needs to develop meaningful partnerships with everyone – other public sector entities, higher education entities and private sector entities – who can impact (add value) work place safety and health problem resolution."*

Model of a "Smart" Tripod Orchard Ladder

To date, the Smart ladder is still in prototype. The promise of this device is that it will be both an excellent training and training assessment tool. As the device can monitor a worker's status with respect to position, movement and balance and either warn or just record this information, it can be used both to teach workers to stay within the confines of the ladder stability envelope and can later be used to silently monitor the change in behavior brought about by that training. The smart ladder can also identify the benefits of changes in worker equipment or behavior designed

to increase ladder safety. The outcomes brought about by this device have not as yet been realized. Further development will be needed.

Technology Roadmap

As a result of the now acknowledged impact and cost of orchard worker injuries and in particular, ladder injury, the United States tree fruit industry is turning to technology to reduce labor and the burden of that labor. In 2003, the US tree fruit industry developed a Technology Roadmap to improve the sustainability, efficiency, and quality of fruit production in the United States. The Technology Roadmap seeks not only to improve the operational efficiency of tree fruit harvesting, but also to create a more prosperous, skilled, year-round work force that works under safer conditions (Warner, 2004). The tree fruit industry acknowledges that a past practice of merely increasing workload in order to increase productivity is outmoded, yet pure reliance on technology is likely to fail unless it also improves the lives, social conditions, and economics of the industry.

A first and critical component in the Technology Roadmap is to semi-automate labor-intensive aspects of fruit orchard work, including harvesting, pruning, and fruit thinning, in order to increase productivity, with the ultimate goal to fully-automate harvesting and other labor-demanding activities in 10-15 years. The aim is to produce improved quality fruit at lower production costs. These industry changes will result in fewer, but more highly trained workers working in technologically advanced orchard management systems. As part of the transition to automated orchard activities, a near-term and central goal of the Technology Roadmap is to transition from performing orchard work on ladders to performing orchard work on mobile, raised platforms. Given the aggressive goals of the Technology Roadmap, mobile platforms are moving from an experimental tool to an actual product that will be used in orchard activities.

Tractor Injuries

Launching of National Tractor Safety Initiative.

This project brought together all the NIOSH Agricultural Centers in their first joint project to address a known problem area. The Centers worked together to develop an informed solution to the high fatality and injury rates from tractors. Through a two-year grant form NIOSH, we are building partnerships, finalizing the evidence package, and conducting audience research. While this initiative is still in an early phase, we are preparing for a national social marketing campaign to reduce farmer injuries and deaths.

Research has demonstrated that the following key recommendations would drastically reduce tractor injuries and deaths:

- Establishing a range of incentives to retire older tractors or retrofit them with ROPS
- Increasing the use and maintenance of preventative and protective technologies
- Mounting a social marketing campaign aimed at safety tractor use
- Building private and public sector (especially legislative) support for the initiative

Children's Farm Injuries

PNASH's educational intervention evaluation projects have improved the effectiveness of two ongoing children's safety programs: Magic Valley Safe Kids Coalition's Safety Day Camp in Idaho, and Washington State University Extension's Teen Tractor Safety program in Skagit County. In addition, PNASH has continued our commitment to children's safety and educational interventions by initiating an evaluation of the new Washington State Safety and Health for

Agricultural Teens, a curriculum that will be implemented in Washington state through Ag-in-the-Classroom in 2006.

Forestry Injuries

Improving injury record keeping for wildland firefighters.

This study reviewed injuries that were documented on two large fires, to determine if individual characteristics, environmental factors, fatigue and/or fitness levels affected the numbers and types of injuries. The report back to the USDA Forest Service identified areas to improve firefighter safety and reduce injuries, both on the fireline and among fire support personnel in the fire camp. It also proposes future record keeping and research needs to better define the types of injuries, the resources affected, and suggests looking at fire illnesses as another component of the wildland fire health and safety program. Improvements in record keeping and further investigation could lead to improved safety and health for wildland firefighters.

MUSCULOSKELETAL DISORDERS

INTRODUCTION

There is a growing awareness in the industry and among occupational safety professionals on the burden of work related musculoskeletal disorders. In response to industry concerns, PNASH investigators have approached this problem both in packinghouses and in the field. In conducting these investigations, PNASH has worked with affiliated programs at the University of Washington: The Field Research and Consultation Group and the Ergonomics Program.

GOALS

The goal of the PNASH Center's Musculoskeletal Disorders program is to reduce occupational injuries among workers in agricultural industries. The sub-goals are to:

- Assess the hazards of musculoskeletal disorders in high-risk occupations
- Develop targeted interventions aimed at reducing the frequency of risk conditions that lead to injury
- Evaluate the effectiveness and the cost-benefit of interventions

BACKGROUND AND SIGNIFICANCE

The U.S. tree fruit industry is struggling to survive in the increasingly competitive global agricultural economy. Growers in China, New Zealand, Chile, Italy, Turkey, and Mexico are producing greater portions of the global apple market share. According to the US Apple Association, between 2000 and 2003, apple imports to the U.S. rose by 30% while exports simultaneously declined by 8%. Increasing labor costs and declining labor availability contribute to U.S. growers' challenge to compete with foreign suppliers. Labor is the greatest expense in orchard activities involving hand-picking, pruning, and thinning fruit. Good labor supply and low wages in foreign countries increase the competitive pressures on U.S. growers. The supply of workers available for hand harvesting in the U.S. has steadily decreased as agricultural workers go to better paying, year-round jobs in other industries. The end result is that orchard owners and growers have to respond to the changing demographics of the agricultural workforce, relying less on migrant and temporary workers and developing the ability to offer competitive, higher-paying year round jobs.

Agriculture has historically been one of the most hazardous and physically demanding workplaces in the U.S. From previous PNASH research we know that falls from ladders are the most common injury reported by orchard workers in Washington, and thus they result in the highest number of workers' compensation claims filed by agricultural workers. To compound these safety problems, the agricultural workforce and the U.S. work force is aging. Ladder work cannot be safely and efficiently preformed by individuals who are not in good physical condition, who have had injuries limiting physical capacity or mobility, or are at an age where their physical capacity has decreased. In the case of these individuals, redesigning the worksite to reduce the physical demands would open up new avenues of employment.

The tree fruit industry also employs thousands of workers throughout the year in packing houses, warehouses, packing sheds and canneries. The U.S. Bureau of Labor Statistics lists more than 45,000 employed in the 45-2041, Graders and Sorters, Agricultural Products category (Bureau of Labor Statistics, 2004). However, many if not most fresh food packing and sorting workers are part-time and temporary, interspersing warehouse work with field work or other agricultural work throughout the year. Thus, the actual number of people working in fresh fruit or vegetable packing houses, processing warehouses, or canneries is much higher.

Some research has been reported on health and safety conditions in the packing houses. Fruit and vegetable packing was among the top 5 industries for gradual onset upper extremity disorders in Washington state workers compensation claims between 1989 and 1996. In the period from July 1994 to July 1995, three occupational groupings accounted for 57 percent of the unemployment insurance claims filed in Yakima County. They were agriculture (32 percent), processing jobs (12 percent), and packing and material handling (14 percent), all of which are based in the agricultural economy (Labor Market and Economic Analysis Branch, 1997).

ACTIVITIES

Packinghouse Hazard Assessment

Between 1997 and 1999, PNASH investigators conducted two studies in Washington packinghouses, a musculoskeletal hazard assessment and a study of the perceptions of workplace health and safety risks among the primarily female Hispanic workforce that conducts this work. Sixty-nine workers were interviewed using a combination of quantitative and qualitative research methods. The hazard assessment was led by the PNASH-affiliated University of Washington Field Research and Consultation Group.

Packinghouse Training Intervention

The "Hispanic Farm Workers One-Act Plays" was a multiphase project conducted by PNASH satellite Center for Farm Safety and Health. In Phase I, four one-act Spanish plays presented health information and farm safety training to agricultural workers. The plays are delivered live by a troupe of community-based actors and evaluated for effectiveness in imparting knowledge and also developed into videos for sustained use. Play #4 "Dora Evelia" provides training on bending, lifting, and ladder safety. In Phase II, an educational intervention program was developed for migrant and seasonal packinghouse workers in eastern Washington. This training program was largely based on the ergonomic play, "Dora Evelia." This project is still active, with data analysis and dissemination of the study results due in fall 2006.

The Virtual Corset: An Objective Tool for Measuring Postural and Vibration Exposures

This pilot project led by PNASH investigator Dr. Peter Johnson developed a new device, which allows ergonomic researchers to continuously collect simultaneous data on back, side, and limb dynamics of agricultural workers over the course of their day or multiple days. This "Virtual Corset" was developed in conjunction with Microstrain, Inc., and will further our understanding of the relationship between cumulative exposure to vibration, posture, and musculoskeletal disorders.

The Virtual Corset activities included the development of a pager-sized logger with 2mb of built-in memory called the Virtual Corset which non-invasively, and continuously collects data on postural exposures in two dimensions. The pager sized Virtual Corset can be mounted on the upper arms, sternum, or upper back and continuously records a worker's postural exposures, in two dimensions, relative to gravity. With programmable sampling rates, the Virtual Corset can collect continuous data over a whole work shift or over multiple days (up to 80 hours). This measuring capability has not been practical previously due to memory and battery power limitations. We have also explored the utility of using a different continuous, inexpensive, non-invasive exposure assessment device called a Ballistic Actigraph to characterize repetitive exposures to the hand.

Ergonomic Evaluation of New Tree Fruit Harvesting Technologies

Most recently we have successfully pilot tested the proposed suite of direct measurement tools to measure and characterize postural exposure for assessing musculoskeletal risks to workers using

new tree fruit harvesting mobile platforms. Data is obtainable from the low back (Virtual Corsets), postural exposure data from the upper arms (Virtual Corsets), hand activity exposures (Actigraphs), and metabolic loading (Heart Rate Monitors) during orchard work. Using a repeated measures design, we collected and analyzed exposure data from four workers while they performed 30 minutes of pruning work on a mobile platform, as well as during 30 minutes of pruning on ladders.

In order to measure back flexion/extension and lateral bending, one Virtual Corset was attached to the upper torso of each worker in the thoracic region of the spine between the shoulder blades using an adjustable, cross-shaped Velcro strap. To measure upper arm abduction/adduction and flexion/extension, two Virtual Corsets were attached to the lateral aspects of the upper arm mid-way between the shoulder and elbow using Velcro straps. To measure hand activity, two Ballistic Actigraphs were attached to each wrist, in the same manner as wrist watches.

SIGNIFICANT FINDINGS

Packinghouse Hazard Assessment

Between 1997 and 1999, PNASH investigators conducted two studies in Washington packinghouses, a musculoskeletal hazard assessment and a study of the perceptions of workplace health and safety risks among the primarily female Hispanic workforce that conducts this work. Sixty-nine workers were interviewed using a combination of quantitative and qualitative research methods. The hazard assessment was led by the PNASH affiliated University of Washington Field Research and Consultation Group.

Most of the problems of apple warehouse work relate to the physical labor involved in sorting and packing fresh apples. Repetitive motions, heavy lifting and awkward positions are examples of the problems identified by the Field Group**.** The Field Group survey of musculoskeletal injuries among male and female workers in three Yakima area warehouses found a prevalence of 70% for any problem that occurred in the current job (Simcox et. al. 2001). The Field Group defined a work-related musculoskeletal injury as one that occurred at least once a week, or lasted one week or more, was not an accident, occurred on the current job, and had affected the worker within the previous year. Based on these criteria, 52% of the Field Group sample had experienced an injury. Sixty-two percent of all women surveyed in the Field Group study met these criteria, including 55% of all Hispanic women. In the study of risk perceptions, 54 percent of the participants reported a workplace injury or illness (37 out of 69). Some participants viewed accidents as an inevitable hazard of apple warehouse work. And in fact, 45 pound boxes do fall, packing carts tip over, and fingers get caught in machinery. More insidious are the acute injuries that result when well-meaning workers try to prevent boxes of apples from falling and wrench their backs by reaching or grabbing heavy objects with sudden movements. In these cases, workers feel particularly wronged when the employers try to downplay the injury or refuse to pay for treatment. These workers feel that their injury was caused when they were specifically doing something to help the employer, and the consequences should be compensated. Some worker comments included,

"For me, it is a very fast and hard job. I am not used to it. I don't know how dangerous it is, but when you see people getting hurt, you just wish it does not happen to you."

"But still, people are very pressured, and have a lot of work. They get way too many injuries because of what happens. They try to do 10 days of work in one week. They force the people to do a lot of work. It is difficult."

"I don't think there is much they can do [to prevent risks] because the risks are there. All they can do about it is let you know, and talk to you about it. And let you know where are the most risks. Other than that, preventing someone from getting hurt, no, anyone can get hurt."

Development and Evaluation of Training Interventions
The "Hispanic Farm Workers One-Act Plays" Phase I project developed four one-act Spanish plays, including Play #4 "Dora Evelia" for training on bending, lifting and ladder safety.

With funding from NIOSH and a Washington State Department of Labor and Industries Safe@Work grant, performances were presented across a three-county region of Eastern Washington. To date, more than 700 individuals have viewed the safety play performances in a variety of community settings with positive results. A video of the live play has been disseminated to regional producer associations and educators.

In Phase II, an educational intervention program was developed for migrant and seasonal packinghouse workers in eastern Washington. This training program was largely based on the ergonomic play, "Dora Evelia." Three large fruit packing houses participated in training sessions for a total of 275 participants. Of these, 220 participants completed the follow-up observation post-test sessions and received the certificate of completion. This project is still active, with data analysis and dissemination of the study results due in fall 2006.

The Virtual Corset: An Objective Tool for Measuring Postural and Vibration Exposures **(Figure 2)**
We have been involved in a collaborative study with the University of British Columbia where over 200 full-day low back postural exposure measurements have been collected in five heavy industries. In addition, we have successfully developed and implemented a software platform to evaluate the full-day low back postural and movement velocity exposures.

We have also explored the utility of using a different continuous, inexpensive, non-invasive exposure assessment device called a Ballistic Actigraph to characterize repetitive exposures to the hand. Orchard work is hand intensive, and we would like a way to characterize and measure difference in hand exposures across different mobile platform designs and measure differences across the various proposed work methods.

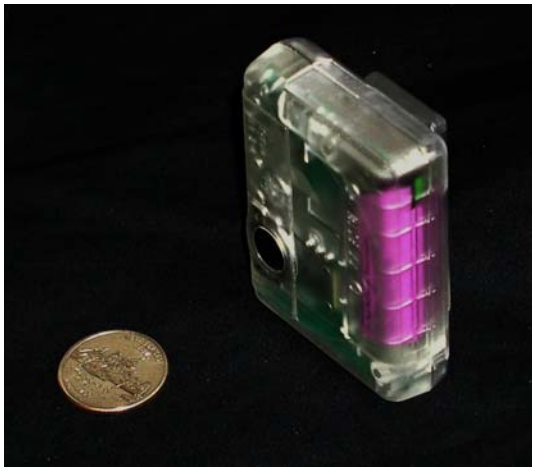

Figure 2 –The Virtual Corset (left) and Ballistic Actigraph (right).

Ergonomic Evaluation of New Tree Fruit Harvesting Technologies
The recent 2005 pilot of an assessment of tree fruit harvester musculoskeletal risks has demonstrated the field utility of the Virtual Corset and Actigraph and promise for a future comprehensive field study.

PRODUCTS/OUTPUTS

Further products are reported in the companion database.

Publications

Simcox N, Flanagan ME, Camp J, Spielholz P, Snyder K [2001]. Musculoskeletal risks in Washington state apple packing companies. Field Research & Consultation Group, UW Department of Environmental Health, Seattle, WA.

Karen Snyder, Doctor of Philosophy [2001] UW Department of Anthropology. Doctoral Dissertation: Perception of risk among female workers in the fruit packing industry: a biocultural approach.

Johnson P, Townsend C and Arms S. [2002] The testing and validation of a fast response inclinometer. Proceedings of the IVth World Congress of Biomechanics, Calgary, Canada, WCB: Abstract Number 1107.

Johnson P. The Virtual Corset – a new logger for the ambulatory assessment of physical exposures. Ag Connections, Vol 1 No 4, Autumn 2003.

Snyder, K [2004]. Risk perception and resource security for female agricultural workers, In: Michael Alvard (ed). *Socioeconomic Aspects of Human Behavioral Ecology,* Research in Economic Anthropology, Volume 23: 271-292, 2004.

Questionnaires and Surveys

Perception of Risk among Female Workers in the Fruit Packing Industry Survey (English/Spanish): Personal and detailed interviews to test whether reproductive status, household resources, personal and general working conditions, and socioeconomic and cultural context predict differences in perceptions of health and safety risks and a greater tolerance for workplace hazards.

Yakima Farmworker Community Surveys [2004 and 2005].

Sampling and Analytical Methods

The Virtual Corset – miniature, two-axis posture measurement system with 2 Mb of memory.

Tools for Education and Prevention

Musculoskeletal Risks in Washington State Apple Packing Companies: An ergonomic evaluation of job tasks in Washington apple warehouses that led to the development of a publication that includes ergonomic risk factor reduction recommendations.

Spanish Language Safety Play and Curriculum: VHS and DVD format Reducing Musculoskeletal Injuries (with English subtitles) also streamed on the Farm Center Web page.

OUTCOMES

Influencing Work Practices in Packinghouses

To date, more than 700 individuals have viewed the Hispanic live play "Dora Evelia," which teaches safe bending, lifting and ladder safety through performances in a variety of community settings with positive results. The human resources manager of a large employer commented that "*we are finding that the use of theater is a very effective way of impressing the safety message on our workers*." The video of the play has been purchased for use by 20 producer associations and educators. One producer is using the play scripts as a training tool. The recent training program largely based on the ergonomic play, "Dora Evelia" has been delivered to three large fruit packinghouses for a total of 255 participants. Of these, 220 participants completed the follow-up observation post-test sessions and received a certificate of completion. Observed behavior change data are currently under analysis.

Researchers using Virtual Corset to Measure Ergonomic Exposures

PNASH investigator Dr. Peter Johnson has developed and introduced a new tool to assess postural and vibrational exposures to agricultural workers. This tool is currently being used in Washington state in a pilot investigation of the ergonomic risks posed to workers using a new platform harvesting technology.

This tool has been disseminated to researchers to use in field investigations. While PNASH proceeds to use this tool to study risks to agricultural populations, we are also offering the tool and methods to other researchers to adopt. We have been involved in a collaborative study with the University of British Columbia where more than 200 full-day low back postural exposure measurements have been collected in five heavy industries. The Virtual Corset is an important research tool that has been a highlighted in the NIOSH e-news and the UW Department of Environmental and Occupational Health Sciences 2003-2005 Biennial Report.

Serving the Health and Safety Needs of a Modernizing Industry

The critical component in the Technology Roadmap is to semi-automate labor intensive aspects of fruit orchard work, including harvesting, pruning and fruit thinning, in order to increase productivity, with the ultimate goal to fully automate harvesting and other labor demanding activities in 10-15 years. The aim is to produce improved quality fruit at lower production costs. These industry changes will result in fewer, but more highly trained, workers employed in technologically advanced orchard management systems. As part of the transition to automated orchard activities, a near-term and central goal of the Technology Roadmap is to transition from performing orchard work on ladders to performing orchard work on mobile, raised platforms. Given the aggressive goals of the Technology Roadmap, mobile platforms are moving from an experimental tool to an actual product that will be used in year-round orchard activities. The pilot

and proposed work of the PNASH Center to assess and control the musculoskeletal hazards will impact the developing technology that will be promoted by the tree fruit industry.

Karen Lewis, WSU Extension, in the Good Fruit December 2005 issue was reported as saying *"it's a benefit to the tree fruit industry to have the University of Washington researchers bring their ergonomics skills to help address the problem."*

NOISE AND VIBRATION EXPOSURE

INTRODUCTION

Vibration and noise represent a major occupational hazard to agricultural workers. Data collected from a small PNASH project in forestry has demonstrated that workers employed in these common Northwest occupations experience substantial over-exposure to vibration and noise.

GOALS

The goals of the PNASH Center's program area in noise and vibration were to conduct a task-based assessment of the relevant hazards that would allow:

- Identification of specific activities that contribute to hazardous exposures.
- A focus on the combined aspects of such exposures that contribute to higher risk.

BACKGROUND AND SIGNIFICANCE

Work in the forestry industry traditionally has involved exposure to a wide variety of safety and health hazards. The multibillion-dollar forestry industry, which includes the most dangerous occupation in the United States, logging, employed approximately 122,000 workers nationwide in 1996. The fatality rate for loggers at the time of this work was 128 deaths per 100,000 workers, compared to the overall U.S. rate for all occupations of 5/100,000. Washington and Oregon, in the U.S. Pacific Northwest together represented 16.7% of total U.S. logging employment, and accounted for 73 logging deaths annually, or 9.5% of the annual U.S. logging fatalities.

As a result of these alarming fatality statistics, most health and safety efforts in the Northwest have focused on the prevention of traumatic injuries. However, forestry workers are at risk for a variety of other occupational diseases. In particular, exposure to occupational hand-arm vibration (HAV) has been associated with a variety of adverse health effects, collectively known as hand-arm vibration syndrome (HAVS), since the early 1900s. Additionally, long-term whole-body vibration (WBV) exposure to seated persons has been associated with an increased risk of degenerative lumbar spine injuries, central nervous system disturbances, and possible damage to the digestive and genital/urinary systems.

Occupational noise exposure is common in both forestry work and in many other agricultural occupations. The Washington State Department of Labor and Industries has seen compensation claims for noise-induced hearing loss increase ten-fold in recent years. Occupational noise exposure is recognized as a causal factor for permanent, irreversible hearing loss.

ACTIVITIES

Noise and Vibration Exposure in Forestry Workers

This project conducted in 1998 to 2002 used a novel task assessment instrument developed for forestry workers. Task-based assessment offers an important departure from traditional exposure assessments in forestry that focus on job titles or single tools. Information on tools as exposure sources is embedded within task assessments, along with other factors such as posture, force repetition, and temperature. The assessment methods used NIOSH and OSHA exposure metrics.

A total of 58 workers operating 17 types of equipment were assessed for noise and vibration exposure, health status, and work history in Northwest logging sites: 32 in Washington, 10 in Alaska, and 16 in Idaho. Thirty office worker control subjects were recruited from the UW School of Public Health and Community Medicine, and 3 forestry technician control subjects were recruited from the Washington Department of Natural Resources. Three-hundred seventy four vibration measurements (115 WBV and 259 HAV) and 57 full-shift noise exposure measurements were collected, as well as 89 health effects questionnaires and 65 work history questionnaires.

SIGNIFICANT FINDINGS

Noise and Vibration Exposure in Forestry Workers

The results gained through the use of the task-based assessment suggested that exposure reduction strategies should move beyond the traditional HAV and noise control targets. In addition to chainsaws, heavy equipment controls such as joysticks, operating levers, and other handle-type controls, were found to produce HAV levels well above the ACGIH TLV. The highest HAV exposure sources also are associated with significant noise sources: chainsaws, falling operations, and yarding and landing operations in particular. A similar picture emerges from task assessment of whole body vibration (WBV) exposures. The greatest WBV sources were log processing, road construction, front-end loaders, and excavators. The task and tool associated with the highest noise exposure levels were unbelting chokers on landings and chainsaws, while the task and tool associated with the highest vibration exposure levels were log processing and front-end loaders (WBV), and notching stumps and chainsaws (HAV). Thus, using task-based assessment, specific exposure sources are not treated in isolation but contribute to a constellation of factors in a high-risk task.

PRODUCTS/OUTPUTS

Publications

Robert Leo, Master of Science [2001] UW Department of Environmental Health. Systematic Observation of Noise Exposure and Hearing Protector Use in Worksites in Two Noisy Industries.

Neitzel R, Yost M [2002]. Task-based assessment of occupational vibration and noise exposures in forestry workers. AIHA Journal *63*:617-627.

Websites/Listserves

Occupational Noise and Vibration Exposures in Forestry Workers. Developed and maintained by investigator, Rick Neitzel, this site provides an overview of the Center's research in noise and vibration in forestry and offers educational materials in links and downloadable documents. http://staff.washington.edu/rneitzel/forestry.htm

OUTCOMES

Noise and Vibration Exposure in Forestry Workers

This study has impacted the Northwest logging industry in many ways. In 2003, at the state agency level, Jim Sedore of the Washington Department of Natural Resources said he was

"using the results of the report on noise and vibration to assess whether timber cruisers and other woodland DNR employees need to be included in a hearing conservation program, and whether any administrative controls need to be put into place for their employees that operate chainsaws."

From an industry standpoint; Alaska Pacific Logging in Craig, AK stated in 2003 that they were going to start making hearing protection available to their workers based on the results of our noise monitoring, as well as replace a broken window in one of their log yarders to reduce the noise levels in the cab. Allen Cutting Company in Shelton, WA was contacted in May 2003 were they then reported that they were going to start encouraging use of anti-vibration gloves among the fellers they employ.

SPECIAL POPULATIONS – THE HIRED FARMWORKER AND THEIR FAMILY

INTRODUCTION

The PNASH Center's emphasis is primarily on populations not well represented in current research, such as hired laborers, migrant/seasonal workers, and their families. This focus is seen across the great majority of our projects and program areas. In this section, we shall share our major efforts and outcomes that are not already addressed through the program areas of pesticide interventions, pesticide exposure methods, traumatic injuries, and musculoskeletal risks.

Our work with and for the Northwest farmworker community is possible through our partnerships with the Washington State Department of Agriculture; Washington State University; Northwest Regional Primary Care Association; and a number of community organization, farmworker health clinics, and producers. Furthering our reach to the farmworker is our Center's field office in the Yakima Valley and the recent development of a community health worker (CHW) network.

GOALS

The goal of the PNASH Center's emphasis on hired farmworkers and their families is to address health disparities of this vulnerable population. The subgoals are to develop:

- Health care capacity to serve farmworkers and their families
- Farmworker community capacity to identify and address health disparities
- Communication tools for low literate Hispanic farmworkers

BACKGROUND AND SIGNIFICANCE

Agricultural workers, and orchard workers in particular, are exposed to a variety of hazards that contribute to injury, disability, and death. Their work life and work activities vary by season and by the specific needs of the growers. Although picking fruit is often viewed as the primary role of the orchard workers, they are involved in a multitude of other tasks over the farming seasons. All of these activities are accompanied by hazards that may result in injuries and illnesses. Examples of commonly reported events are back injuries, eye injuries, sprains and strains, amputations, fractures, cuts, lacerations, burns and electrocutions, and poisonings (from chemicals and pesticides). Traumatic occurrences were related to improper operation of machinery as well as to livestock, ladders, and electricity. In addition to multiple physical hazards, orchard workers are often exposed to working conditions that increase their susceptibility to injury. For example, they may be required to work long hours under severe time constraints and their work may be hampered by weather conditions.

Agricultural communities are a great place to raise kids. However, the farm is a complex workplace that contains a broad spectrum of hazards, and that the boundary between workplace and home is often hard to draw. In the past decade, new insights into more subtle mechanisms of toxicity, and concerns regarding the special vulnerability of children to environmental pollutants have led to a new focus on children's environmental health. An important wake-up call was a 1996 Executive Order directing all federal agencies to develop an explicit strategy for including children's health in their evaluations. Passage of the Food Quality Protection Act of 1996 pointed the spotlight directly at pesticide health risks and children. This law, approved by a unanimous vote of Congress, requires the Environmental Protection Agency to review the toxicity of every pesticide, and to determine both the acute and chronic health risks these chemicals pose to children. This increased scrutiny has led to new questions about children and

pesticides. Thus, the hired farmworker may inadvertently bring pesticides home to his or her family through the take-home pathway.

ACTIVITIES

Health Care Providers

The rural primary health care provider is an excellent channel for PNASH's work to reach agricultural communities. Yet, there are significant barriers to working with this target audience. The nature of clinician's work is highly scheduled with little free time, and the work sites are remote, scattered, and most often without the technical infrastructure to use distance learning technologies.

In the last program cycle PNASH began in-person interviews at Northwest clinics. Interviews took place with leadership and staff, from which PNASH learned strategies for health care provider outreach and research needs. Following up on this information, a new project was developed - a farmworker mental health diagnostic tool in an audiotape format to address language and literacy barriers. For professional education, PNASH trained clinicians on pesticide health effects and how to serve as medical monitors under the new Washington state cholinesterase monitoring rule. Training took place through the PNASH and WSU sponsored Pesticide Issues Conference, PNASH Pesticide Medicine course, clinic on-site training, the Western Migrant Stream conference, and distribution of a PNASH-produced manual.

More recently we helped establish a statewide Community Health Worker (CHW) network, which we have come to recognize as the best way to contact farmworkers outside of their workplace. In May 2006, PNASH co-hosted an intensive teacher training program in which 26 CHWs participated from Washington, Oregon, and Idaho. The curriculum covered pesticides, specifically organophosphates (OPs), routes of exposure, the behavioral aspects of children and adults that lead to children's encounters with OPs, the biologic factors that make children more susceptible to the adverse effects of pesticide exposure, and the short and long-term effects of exposure.

This last year we have also developed an informal network with physicians and midlevel practitioners who see farmworker clients. This was a by-product of key informant interviews conducted as part of a risk communication project on the neurodevelopmental effects of organophosphate exposure in children. During a heat wave last summer that resulted in the death of a farmworker, we were able to alert our healthcare providers and provide them with a literature summary of the most efficacious means to lower body core temperature in cases of heat shock. A new four-year cooperative agreement between PNASH and the EPA provides health care providers with training in their higher education curriculum. Together with UW medical school, two nurse practitioner schools, one physician assistant (PA) program, two schools of nursing, and a rural premedical program, we are integrating pesticide issues into their curricula. We have a close partnership with the Northwest Primary Care Health Association, with which we partner on activities such as the Western Migrant Stream Forum, CHW Network and continuing education for health care providers.

Farmworker Community

To develop a relationship with and serve the farmworker community, PNASH, under Dr. Matthew Keifer, developed and secured support for two large community-based participatory research projects. The following projects focus on the development of strategies to enable local Hispanic communities to better respond to the health risks faced by workers in regional fields and orchards.

El Proyecto Bienestar (Well Being Project)
At the heart of this project are the Yakima Valley agricultural workers and their families. A community advisory board that includes 13 different constituencies guides the project. Along with the University of Washington, three partners serve as catalysts, educators, and resources for the community: Northwest Communities Education Center/Radio KDNA, Heritage College, and Yakima Valley Farm Workers Clinic/Northwest Community Action Center. As a part of *El Proyecto Bienestar*, a community-based participatory research project (CBRP) in the Yakima Valley, two community surveys were done in 2004 and 2005 to understand the environmental and occupational health concerns of Yakima Valley farmworkers and their families. A total of 445 surveys were completed and their results are now informing 2006 research activities.

Idaho Partnership for Hispanic Health. This partnership, newly formed in collaboration with the Idaho Mountain States Group, will address health disparities among Idaho Hispanics. PNASH is advising on community-based participatory research methodologies and will provide research and health care expertise to help communities address safety and health interests.

In addition to our CBRP projects, our joint enterprise with farmworker clinics to form a regional CHW Network is expanding our understanding of and outreach to other farmworker communities throughout the Northwest.

Low Literate Communication Tools
In the course of conducting our work, novel communication tools have been developed to survey and reach out to the often low-literate Hispanic farmworker. These tools include:

Community Theater Troupe: Health and Farm Safety Training for Hispanic Agricultural Workers. Development of four one-act plays for farmworkers in the state of Washington.

Narrative Based Model for Presenting Safety Information
This project defined and contrasted two narrative genres that communicate safety information to agricultural workers. It documented the appeal of informal stories and formalized narratives based on the responses of farmers with varying agricultural experience and knowledge

Self-administered Audiotape
This study developed and tested a mental illness diagnostic tool for use among farmworkers with varying literacy skills. It found that a self-administered audiotape is effective. The diagnostic audiotape has been distributed to Western farmworker clinics and copies continue to be available on request.

Icon Based History Questionnaire
This early PNASH project validated an icon based occupational history questionnaire for use among Hispanic migrant and seasonal farmworkers. The questionnaire is specially designed to obtain lifetime work histories from illiterate or semiliterate subjects for use in long-term exposure studies. More recently, the icon format has been used in a computer-based exposure history questionnaire. Currently, the touch-screen exposure/medical history questionnaire is being used in clinics as an efficient tool for use with low-literacy Hispanic pesticide handlers being monitored under the new Washington state cholinesterase monitoring rule.

SIGNIFICANT FINDINGS

Health Care Providers
From PNASH's 2002 interviews with Northwest farmworker clinics we learned strategies for meeting the outreach and research needs of health care providers, which include farmworker

housing and health effects, skin diseases, depression, and *Promotora* program evaluation. The major health issues for the farmworker population were considered to be poor nutrition, diabetes, substance abuse, depression, asthma, and domestic violence. The most common occupational illnesses were described as musculoskeletal and allergic related.

Presently, in order to develop appropriate risk communication materials for health care providers who serve agricultural workers, we conducted an informational needs assessment. Key informant interviews were conducted in 2005 with 23 physicians (52% Family Practitioners and 39% Pediatricians), 14 mid-level practitioners (MLP) (9 Physicians Assistants and 5 Nurse Practitioners), and 12 Community Health Workers (CHW), 4 of which were program supervisors. The key preliminary findings were as follows:

- 51% of the providers had no previous training on pesticides, and the largest group without previous training were mid-levels (64%).
- Only 2 physicians reported that pesticides were covered in their medical or residency training.
- 61% do not feel comfortable handling patient's questions about pesticides.
- The majority of providers in all three disciplines had an interest in receiving more information on the effects of pesticide exposure in children (73%) and the neurodevelopmental problems of OP exposure (71%).
- More CHWs reported using pesticide information in their work (83%) compared to MLPs (64%) and physicians (35%).
- More MLPs are asked ("frequently" or "sometimes") pesticide related questions by their agriculture working patient population (43%) compared to MDs (17%) and CHWs (33%). But in contrast, physicians were mentioned most frequently as the provider who would most likely discuss pesticide issues with their patients.
- Physicians and mid-level's turn first to the Poison Control Centers for pesticide information. The next best source for physicians in order of preference was the Internet, then a colleague or expert in the community. An expert was chosen before the Internet by mid-levels as well as community health workers. All groups mentioned that they would use Internet sites and written summary materials.
- Conferences or workshops were mentioned as a preferred source of information by both Mid-level practitioners (conferences) and CHWs (popular education workshops).
- Oral presentations and radio were considered the best means to reach farmworkers with pesticide information according to community health workers with the best ties within the community.

These results will inform our development of appropriate training materials.

Farmworker Community

From *El Proyecto Bienestar* (Well Being Project), Dr. Mathew Keifer's community-based participatory research project in the Yakima Valley, PNASH learned about the major health concerns in this important agricultural community through key informant interviews, two years of community surveys, and a town hall meeting in April 2006. More than 100 community members attended the event were they learned about the previous study activities and were invited to speak about risks they did not feel were represented on the list from our previous data collection.

El Proyecto Bienestar Hispanic Agricultural Community Health Concerns

EXPOSURES

Pesticides and Chemicals
Water Contamination
Extreme Workplace Temperatures
Air Contamination

OUTCOMES
Work-related Illnesses and Conditions
Work-related Injuries
Cancer
Dehydration or Heat Illness

CONTEXTUAL FACTORS
Abusive Workplace Conditions
Low Wages or Job Instability
Lack of Documentation
Lack of Access to Medical Care
Problems with L&I Claims

Low Literate Communication Tools

Community Theater Troupe

The use of Spanish-language live theater has been proven an effective means to provide farmworkers with information on health hazards and illness prevention strategies. The difficulty we experienced with live theater is securing the fiscal and management support necessary to sustain the theater troupe.

Narrative Based Model for Presenting Safety Information

This project investigated the appeal of informal stories versus formalized narratives based on the responses of farmers with varying agricultural experience and knowledge. Results indicated the highly generative quality of informal stories; they usually stimulated further storytelling or higher level thinking about safety. When safety information was packaged in informal, unscripted narrative, receivers of the information added their own comments and evaluation to match or build upon the previous story. In contrast, pre-planned formal safety narratives may have given the impression of being official, complete, and beyond questioning. The informal stories, by their very nature, invited participation and engagement. Based on these findings, we suggest three hypotheses for future research:

- Informal stories are an effective tool in safety training.
- Stories need to have sensory impact.
- Stories must accommodate differences among learners, taking into account such factors as age, experience, type of farm, interests, and cognitive styles.

Self-administered Audiotape Questionnaire

As a component of the mental illness diagnostic tool study, a self-administered audiotape questionnaire was developed for use among farmworkers with varying literacy skills. It found that a self-administered audiotape is effective and PNASH investigators have used the tool in a number of subsequent studies with a high degree of success.

Icon Based History Questionnaire

This early PNASH project validated an icon based occupational history questionnaire for use in Hispanic migrant and seasonal farmworkers. The questionnaire is specially designed to obtain lifetime work histories from illiterate or semiliterate subjects for use in long-term exposure

studies. More recently, the icon format has been used in a computer-based exposure history questionnaire. Currently, the touch-screen exposure/medical history questionnaire is being used in clinics as an efficient tool for use with low-literacy Hispanic pesticide handlers being monitored under the new Washington state cholinesterase monitoring rule.

PRODUCTS/OUTPUTS

Further products are reported in the companion database.

Publications

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Fenske RA [2002]. Incorporating health and ecologic costs into agricultural production [editorial]. *Environ Health Perspect* 110(5):A228-229.

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Swenson E. Development of a community theater troupe: health and farm safety training for Hispanic agricultural workers. *Ag Connections*, Vol. 2 No. 2.

Weyrauch KF, Boiko PE, Keifer M. Building informed consent for ChE monitoring among pesticide handlers. In Washington State. *Am J Ind Med* 2005 Sep;48(3):175-81.

Questionnaires and Surveys

Icon Based Occupational History Questionnaire: A questionnaire designed to obtain lifetime work histories for illiterate or semiliterate subjects for use in long term exposure studies.

Asthma Questionnaire in Spanish: For the detection of asthma in community-based studies of Spanish-speaking Mexican populations.

Poison Oak Intervention Questionnaire (English/Spanish): A questionnaire to measure farmworkers' ability to recognize a poison oak plant.

Farmworker Mental Health Questionnaire: A mental illness diagnostic tool for use among farmworkers with varying literacy skills. This survey is reliable for diagnosis of depression and mental illness in farmworkers who cannot read well enough to answer the standard self-administered diagnostic tool.

Sampling and Analytical Methods

Diagnosis of Mental Illness among Farmworkers Audio Tool: Spanish language tape for use in the identification of depression and other mental health disorders, distributed free at conferences, meetings, and by request [2003].

Tools for Education and Prevention

Literacy and Safety: Safety Materials for Migrant Farmworkers: Guide for educators to develop materials for farmworkers that are efficacious/readable as well as culturally and socially sensitive.

Mental Illness Audio Survey (Spanish). Developed in consultation with psychiatric and literacy experts. The audio survey included questions about depression, substance abuse, panic and generalized anxiety, domestic violence, economic and family stressors, and firearm availability.

Play Videos and Play Script Production Packet.

Poison Oak Intervention Poster and Pamphlet: Developed in a joint effort between L&I and the PNASH Center, the poison oak intervention uses a combination of a warning poster targeting farmworkers (Spanish) and an information pamphlet directed towards the owners and managers.

In addition, the project utilizes a Spanish-language questionnaire to measure participants' ability to recognize a poison oak plant.

Courses and Workshops

Farm Summit [1998], March 5-6, 1998, Portland Oregon.

Cultivating Collaborations [2003]. September 16-18, 2002, Coeur d'Alene, Idaho.

Cultivating a Sustainable Agricultural Workplace Conference [2004], September 12-14, Troutdale, Oregon.

El Proyecto Bienestar (The Well-Being Project) Town Hall Meeting [2006], April 7, 2006, Sunnyside, Washington

Northwest *Promotora* Pesticide Training Workshop [May 2006], May1-2, 2006, Leavenworth, Washington.

Continuing Education Courses. PNASH annual continuing education courses are usually full-day courses and are accompanied by a course manual. Courses are designed to train health care and safety professionals and are conducted in collaboration with other academic partners.

Websites/Listservs

Pacific Northwest Agricultural Safety and Health Center, http://depts.washington.edu/envhlth/.

Environmental Justice, http://depts.washington.edu/envhlth/.

OUTCOMES

The intermediate impacts of PNASH's hired worker program area have included:

- The engagement of the Hispanic farmworker community through two community based participatory research projects: Washington and Idaho.
- The establishment of the Northwest Community Health Worker Network and Listserv.
- Training of clinicians in the diagnosis, treatment, and prevention of pesticide poisonings through training of community health workers and professional education such as short courses and the insertion of pesticide related content into higher education for premed, nursing, and mid-level practitioner students.

From the farmworker community at *El Proyecto Bienstar's* Town Hall in 2006 we heard the encouraging words from community members, "*That is good to have persons like you to help the farmworkers. I have worked in the fields and in the warehouses and it's an injustice the treatment they get.*" And direction to "have more meetings for the people, because we need lots of information about health and safety of the people."

From the community students who learned about occupational safety and health and conducted research on their own community we heard, "*the only way to find out what a problem may be in the community is to go out and find out people's opinions,"* and "*I also learned that environmental health can be practical and applicable to all groups of people, rather than ignorantly, idealistic, and filled with unattainable goals, as I thought before*." One of the same community member/students offered to PNASH researchers, "*Thank you for trying to help the community."*

While these are inspiring sentiments, evidence of actual use of information is the type of transfer outcome we're looking for. After PNASH's May 2006 Promotora Pesticide Training Workshop, follow-up comments from farmworker health clinic outreach directors included:

"What an excellent and worthwhile class! (name omitted) began using materials and knowledge from the class during a home visit to a family in White Swan on Wednesday… I have no doubt (names omitted) will use materials in the near future. Thank you for such a fine training. We'll be providing the message to our high risk (from pesticide exposure) asthma clients."

"It is amazing to know that there are people as you. The training had all components to achieve a behavior change. You let us develop our skills not only in the cognitive area, but also in the psychomotor, and particularly in the affective areas. Thanks so much for letting me participate. I enjoyed it. This morning I had the opportunity to talk on my radio program about pesticides. This show was terrific, I received several calls from people who work in Skagit Valley as farmers."

From El Proyecto Bienstar's project partners who are leaders and practitioners of farmworker community education and health care, we heard:

"Farmworkers are a vulnerable work force to health and safety hazards at the work site, be it the harvest fields or warehouses. They are also subjected to humiliations, wage abuses, and sexual harassment because of their educational and economical disadvantaged status. The Proyecto Bienestar research findings will be the leverage to initiate solutions to these health and safety issues."
- Ricardo R. Garcia, Executive Director, Northwest Community Education Center

"One of the early accomplishments of El Proyecto Bienestar was to establish a structure for communications and decision-making that is fully inclusive and participatory. Through this process, local Hispanic populations--frequently disenfranchised, though disproportionately exposed to occupational and environmental risks--are genuinely engaged and have a voice both in assessing the type and extent of risks and also in determining the steps to mitigate those risks."
- Eric Leber, Professor, Heritage University

"For Yakima Valley Farmworkers Clinic, El Proyecto Bienestar has been a powerful example of a genuine community-based participatory research partnership. It has enriched the community particularly through the training and education opportunities it has provided to local youth who are pursuing health professions education. In this way it has operationalized our belief that in addition to the immediate issue of interest, the university's presence in the community should provide long term benefit and enrichment."
-Vickie Ybarra, YVFWC, Director, Planning & Development

National Children's Center for Rural and Agricultural Health and Safety

Table of Contents

Background

The National Action Plan for Childhood Agricultural Injury Prevention, with 13 objectives and 43 action steps was developed through a consensus process by 42 individuals representing a wide spectrum of perspectives and experience in the public and private sector.[1] This plan was endorsed in principle by 80 national organizations. In September 1996 the U.S. Congress approved the plan and appropriated $5 million annually to NIOSH for its implementation.

The NIOSH-led Childhood Agricultural Injury Prevention Initiative includes intramural and extramural activities. A highly visible component of the initiative is the work of the National Children's Center for Rural and Agricultural Health and Safety in Marshfield, WI, established in 1997. Prior to its formal establishment as a NIOSH center, staff in Marshfield were conducting activities addressing childhood safety via individual and corporate donors as well as small amounts of public funding through the NIOSH Midwest Agricultural Research Center and the federal Maternal and Child Health Bureau.

Some of our accomplishments are noted through specific, measurable outcomes. Yet, our most notable achievements are probably related to our national leadership role in identifying priority issues, developing work teams with many collaborators, and moving issues to the national forefront. The updated national action plan from the 2001 Summit on Childhood Agricultural Injury Prevention[2] continues to guide research and interventions for the future. Our Center's theme is *Building Partnerships to Protect Children at Work and Children at Play on our Nation's Farms and Ranches."* Through public-private sector partners, we are conducting outreach, prevention interventions, education and training, and research projects that reflect the geographic, cultural and ethnic diversity of American agriculture. Special attention is being given to the growing Spanish-speaking migrant and immigrant population that is becoming a major component of the agricultural landscape. To further reach underserved populations, our mini-grant program has actively solicited proposals that address the unique agricultural health and safety issues among Anabaptist groups, American Indians, and African Americans.

Since the beginning of NIOSH's children's initiative in late 1996, progress has been made on many fronts. To confirm that progress, we now have NIOSH/USDA injury surveillance data to demonstrate a decline in childhood agricultural nonfatal injuries. Key findings from data collected by the National Agricultural Statistics Service and analyzed by John Myers and colleagues at NIOSH reveal that: a) the majority of all childhood agricultural injuries and fatalities affect children who live on a family farm; b) there is a continual decline in the number of children living on farms (15% decline from 1998-2001); c) the number of injuries from 1998-2001 dropped by 29% while the rate dropped only 3.1% (associated with a smaller denominator); and d) while most types of injuries have declined, data reveal an increase in ATV and horse-related injuries.[3]

Leadership

Our NIOSH-funded National Children's Center for Rural and Agricultural Health and Safety serves as a beacon to other professionals, highlighting major disease and injury prevention issues within the context of rural environments and production agriculture. We accomplished that task

by setting standards, providing guidance and technical assistance, disseminating resources to professionals who then work with the public, and continually encouraging child safety and farm safety advocates to address prevention issues for children at work and/or at play on farms and ranches. We have disseminated NIOSH injury surveillance results and suggested interventions targeted to prevent the most common sources of injury.

Our staff serves as advisors to several national groups and support efforts of the NIOSH Federal Advisory Task Force for Childhood Agricultural Injury Prevention. Non-government organizations (funded by agribusiness or via membership) that bring farm safety education directly to farm families and employers of young farmworkers view our Center as the leader in this field. Difficult, complex issues are brought to our attention to help their staff interact effectively, in terms of advice and example, within the farming community.

The National Children's Center has provided testimony and public statements in a number of venues since its establishment. In 1999, NIOSH convened a public forum in Washington, DC, for a mid-course review of its childhood initiative. The Center Director and several scientists evaluated progress to date and provided input to that review. In 2002-03 the Department of Labor requested comments on the proposed changes to the Fair Labor Standards Act (Child Labor in Agriculture) and Hazardous Occupations Order. We carefully reviewed the data and considered the reality of farm work in offering statements to support selected changes in federal regulations. The NIOSH NORA II initiative prompted our staff to assess gaps in research and programming and submit written statements and oral comments at Town Hall meetings. On several occasions, the extramural funding offered by USDA and MCHB has been shaped from input provided by our staff. Plenary presentations regarding U.S. efforts for protecting children on farms and ranches have been delivered at international conferences in Australia, Canada and Sweden. Our staff has been fully responsive to the leadership expectations of a national center.

Consensus-development techniques have been refined through several leadership roles of our staff. Modeled on the National Committee that developed the 1996 action plan, a new objective was to find common ground for addressing the unique needs of farmworker adolescents, largely Hispanics, hired for fruit and vegetable harvesting. Over a 16-month period we led teleconferences, email communications, draft documents and an in-person meeting involving 26 individuals including migrant farmworker advocates, such as Farmworker Justice Fund, and their natural adversaries, the employers' organizations, including American Farm Bureau Federation and the National Council of Agricultural Employers. Despite some initial conflicts, we led the group through a respectful process that yielded the 26 page report, *Migrant and Seasonal Hired Adolescent Farmworkers: A Plan to Improve Working Conditions.*[4]

Leadership opportunities for the National Children's Center are enhanced via our External Advisory Board. Ten individuals serve as advisors, representing agricultural employers, agribusiness, insurance industry, American Indian farmers, Migrant/Hispanic farmworkers, youth-serving organizations and researchers. Advisors participate in periodic teleconference calls, email communications and a biennial in-person meeting.

The leadership role of the National Children's Center is evidenced in activities that are highly visible. We hosted the invitational 1992 Childhood Agricultural Injury Prevention Symposium

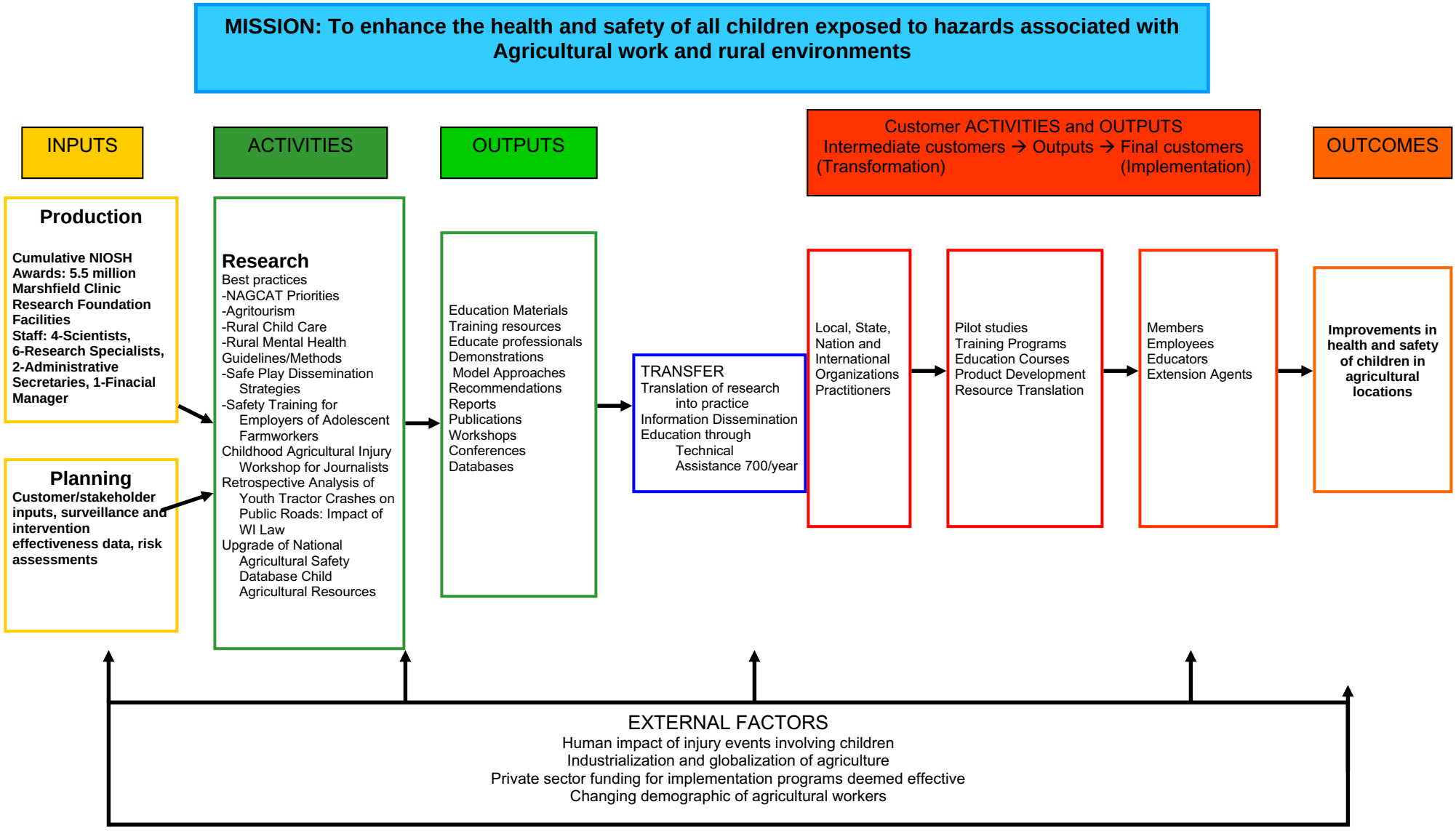
with Dr. Donald Millar, NIOSH Director, as a key participant. In 1995, we hosted the first major open event on this topic, the Child & Adolescent Rural Injury Control Conference in Madison, WI, with Dr. C. Everett Koop as the keynote speaker. The 2001 Summit on Childhood Agricultural Injury Prevention was planned and conducted in Minneapolis, MN, by our staff, with a subsequent report of consensus-derived recommendations. In June 2006, our staff hosted the National Institute for Farm Safety annual conference in Sheboygan, WI, with Dr. John Howard, NIOSH Director, as the keynote speaker. By September 2006 farm owners and parents across the U.S. will be blitzed with a public awareness campaign, led by the National Children's Center with support from 10 other national groups. Collectively our message is intended to shape social norms that emphasize the presence of children younger than 12 years on or near tractors is never acceptable. Leadership activities such as this are a positive reflection on NIOSH's commitment to safety and health for children who live, work, or visit on farms.

Communications

Our *NURTURE* newsletter is sent in print copy to about 2,000 recipients and posted on-line to facilitate information dissemination across the U.S. The purpose of *NURTURE* is to share information regarding major childhood agricultural health and safety programs occurring across North America. Additionally, *NURTURE* tries to highlight and promote collaborations between researchers and the farming community. Prior to each newsletter preparation, stories and announcements are solicited from all NIOSH Agricultural Centers, the CDC Injury Prevention Centers and non-government organizations addressing child safety, youth programming and farm safety. Feedback from readers indicates the newsletter is timely and informative. In addition to the quarterly four-page newsletter, an annual *Year in Review* (20 pages) summarizes the major projects, publications and presentations conducted by our core (NIOSH-funded) staff.

The National Children's Center hosts two websites that are continuously upgraded to provide relevant information. The general site gives an overview of many program initiatives and provides downloadable public education resources and professional reports. The NAGCAT site (www.nagcat.org) is the primary means for disseminating all resources related to youth working on farms. Over this first decade, the websites experienced continual growth in content and a steady increase in visitors from all over the world.

Logic Model


MISSION: To enhance the health and safety of all children exposed to hazards associated with Agricultural work and rural environments
INPUTS
ACTIVITIES
OUTPUTS
Customer ACTIVITIES and OUTPUTS
Intermediate customers → Outputs → Final customers
(Transformation) (Implementation)
OUTCOMES
Production
Cumulative NIOSH Awards: 5.5 million
Marshfield Clinic Research Foundation Facilities
Staff: 4-Scientists, 6-Research Specialists, 2-Administrative Secretaries, 1-Finacial Manager
Planning
Customer/stakeholder inputs, surveillance and intervention effectiveness data, risk assessments
Research
Best practices
-NAGCAT Priorities
-Agritourism
-Rural Child Care
-Rural Mental Health Guidelines/Methods
-Safe Play Dissemination Strategies
-Safety Training for Employers of Adolescent Farmworkers
Childhood Agricultural Injury Workshop for Journalists
Retrospective Analysis of Youth Tractor Crashes on Public Roads: Impact of WI Law
Upgrade of National Agricultural Safety Database Child Agricultural Resources
Education Materials
Training resources
Educate professionals
Demonstrations
Model Approaches
Recommendations
Reports
Publications
Workshops
Conferences
Databases
TRANSFER
Translation of research into practice
Information Dissemination
Education through Technical Assistance 700/year
Local, State, Nation and International Organizations Practitioners
Pilot studies
Training Programs
Education Courses
Product Development
Resource Translation
Members
Employees
Educators
Extension Agents
Improvements in health and safety of children in agricultural locations
EXTERNAL FACTORS
Human impact of injury events involving children
Industrialization and globalization of agriculture
Private sector funding for implementation programs deemed effective
Changing demographic of agricultural workers

Major Accomplishments

Work Guidelines for Children

Released in 1999 by our Center, the North American Guidelines for Children's Agricultural Tasks (NAGCAT) have become a key resource for safety professionals and farm parents.[5] The core content for 62 specific agricultural tasks was systematically developed based on the job hazard analysis framework and then visually depicted in posters so parents could match a child's developmental capabilities with appropriate work assignments, training, and supervision. The dedicated website (www.nagcat.org) is periodically upgraded and experiences a steady flow of visits. A five-year assessment of the impact of NAGCAT was conducted in March 2005.[6] It revealed many professional publications citing the relevance of NAGCAT and numerous references in the lay press. Most importantly, a study published in the American Journal of Public Health by A. Gadomski of the NIOSH Northeast Center reported the efficacy of NAGCAT in reducing injuries by about 50%.[7] Areas that warrant further work include research to enhance our understanding of parents' barriers to using NAGCAT, and simplifying resources into a core set that are easily disseminated. The concept of NAGCAT has now been adopted in Australia and Sweden. The World Health Organization has expressed interest in using the process and template of NAGCAT for developing countries. Resources have been translated into five languages.

NAGCAT's most important impact is that it has changed how youth are assigned work tasks in agriculture. The emphasis is no longer on "age" of child but on "child development principles." This paradigm shift has affected approaches and training programs used by farm safety as well as rural recreational safety professionals. More recently, some safety professionals have suggested the same concepts be used to guide the work of aging, senior farmers. Another major lesson learned with NAGCAT was that by engaging more than 100 people in their initial development the "ownership" of NAGCAT was diffused. Unlike other child safety resources affiliated with one author or one institution, NAGCAT has achieved the status of being universally owned.

Network of Child Farm Safety Advocates

The Childhood Agricultural Safety Network of national organizations has been growing into an increasingly stronger group of trusted colleagues. Started as a loose knit group of colleagues, the Network has evolved into a group of knowledgeable and committed colleagues. The Network's purpose is to "set a vision and facilitate coordination of childhood agricultural injury prevention efforts across North America." Our NIOSH funds are used to support individual training in principles of safety and health, ongoing communications within the Network and periodic in-person meetings. Active organizations in the Childhood Agricultural Safety Network (CASN) include Farm Safety 4 Just Kids (Earlham, IA), Progressive Agriculture Foundation (Birmingham, AL), Migrant Clinicians Network (Austin, TX), National Center for Farmworker Health (Buda, TX), AgriSafe Network (Iowa), National Safe Kids Campaign (Washington DC), National Safety Council (Itasca, IL) with the National Education Center for Agricultural Safety (Peosta, IA), the National FFA (Indianapolis), National 4-H Council (Chevy Chase, MD), American Farm Bureau (via North Dakota Farm Bureau) and Safe Kids Canada (Toronto). As facilitators of this Network we note that several of these organizations vigorously compete

against each other for corporate sponsorship and media attention. Now, largely through our efforts, organization leaders and representatives sit around the same table discussing priority issues, long-term strategies, and areas where cooperation supersedes competition.

Guidelines for Safe Play Areas on Farms

Injury and fatality data reveal that more than half the children injured or killed on farms are not working at the time of the incident. Previously, most attention regarding farm safety for children focused on working conditions. In response to new insights based on the etiology of childhood farm injuries, our Center published *Creating Safe Play Areas on Farms* in 2003 to serve as a guidance document for safety professionals and community leaders.[8] Since that time, there has been a significant increase in attention to this topic of safe, structured, supervised play areas for children on farms. Safety Day Camps for youth often have an adjunct program for parents to promote fenced, supervised play areas and organizations such as Farm Safety 4 Just Kids, Cooperative Extension, and the National Education Center for Ag Safety (NECAS) have demonstrated how to construct play areas at farm community events. The farm press has picked up on this topic in trade journals and newspapers, and several national farm organizations have featured this topic at annual conventions. We continue to build on this theme through social marketing techniques and new research and intervention projects here at our Center and in collaboration with other NIOSH Agricultural Centers.

Promoting Accurate and Influential Media Stories

In 2004, the National Children's Center hosted its first two-day Journalists Workshop in Marshfield, WI. Using an immersion technique, nine journalists experienced an inside view of childhood agricultural injuries and fatalities and learned principles of farm injury prevention for children. By meeting with both professionals and active farm parents, they came to appreciate the value of story-telling to ultimately influence social norms. The second workshop, convened in 2005 in upstate New York, used participant feedback from 2004 to tighten the objectives and agenda. Our Journalists Workshop initiative has had a positive influence on the number and quality of writing outputs of participants, which subsequently impacts the perspectives of their story readers. The workshop has yielded more than 100 published popular press articles that reflect principles learned through this training. Now into our third year, we continue to refine and improve this novel intervention because it has already prompted positive changes in media reports of child agricultural injuries. Two other projects, funded by NIOSH, have emanated from our Journalists Workshop. The University of Kentucky, with its agricultural journalism academic program, has adopted concepts of this initiative for students in the schools of journalism and nursing.

Youth, Tractors and Policy

Policy-relevant research and interventions are an important focus for our Center. We believe a center should conduct work that will guide decisions of people in a position to change organizational policy (e.g., 4-H tractor training, insurance incentives) as well as local, state and federal regulations affecting youth work in agriculture. Research regarding youth operating farm tractors on public roads recently found that a state law intended to prevent farm tractor

injuries/fatalities among youth had minimal effect.[9] A related project searched and identified the variations in 50 state laws for youth tractor operations.[10] Projects such as these can be instrumental in identifying model legislation with the highest likelihood of achieving the desired outcomes – injury reduction.

Small Grants to Facilitate Novel Projects and Partnerships

We are especially proud of our Center's mini-grant program that provides seed money for projects that otherwise could not compete for federal research grant funds. We have refined a process for soliciting, reviewing, selecting and then guiding projects conducted by individuals across the U.S. Our forms and protocol have been shared and adopted by two other NIOSH Ag Centers. The goal of our mini-grant program is to support feasibility and pilot projects in the outreach, prevention/intervention, education, and research areas within NIOSH's Childhood Agricultural Injury Prevention Initiative.[11] Funds are designated for short-term projects with a maximum duration of 12 months and maximum funding of $15,000. Organizations and individuals throughout the United States are eligible to apply for funds. Funds are allocated to support projects that: 1) test innovative strategies in the prevention of childhood agricultural illness and injury; 2) strengthen partnerships between safety professionals, agricultural organizations, and the media; and 3) translate research findings into practical applications.

To date, we have funded 20 separate external projects and reported their findings in the *NURTURE* newsletter. Several of the projects stimulated further programs and research endeavors. For example, the North Dakota Farm Bureau project that tested incentives to motivate farm owners to build fenced-in play areas led to the June 2006 announcement by Manitoba Labour that $500 grants are now available to Manitoba farmers for purchasing supplies for play areas. Another positive impact of the mini-grant initiative has been the development of partnerships between migrant advocates and traditional farm safety groups. A joint mini-grant between Migrant Clinicians Network (MCN) and Farm Safety 4 Just Kids (FS4JK) resulted in the development of a Spanish *Aunque Cerca Sano* comic-style book regarding pesticide safety and children. It was prepared by MCN, printed and stocked by FS4JK, then widely disseminated by both organizations. To date, there have been four printings, more than 200,000 copies distributed and the demand for an English version has just been addressed. In another joint mini-grant, the farm safety day camp programs led by Progressive Agriculture Foundation were modified with help from MCN to address Spanish-speaking, migrant children. With the new curriculum, Progressive Agriculture staff has now convened six camps in four states with special tracks for migrant children.

Yet another example of a positive impact of our mini-grants occurred with the FY '04 funding of three separate projects addressing safe play areas on farms. Rather than approve the proposals as submitted, we worked with the principal investigators to modify the objectives of the three projects so they would be complementary and comparative. Teleconference calls connected the project staff mid-way through the year to assess problems and status. Results and overall "lessons learned" were then shared in a session at the 2005 National Institute for Farm Safety annual conference. The outcome from this was a collective view of what works and doesn't work in promoting the concept of safe play areas on farms within the farming community.

The mini-grant program offers a special opportunity to address minority and underserved populations. To date we have funded four mini-grants for Spanish-speaking populations, three for Amish farm families, one for Hmong farm families, and one related to American Indians. Unfortunately, no quality proposals were received addressing children of African American farmers/farmworkers.

Professional Training

Since 1997, the National Children's Center has conducted professional education and training via several mechanisms. A three-day Rural Youth Safety Training program was held in 1998, 1999, and 2000. With declining registration for the three-day event, we changed our approaches. Webinar or Elluminate lectures have been provided to graduate students and colleagues at six different universities. A half-day pre-conference on Childhood Agricultural Injury Prevention was held prior to the 2005 National Institute for Farm Safety conference and sessions have been led at National Injury Conferences hosted by the CDC in Atlanta and Denver. In addition to formal training, staff members are repeatedly contacted for advice, technical assistance, and formal consultation on new initiatives that are under consideration. While our Center is not directly affiliated with any university, we have adjunct faculty appointments at several academic institutions and have undergraduate and graduate students conducting projects with guidance from our staff.

Evaluation

During the Center's first five-year cooperative agreement, we contracted with an external evaluator to assess the formative stages of the Center. With an annual allocation of $10,000 - $25,000 dedicated to comprehensive and systematic evaluation, we were able to identify strengths and weakness of our infrastructure, communications, staffing patterns, and outreach activities. Additionally, evaluation feedback aided our consensus-development methods that were critical to projects such as NAGCAT, the 2001 Summit results, and the Safe Play Areas on Farms initiative. For the past four years, we have modified our evaluation methods. The internal tracking of progress on eight different projects is streamlined via a Benchmark Metrics system that is updated monthly prior to the Center's staff meeting. This electronic system has forced project staff to be accountable for achieving objectives on time and it maintains documented evidence of major developments and roadblocks.

Emerging Problems

Several developments are affecting our approaches to childhood agricultural injury prevention. These include changes in the demographic profiles of people at risk, changing technologies, globalization of agriculture, and shrinking corporate funds for implementing programs that have been shown to be effective.

The number of children at risk for agricultural injuries and fatalities is steadily declining as the number of traditional family farms decline. NIOSH childhood agricultural injury surveillance efforts have been especially helpful in highlighting current conditions and changing patterns of injuries.[12] Despite the drop in overall injuries, the fact remains that children are being injured

and killed in a dangerous, occupational setting. No other industry has the magnitude of this problem, and virtually all of the injuries and deaths are preventable. Child farm safety advocates continue to be challenged by social norms and traditional practices that imply that certain unsafe parenting practices (e.g., allowing young children as riders on tractors) are acceptable.

NIOSH data have been helpful in showing the relationship of household/residency status to the risk of injury. We know that the vast majority of injury/fatality victims live on family farms. Anecdotally, it is suspected that most farms where hazards exist and unsafe practices prevail have economical hardships and/or are using farm practices handed down over time. It is especially difficult to influence positive behavior changes on farms that cannot afford safety upgrades or where culture and tradition limits our access to providing safety information, e.g., within the growing Anabaptist population.

NIOSH funding for childhood agricultural injury prevention has been handled differently than that for other agricultural research programs. With a targeted appropriation from Congress, NIOSH is charged with implementing a specific action plan.[1] Proposed actions within the plan do not fit the traditional NIH research model. The initial 1996 RFA for the Children's Center required applicants to propose projects based directly on the action plan. Subsequent RFA's required an increasing proportion of the Center's budget be dedicated to research. NIOSH will need to determine how to address the contrast between the two approaches – implementing the action plan vs. conducting NIH-style research.

Another emerging issue associated with funding involves the private sector. In the early phase of the children's initiative, agribusinesses were willing to fund programs and resources of many different organizations, providing they saw a marketing opportunity for themselves. Currently, two major programs (Farm Safety 4 Just Kids and Progressive Agriculture Foundation) have full time fundraisers. For our Center's initiatives that require funding, e.g., calendars, we are unable to secure funds from the same corporate sponsors of these programs because they now limit donations to these two high profile programs. At the same time, Cooperative Extension outreach across the country has diminished with loss of USDA support of farm safety programs. These factors of limited corporate funding and reduced outreach by Extension create a challenge in reaching the farming community directly. They also emphasize the importance of our Childhood Agricultural Safety Network for working in collaboration to facilitate access to corporate funds, ensuring that effective programs are getting directly into the farming community.

Summary

The above examples demonstrate how the National Children's Center influences the perspectives and actions of agricultural safety professionals and agribusiness leaders. Our projects have addressed the primary issues associated with children at work and at play on farms and ranches. The farming community has welcomed the educational resources and safety principles emanating from the Center's work. Qualitative feedback from stakeholders indicates that outputs from this Center are viewed as relevant, practical, culturally appropriate, and timely.

Our Center is geographically located in the "heart of America's dairy land" and we have ready access to farm owners, farm parents and agricultural industry representatives. These elements of

staff commitment, expertise and local as well as national collaborations have contributed to the overall success of our Center.

The full impact of the National Children's Center work and its leadership role is difficult to quantitatively measure, and the final outcomes are yet to be realized. Yet, it is possible that this Center, with a sole focus on children and working closely with colleagues across the country, has influenced the measurable decline in childhood agricultural injuries as reported by NIOSH.[3]

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The North American Guidelines for Children's Agricultural Task

Background and Resources

The 1989 landmark article "We Kill Too Many Farm Kids"; published in Successful Farming magazine raised public awareness regarding the dangerous, hazard-plagued environment in which children often work and play.[1] Until that time, childhood agricultural injuries were generally accepted as a condition of family farm life, knowing that agriculture in itself is a very hazardous occupation. Shortly thereafter, USA Today[2] and The Boston Globe[3] described devastating injuries experienced by children working on family farms; then the Fresno Bee published a 3-part series on "Children: The Forgotten Farmworkers" which depicted disturbing living and working conditions of migrant farmworker families.[4] These publications, along with other developments, led agricultural safety specialists, farm journalists, and others to raise questions regarding the role of children in agricultural work.

According to the National Safety Council and CFOI the U.S. fatality rate for all occupations is consistently far less than that for agricultural workers. Only construction, mining and transportation have rates comparable to agriculture. By the early 1990s there was increased attention to the toll of pediatric farm-related fatalities. A study by Rivara initially suggested the more than 300 children die on farms annually.[5] This was subsequently reported to be 104 children (19 years and younger) who die each year as a result of agricultural injuries.[6] This same study revealed a rate of 8.0 deaths per 100,000 child farm residents and an average of 22,288 emergency department treated injuries per year. The Rivara reports did not differentiate children as workers versus bystanders at the time of injury. A study funded by the National Institute for Occupational Safety and Health (NIOSH) reviewed the number and rate of agricultural-related injuries among workers treated in hospital emergency departments. Results indicated an estimated 10,700 events among children (19 years and younger) from October 1995 to September 1997; this equated to a rate of 2.7 injuries per 100 full time equivalent young workers.[7] Overall, the mixture of reporting systems and databases made it difficult to report accurate statistics of all work-related childhood agricultural injuries in the U.S. However, efforts led by NIOSH to remedy this situation have more recently provided a clearer picture of work versus non-work related injuries to children who live on farms and to visitors and workers (NIOSH website).

In 1992, the 120 participants of a Childhood Agricultural Injury Symposium were convened to address issues and interventions from multiple perspectives.[8] Discussions acknowledged the lack of general standards or guidelines indicating appropriate work for children in agriculture. For a number of reasons, the child labor in agriculture laws[9] are viewed as too general and somewhat irrelevant for helping adults assign agricultural jobs to children. The absence of scientifically sound principles or occupational safety standards for children's agricultural work served as the genesis of this initiative.

Starting in 1993, a small group of individuals began discussing various approaches, options, challenges, and barriers to developing guidelines for children's work in agriculture. Preliminary discussions among nurses, farm safety specialists, and farm journalists occurred at meetings of the National Institute for Farm Safety. During this same period, farm parents were queried regarding factors influencing their decisions to involve children in agricultural work.[10] These activities led to a pilot test to determine the feasibility of such an effort.

The *1996 National Action Plan* developed and disseminated by the National Committee for Childhood Agricultural Injury Prevention included 13 objectives for protecting children from agriculture-related disease and injury.[11] This plan was acknowledged by the U.S. Congress, which appropriated funds to the NIOSH for its implementation. Objective number three of the plan states: *"Establish guidelines for children's and adolescents' work in the industry of agriculture."* The action steps to achieve this were to: a) Develop, test, and modify developmentally appropriate guidelines for children's participation in agricultural work, based on research results as well as psychological and physical development theory and principles. This effort should be conducted through a consensus-building process involving federal agencies and private sector representatives; and b) Develop and evaluate age-appropriate guidelines for work practice standards of adolescents formally employed in agricultural work. This effort should be conducted through a consensus-building process and should serve to guide relevant public policy.

The action plan went on to state that *"Many committee members and farm organization representatives stated that the establishment of work guidelines is the foundation upon which to build all other strategies. These guidelines should include work time restrictions and emphasize that children's work should not interfere with their ability to attend school and concentrate on studies. The consensus-building process for developmentally- and age-appropriate guidelines for children's agricultural tasks will involve efforts of farm parents, along with specialists in agricultural safety, child development, pediatrics, human factors, ergonomics, industrial hygiene, injury control, migrant issues, and agricultural journalism".*

Goals and Objectives

Initially, the goal of this program was to respond to the directive in the National Action Plan - to develop guidelines that will assist parents and other adults in assigning appropriate and safe farm jobs for children 16 years and younger. However, in the 10 years since then, numerous research studies, intervention programs and outreach endeavors have occurred. Only a sampling of that information is provided here.

Major Projects

The major initiatives associated with NAGCAT are categorized as 1) development of original NAGCAT core content; 2) public resource development; 3) dissemination; 4) research to evaluate dissemination methods; 5) evaluation of NAGCAT using a case-series review; 6) methods to set national priorities; and 7) technical assistance for ongoing, global use of NAGCAT.

Original Core Content

Commencing in late 1996, with funding primarily from NIOSH, a core group of individuals from Marshfield, WI, initiated the planning, implementation, and evaluation of the project now known as "North American Guidelines for Children's Agricultural Tasks (NAGCAT)." The intent of the NAGCAT project was to generate developmentally-appropriate agricultural work guidelines, based upon physical, cognitive, and psychosocial child development principles. The consensus-development methodology for NAGCAT included several key steps. First, the center undertook a pilot test to assess the feasibility of developing agricultural work guidelines. The 14 member team convened to debate the merits of various approaches to developing guidelines, with critical issues being raised such as economic and environmental forces affecting farm practices, migrant housing conditions, and wide variations in agricultural practices. As a result of this meeting, the decision was made to pursue a full-scale endeavor to develop a series of North American Guidelines for Children's Agricultural Tasks.

The coordination of this project emanated from Marshfield, WI, with the Principal Investigator, Barbara Lee, PhD, and Project Manager, Barbara Marlenga, PhD. An extensive review of more than 200 research papers, book chapters, government reports, and other resources in the literature revealed that there were no existing studies, reports, or labor standards that would fulfill the needs expressed for agricultural work guidelines for children. There was minimal empirical evidence upon which to build guidelines, thus, a consensus-development methodology was applied.

Base funding of $60,000 was received from NIOSH through the Midwest Center for Agricultural Research, Education, and Disease and Injury Prevention (PIs-Paul Gunderson, PhD and Dean Stueland, MD). The 1996 pilot study was funded with $10,000 through the CDC-funded Injury Prevention Research Center at the University of Iowa (PI- Craig Zwerling, MPH, MD). By 1997 funding was also allocated within the National Children's Center for Rural and Agricultural Health and Safety, at that time supported partially by the federal Maternal and Child Health Bureau and primarily by NIOSH. Canadian support funds were secured through the Canadian Coalition for Agricultural Safety and Rural Health.

Establishment of the primary project team involved securing six individuals from the U.S, three from Canada, and three from Mexico who made a commitment to participate in the project for at least two years. Selection of team members was based upon participation in the pilot study, experience in agricultural safety, and geographic diversity. For the most part, project team members remained actively engaged in the process; interacting on major issues, and participating on teleconference calls and in-person meetings. The Mexican participants' roles were difficult to maintain for a number of reasons. From March 1997 through June 1999 a series of eight in-person and 10 teleconference meetings were convened. In addition, project team members interacted through numerous electronic mail and facsimile communications. Informal meetings also occurred in conjunction with other events during which several project team members were together. In an effort to facilitate teamwork and mutual respect, a guiding framework for completing tasks within a consensus model was developed and agreed upon by project team members (refer to pg 4 of the NAGCAT Professional Resource Manual-available at www.nagcat.org).

An initial step for developing guidelines required identification of those jobs across North America in which children were most likely to participate. The project advisors submitted lists of jobs most frequently performed by children in their geographic regions. The Farm Safety 4 Just Kids organization from Earlham, IA, solicited similar input from their chapter leaders. Initially, the plan was to generate guidelines for 25 general and up to 50 specific jobs. The first list of jobs to be considered was reviewed for redundancy, different types of jobs that involved similar tasks, and potential gaps. As the project evolved, the list of jobs was refined and, by January 1999, included 62 different jobs, of which ten (e.g., bending, climbing, hitching implements) might be described as "general" in nature. In order to package related illustrated guideline posters together, these 62 different jobs were then categorized by topic -- animal care, tractor fundamentals, haying operations, implement operations, manual labor, specialty production, and general activities.

The project team spent considerable time determining a systematic format for collecting and documenting relevant variables associated with the spectrum of agricultural jobs. Over time, several options were considered and consensus led to a decision to use a modification of the job hazard analysis framework as used in industrial occupational safety. For each task within a specific job, the variables of interest would be: a) hazards; b) injury/disease concerns; c) recommended procedures; d) age; e) level of adult supervision; and f) training required. These elements were depicted within a matrix chart, requiring that individual "cells" be filled in with specific content. In March 1998, as a result of intense discussions with child development specialists, the project team decided to shift away from "age" issues by adding content reflecting characteristics of child development. Thus, the job hazard analysis framework was augmented with a "checklist" to allow adults to assess physical, cognitive, and psychosocial readiness of a child in relation to the other variables in the job hazard analysis framework. The concept of assigning work based on developmental stage rather than age was a major turning point in the project that led a paradigm shift that has had a major impact on nearly all childhood agricultural injury prevention initiatives.

Because of the diversity of the jobs to be analyzed and the intense requirements for gathering relevant information, contractual arrangements for drafting guidelines were made with individuals having appropriate expertise. Upon receiving the first draft of a job, the content was checked and cross-checked by different project team members. Once most cells within the matrix chart of each job hazard analysis framework were filled, the draft was sent out for peer reviewers. Over an eight-month period, 102 peer reviewers critiqued the details within the matrix chart (i.e., job hazard analysis framework) of one or more agricultural jobs. In addition to the peer reviews, approximately 30 active farm owners/growers and teen workers reviewed the drafted materials. The net effect of having so many people involved in the development of guideline content had another major impact. As one insurance company representative stated, “These guidelines belong to all of us across the U.S. because we were all part of their development.”

Resource Development

By late 1998, it became apparent that the volumes of information being generated by the project team could be used as the basis for a number of different educational and training resources but were not practical for use by farm owners and parents. To address that issue, a contract was developed with Thiel Visual Design, Inc. of Milwaukee to develop a basic NAGCAT symbol that would identify resources based on project results and 11 x 17 illustrated posters for farm owners/parents. Drafts of resources were assessed through feedback sessions with farm mothers. Given that NIOSH funds were earmarked for generating the core content of guidelines it was necessary to solicit private sector funds for design and printing. In January 1999, we began formal solicitation and raised more than $100,000 from corporate sponsors noted in the guideline booklets.

Dissemination

By mid-1998, a decision was made to disseminate NAGCAT results in four forms: 1) final report to the funding agencies; 2) a Professional Resource Manual designed for agricultural safety specialists; 3) illustrated posters for parents; and 4) selected elements of project results on the Internet.

The official release of NAGCAT occurred June 1999 at the National Institute for Farm Safety annual meeting with Orion Samuelson, radio hall of fame broadcaster and the National FFA's youth vice-president. It was a well publicized forum with Associated Press carrying news releases published across the country. Simultaneously, there was a special edition of *Successful Farming* magazine that carried a 12-page insert describing the background and key components of NAGCAT with three of the actual guidelines. TEXACO Corporation funded the development of this farmer-ready report along with 200,000 reprints that continue to be distributed today. Gempler's, Inc., a farm and horticulture safety supplier of Belleville, WI, agreed to serve as the publisher and fulfillment agency for the public and professional resources. This arrangement lasted for three years until the demand for purchased/print materials subsided.

A dedicated Internet site (www.nagcat.org) was established in 1999 to respond to general inquiries regarding the project. The site began full dissemination of project results allowing individuals to cross-check different agricultural jobs with parent checklists. The site is ideal for parents who want information limited to a specific type of agricultural work. It is also valuable for searching selected elements of the job hazard analysis framework. The site is upgraded periodically and allows for viewer feedback regarding project results.

A scan of farm magazines and agricultural trade journals will reveal that NAGCAT is the most widely referenced childhood farm safety resource in the U.S. Many featured stories use content and illustrations from specific work tasks. The most widely cited NAGCAT tasks relate to tractor operations, handling large animals and ATV use for farm work. The illustrations from NAGCAT posters are often lifted with permission from the website and used for stories or resources by the media and safety professionals.

Coordinated dissemination of NAGCAT information and resources continues through various venues. Several organizations have used our template for producing NAGCAT calendars (available on the website). Each month provides a different NAGCAT job. Regional calendars

are customized to include those jobs most commonly performed by the recipients of the calendar. With NIOSH funding, the National Children's Center has made calendars available to groups that cannot afford a major printing of their own, e.g., community-based programs. In 2005, the provincial government of Quebec translated the NAGCAT posters into French then developed and disseminated a NAGCAT calendar to thousands of French-speaking farmers.

Evaluation of Dissemination Methods

It was important to determine the most effective method for getting NAGCAT information to the primary stakeholders – farm parents. In 2000 Barbara Marlenga, PhD, was awarded a NIOSH RO1 to study NAGCAT dissemination. The study compared the efficacy of the standard, mailed dissemination strategy with an enhanced, multi-phased approach to influence parents' use of NAGCAT when assigning work to their children. Significant findings were that: a) an enhanced approach was effective in increasing farm parents' use of NAGCAT and their knowledge about its content; b) NAGCAT booklets most influenced parents' decisions; c) almost two-thirds of farm children studied were involved in animal care by a preschool age; and d) high parental knowledge of child development was associated with enhanced use of NAGCAT and fewer violations when assigning tractor tasks.[12]

The immediate outcome of this study had important implications for disseminating NAGCAT resources to farm parents. In fact, the simple mailed strategy as used in this study has a sufficient effect in prompting farm parents to use NAGCAT. This option was subsequently adopted in Canada where there were mass mailings of a tabloid/newspaper version of NAGCAT imbedded within provincial farm newspapers. To date, Canadian farmers have received substantially more NAGCAT information than the U.S. because of this simple adoption.
An emerging issue identified by this study was that even in the presence of high knowledge of child development, many children are still assigned to developmentally inappropriate work by parents. These results suggest that the voluntary approach to safety standards is insufficient to remove farm children from known hazards.[13]

Evaluation of NAGCAT Applicability

Starting in 2001, a study was undertaken by Dr. Marlenga and W. Pickett, PhD, to assess whether NAGCAT content was an adequate match with the actual childhood agricultural injury cases being reported in the U.S. and Canada. During the study 283 (30.3%) of the 934 pediatric farm injury cases involved children actually involved in farm work activities. The NAGCAT guidelines were applicable in 65% of these cases. In the judgment of the research team, about 60% of the 283 work-related cases were totally preventable had NAGCAT been available and applied.[14]

Results of this study highlighted the fact that more than half of children injured on farms are not working at the time. Shortly after this study was completed, NIOSH reported the results of their telephone-based survey to confirm this finding. This information was important in shifting the focus toward interventions to protect non-working children, especially preschoolers. Results of this study were used to set priorities for the NAGCAT project for the next five years and to enhance efforts to have farmers create safe play areas on their farms and ranches.

Setting Future Priorities

In 2004 we celebrated the "Five-year anniversary" of NAGCAT which by than had became a standard resource in North America and elsewhere. To be viable for the future, we realized NAGCAT should be dynamic, adapting to the knowledge gained from research as well as to demands for resources and the changing practices in agriculture. As a "best practices" component of the National Children's Center, our staff set out to assess the current scientific and programmatic evidence regarding the efficiency and utility of NAGCAT. Using that information, future priorities would be set.

A systematic, evidence-based method was employed to accomplish project objectives. Data sources included results from a survey of agricultural safety practitioners and researchers, a comprehensive assessment of the peer-reviewed literature, and recommendations from a priority-setting meeting. Five main priorities were identified: 1) address the perceptions and barriers associated with the use and non-use of NAGCAT resources; 2) revise and re-format a core set of guidelines; 3) develop a NAGCAT resource dissemination and marketing plan; 4) provide training and support for agricultural safety professionals and parents using NAGCAT; and 5) conduct further research to facilitate accomplishing these priorities.[15]

This process was deemed useful in setting a course for the future based on evidence in the literature and information provided by survey participants. At issue is the fact that we know NAGCAT use spans is broader than the coverage of our information collection methods; thus, insights regarding future directions may have been limited.

Products and Technology Transfer-Outputs

During its initial dissemination phase, numerous presentations regarding NAGCAT were given to professional audiences. Some of these presentations and published abstracts are:

- Steve Schaefer, Do the Guidelines First - NAGCAT, National Safety Council – Youth Safety Congress, New Orleans, LA, October 16, 1999
- Nancy Brehm, North American Guidelines for Children's Agricultural Tasks, California Child Injury Prevention Conference, San Diego, CA, October 25, 1998
- Barbara Lee, North American Guidelines for Children's Agricultural Tasks, American Agri-Women Convention, Green Bay, WI, November 3, 1999
- Nancy Brehm, Progressive Farmer Safety Day Camp Training Program, Minneapolis, MN, November 1-2, 1999
- Nancy Brehm, Mary Friesen, Barb Lee, North American Guidelines for Children's Agricultural Tasks, National Association of Farm Broadcasters, Kansas City, MO, November 10, 1999
- Mary Friesen & Steve Schaefer, North American Guidelines for Children's Agricultural Tasks, National Agri-Marketing Association Conference, Kansas City, MO, April 11-14, 2000
- Barbara Marlenga & Barbara Lee, Guidelines for Children's Agricultural Tasks, NIOSH Ag Centers Meeting, Cooperstown, NY, April 26-30, 2000

- Nancy Brehm, Using the North American Guidelines for Children's Agricultural Tasks, Ag Safety, Health, & Disability Conference, LaCrosse, WI, May 25, Beth Busscher, Nancy Esser, Barbara Lee, North American Guidelines for Children's Agricultural Tasks, National Institute for Farm Safety Annual Meeting, Dubuque, IA, June 24-29, 2000
- Nancy Brehm, Reaching Rural Audiences, National SAFE KIDS Leadership Conference, Washington, DC, January 15, 2000
- Nancy Brehm, North American Guidelines for Children's Agricultural Tasks, WI Farm Bureau Women's Workshop, Madison, WI, March 13, 2000
- Nancy Brehm, North American Guidelines for Children's Agricultural Tasks, National SAFE KIDS Leadership Conference, Washington, DC, January 15, 2000
- Nancy Brehm, Beth Busscher, North American Guidelines for Children's Agricultural Tasks, National World Congress of Young Farmers, Orlando, FL, February 20-24, 2000
- Barbara Lee, North American Guidelines for Children's Agricultural Tasks, Nordic Conference, Malmo Sweden, September 25, 2000.
- Nancy Brehm Esser, North American Guidelines for Children's Agricultural Tasks, Farm Family Safety Day, Manchester, IA, September 23, 2000.
- Nancy Esser, North American Guidelines for Children's Agricultural Tasks, Texas Ag Teachers Convention, Lubbock, TX, July 31-Aug. 4, 2000.
- Barbara Lee, RN, PhD; Barbara Marlenga, RN, PhD, Guidelines for Children's Agricultural Tasks: Effective Methods for Reaching Farmers and Ranchers, American Public Health Association, Chicago, IL, November 1999.
- Barbara Lee, Barbara Marlenga, Nancy Brehm, Steve Schaefer, Guidelines for Children's Agricultural Tasks: Proactive Strategies for Influencing Farm Families, NIOSH Ag Centers Meeting, Cooperstown, NY, April 27, 2000.
- Barbara Lee, Barbara Marlenga, Sharon Dorfman, Guidelines for Children's Agricultural Tasks: Lessons Learned for the Consensus Development Process, NIFS Meeting, Dubuque, IA, June 24, 2000.
- Barbara Lee, Development of Specific Guidelines for Adolescents' Work in Agriculture, NIOSH Occupational Research Symposium, Pittsburgh, PA, October 2000.

Since these early efforts to promote awareness of NAGCAT among the professional and farming community, more than 50 abstracts, posters and oral presentations have been published or delivered at major conferences such as the World Injury Conference, National Injury Conference, American Public Health Association conference, NIOSH conferences and other major venues. Numerous citations and referrals to NAGCAT are in the lay literature. These include general recommendations to use NAGCAT and specific recommendations applicable to one of the 62 different tasks.

Within the professional literature, NAGCAT is widely reported. Twelve different research studies included NAGCAT as a primary or secondary reference.[15] NIOSH has funded six extramural projects to assess aspects of NAGCAT. Results are streaming in from these studies and many are now being published with peer reviewed study results. These includes work of Barbara Marlenga, PhD, of the National Children's Center, Jay Wilkinson, PhD, of the Ohio NIOSH Great Lakes Agricultural Research Center, Anne Gadomski, MD, of the New York NIOSH Northeast Agricultural Research Center, Fadi Fatallah, PhD, of the UC-Davis NIOSH Western Agricultural Research Center, and Charles Schwab, PhD, of Iowa State University.

Impact on Worker Safety and Health – Intermediate Outcomes

A study published in the American Journal of Public Health by A. Gadomski of the NIOSH Northeast Center reported the efficacy of NAGCAT in reducing injuries by about 50%.[16] Areas that warrant further work include research to enhance our understanding of parents' barriers to using NAGCAT, and simplifying resources into a core set that are easily disseminated.

The concept of NAGCAT has now been adopted in Australia and Sweden. The World Health Organization has expressed interest in using the process and template of NAGCAT for developing countries. Resources have now been translated into five languages.

NAGCAT's most important impact may be that it has changed how youth are assigned work tasks in agriculture. The emphasis is no longer on "age" of child but on "child development principles." This paradigm shift has affected approaches and training programs used by farm safety as well as rural recreational safety professionals. More recently, some safety professionals have suggested the same concepts be used to guide work of aging, senior farmers.

Interaction between Center and Stakeholders

As described in the development of the core NAGCAT content, there has been extensive interaction between Center staff, external professional colleagues, agricultural organizations, non-government organizations and representatives of the farming community. NAGCAT advisors were initially concerned about negative reactions from the farming community, but these did not materialize.

One potentially contentious interaction occurred prior to the release of NAGCAT. The American Farm Bureau Federation Director of Regulatory Affairs, Bryan Little, was contacted with information regarding the purpose and pending release of NAGCAT. There were many questions raised regarding the potential for guidelines leading to regulations. Mr. Little was not convinced of the purpose of the project and insisted that Dr. Lee address the state-level Farm Bureau Policy Directors at a national meeting. This occurred at a Farm Bureau meeting in April 1999. The impassioned interaction resulted in a concession that the Farm Bureau would not speak publicly against NAGCAT unless there was clear evidence that the guidelines were leading to regulations. This was a major relief for the project team, given the known resistance and strong lobbying power of the Farm Bureau.

Identification of Emerging Problems

Several emerging issues have come forth since the release of NAGCAT in 1999. Previously mentioned are the issues of barriers to using NAGCAT by farm parents and the cost of resources for public distribution.

Another interesting issue is the core question, "What is NAGCAT?" Is it the pure, original resources or the core knowledge generated and printed in the professional resource manual? Advisors have suggested that the term, NAGCAT, be reserved for original resources and other

materials merely reference it. Yet, we have witnessed a number of new educational resources that are modified from NAGCAT and still use that term. For us, the problem will be monitoring new NAGCAT-like materials and ensuring that, to some extent, the core principles of child development and parental responsibilities are included.

Summary

Released in 1999 by our Center, the North American Guidelines for Children's Agricultural Tasks (NAGCAT) have become a key resource for safety professionals and farm parents. The core content for 62 specific agricultural tasks was systematically developed based on the job hazard analysis framework then visually depicted into posters so parents could match a child's developmental capabilities with appropriate work assignments, training, and supervision. The dedicated website (www.nagcat.org) is periodically upgraded and experiences a steady flow of website visits. A five-year assessment of the impact of NAGCAT was conducted in March 2005. Results revealed multiple professional publications citing the relevance of NAGCAT and numerous references in the lay press. To date, it is safe to say the NAGCAT is now the most highly recognized and endorsed childhood agricultural injury prevention resource available for professionals (including the American Academy of Pediatrics) and parents.

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Childhood Agricultural Safety Network

Background and Resources

When the National Children's Center was initially established in 1997 there was limited information regarding child-specific efforts in farm safety. At the same time, there was a relatively small number of individuals addressing this population. It was clear that improved communications between involved (or at least interested) organizations and individuals would be helpful. During the first NIOSH five-year cooperative agreement for the National Children's Center, formal collaborations were established with eight national-level organizations. This mechanism involved providing $5,000 to each organization annually if they deemed it critical to their involvement. Funds were used to ensure that each organization would dedicate one staff person to stay abreast of childhood agricultural health and safety issues, and to maintain communications with our Center. Periodic teleconference calls were convened and the system was weak but functional. An evaluation of the system revealed general support and a growing interest in strengthening mutually beneficial cross-organization relationships. The National Children's Center's External Advisors strongly encouraged the expansion of the system, which has evolved to be the Childhood Agricultural Safety Network, known as CASN. With the second NIOSH five-year award we built upon our early experiences and expanded our vision. We now have an annual budget of up to $30,000 (directs) to conduct CASN cooperative projects, networking, and evaluation.

Goals and Objectives

The overall goal of this project is to strengthen partnerships and collaborative initiatives involving the agricultural community, child injury prevention organizations, and minority-serving associations through an effective Childhood Agricultural Safety Network (CASN) that will improve and expand childhood agricultural injury prevention efforts. This project is derived from the updated national action plan developed at the 2001 Summit on Childhood Agricultural Injury Prevention. The mission of the CASN is to "*set a vision and provide leadership and coordination of childhood agricultural injury prevention efforts in a manner that is both geographically and ethnically diverse*."[1]

The primary aims are:
1. CASN members will effectively address childhood agricultural injury prevention.
2. CASN will build stronger partnerships by improving the quality of communications and collaborative efforts among member organizations.
3. The CASN composition will expand and gradually transition into the private sector to be independent of NIOSH funding.

The CASN is a major component of our Center because of its ability to link together the key national organizations committed to children, agriculture, and special population health and safety. The initial years of CASN have provided valuable insights and inspired genuine commitment among participants and their respective organizations, enabling full implementation of proposed activities.

In addition to our Center's staff, CASN includes representatives from the following organizations:

- National Center for Farmworkers Health, Buda, TX.
- Migrant Clinicians Network, Austin, TX.
- Progressive Agriculture Foundation, Birmingham, AL.
- Farm Safety 4 Just Kids, Earlham, IA.
- National Safety Council, Itasca, IL
- AgriSafe Network, Spencer, IA
- North Dakota Farm Bureau, Fargo, ND
- National Education Center for Agricultural Safety, Peosta, IA.
- National FFA, Indianapolis, IN.
- National 4-H Foundation, Chevy Chase, MD.
- Department of Labor and Industries, Olympia, WA
- SAFE KIDS International, Washington, DC.
- SAFE KIDS Canada, Toronto, ON

Major Projects

To achieve the goals of the Network, we rely primarily on communications via the internet and teleconference calls. Quarterly phone conversations are typically attended by eight to 12 people. Topics covered include updates of organizational activities, details of funding opportunities, discussion of complex issues and how others have handled them, and sharing of new knowledge.

Each year, Network members meet twice in-person, typically at the June National Institute for Farm Safety meeting and later at the October National FFA Convention. At the National FFA event (attended by more than 20,000 youth and advisors) the CASN members host a "safety island" in the exhibition hall for three days. They pool their exhibit spaces and each organization can distribute their own resources, conduct informal surveys and interact with convention attendees. This is an excellent opportunity to reach youth that are involved in rural and agricultural issues while bonding with colleagues who share a common purpose. Other in-person meetings are convened at the request of members. For example, in 2000 the CASN piggybacked its meeting to the National Farmworker Health Conference in Sacramento, CA. This ensured the migrant-related organizations could participate while offering important insights for the non-migrant groups. The two-day meeting allowed for site visits to migrant working camps and a migrant health clinic.

The CASN has facilitated the development of formal partnerships between migrant advocates and traditional farm safety groups. A joint project (funded via a Children's Center mini-grant) between Migrant Clinicians Network (MCN) and Farm Safety 4 Just Kids (FS4JK) resulted in the development of a Spanish *Aunque Cerca Sano* comic-style book regarding pesticide safety and children. It was prepared by MCN, printed and stocked by FS4JK, then widely disseminated by many Network organizations. To date, there have been four printings, more that 200,000 copies distributed. In another project between two CASN organizations, the farm safety day camp programs led by Progressive Agriculture Foundation were modified with help from MCN to address Spanish-speaking, migrant children. With the new curriculum, Progressive Agriculture staff has now convened six camps in four states with special tracks for migrant

children. These collaborations would not have occurred had the CASN not interacted regularly; and these special programs for migrant youth would never have materialized.

Another notable outcome from the CASN occurred in 2004 when three different organizations requested mini-grant funds to address safe play areas on farms (the priority topic for grants that year). Rather than approve the proposals as submitted, we facilitated interactions between the organizations, all of whom were CASN members. Staff from the three different projects were familiar with each other and, thus, willing to modify objectives of their respective projects to be complementary. Teleconference calls connected the project staff mid-way through the year to assess problems and status. Results and overall "lessons learned" were then shared in a session at the 2005 National Institute for Farm Safety annual conference. The outcome from this was a collective view of what works and doesn't work in promoting the concept of safe play areas on farms within the farming community.

By way of email communications, Network members maintain contact with each other to keep other members aware of relevant research results, project activities, safety issues and pertinent news happenings. Each CASN organization's website is linked to the other CASN organization websites. Friendships have been developed; and Network members report satisfaction with the modest level of activities with an interest in continued growth of the Network.

In January 2006 a strategy session was held by Marilyn Adams, President of Farm Safety 4 Just Kids, Susan Reynolds, Executive Director of Progressive Agriculture Foundation and Barbara Lee, Director of the National Children's Center. Collectively, these three organizations are the most visible and best funded groups in the U.S. addressing farm safety for children. A commitment was made to follow through with a recommendation from the 2001 Summit on Childhood Agricultural Injury Prevention – "The CASN should develop a comprehensive, long-term, year-round public education campaign with messages about childhood agricultural injury prevention to be disseminated through a variety of media."[1-pg 28] This commitment has now given birth to the Childhood Agricultural Safety Public Awareness Campaign.

The goal of the Childhood Agricultural Safety Public Awareness Campaign, developed and disseminated by CASN members, is to increase awareness among the general and farm/ranch public regarding three major issues over a three-year period. That is, each year all CASN organizations will promote a single, simple safety message. Topics are based on NIOSH injury data and evidence-based prevention methods. Commencing in September 2006 during National Farm Safety and Health Week, the topics will be:
1) youth and tractors don't mix; 2) ATVs and youth operators; and 3) removal of preschoolers from work areas. An advertising agency is on contract to work with CASN members to create one or two images/messages that can be used in newsletters, on websites, trade journal ads, etc. If corporate sponsors are secured, television advertisements may be included.

Products and Technology Transfer-Output

The primary output of the Childhood Agricultural Safety Network is effective communications, trust and cooperation. These attributes have yielded various results for the different Network organizations. There have been new initiatives (e.g., safety day camps for migrant youth, shared

exhibit space at national conventions) spurred by friendships in the Network. There are also many examples of co-authorship of educational resources for lay and professional groups. The Network connection has exceeded typical collegial relationships, promoting a sharing of knowledge and experience in an expeditious and open manner.

Impact on Worker Safety and Health – Intermediate Outcomes

The projects undertaken by CASN members are primarily targeted for adults (parents and farm/ranch owners) who are in a position to protect children from agricultural worksites. There are no immediate, measurable outcomes on adult workers. Over time, the knowledge, attitudes and practices promoted by CASN members are likely to influence the next generation of farm owners. We envision this transition much like automobile seatbelt use. That is, today's generation of children wearing seatbelts are likely to continue that behavior into adulthood with minimal prompting.

Interaction between Center and Stakeholders

This entire project is focused on interactions between national organizations. Our Center's role has been to generate consensus on major issues pertaining to children and agriculture. Through collaborative relationships with grass-roots and community-based organizations there is a rapid transfer of resources and information directly to the end-user who is typically a parent and/or farm owner. Numerically, the outreach is staggering. Farm Safety 4 Just Kids has 130 chapters across North America. Each chapter has local outreach education programs. Progressive Agriculture convenes more 400 safety day camps annually, reaching more than 250,000 children. Through the National FFA and National 4-H Council the outreach efforts are variable depending on the topic and local interest. Other Network members have direct links to farm families and migrant workers as well.

Identification of Emerging Problems

Ideally, all NIOSH-funded projects are subjected to a thorough evaluation and documentation of strengths, weaknesses and outcomes. The Childhood Agricultural Safety Network currently receives base funding and coordination via NIOSH but we have not had the dedicated staff or funds to thoroughly track or quantitatively assess outputs resulting directly or indirectly from federal funding.

This new Childhood Agricultural Safety Public Awareness Campaign presents a challenge in terms of our lack of time and resources for comprehensive evaluation. While there are examples of media campaigns that have been evaluated (e.g., ROPS promotion, helmet use, tobacco-free teens) only minor evaluation activities are planned for this national campaign. For this activity, at least in the first year, we will not benefit from empirical knowledge of the level to which public awareness is raised, ultimately leading to changed social norms. We will, however, be able to assess the extent to which working on a national initiative strengthens the commitment of Network members to work collaboratively on this and other initiatives in the future.

For the Network itself, an emerging problem we foresee is the failure to coordinate and facilitate interactions if and when NIOSH funds are unavailable. Each member organization reports increasing restrictions on its travel budgets and greater limitations on its scope of activities. Currently, several Network members are passionate enough about the topic of children and agriculture to continue joint efforts regardless of funding. However, with the changing profile of production agriculture, new national priorities, and the "next generation" of farm safety advocates, the degree of commitment to preventable childhood agricultural injuries and fatalities is uncertain.

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Creating Safe Play Areas on Farms

Background and Resources

Young children are curious and cannot perceive all the dangers on our nation's farms and ranches. Each year an average of 104[1] children are killed and another 23,000 [2] are injured while living or visiting farms and ranches. Many of these children were playing in farm worksites at the time of injury. These statistics support the need for exploring ways to protect young non-working children on our nation's farms and ranches. Safety professionals and parents agree that the safest place for children when parents are working is at off-site childcare. However, many families do not have access to such childcare as a result of limited availability and high costs. When off-site childcare is not an option, a safe play area is the best alternative.

Goals and Objectives

In response to this need, the National Children's Center for Rural and Agricultural Health and Safety (NCCRAHS) planned and implemented a Creating Safe Play Areas on Farms program area with several facets. This program is based upon the following recommendation from the 2001 Summit on Childhood Agricultural Injury Prevention: "Where children are living and/or visiting a farmstead, supervised outdoor recreation areas should be established based upon safety guidelines used for general farm safety, playgrounds and schoolyard safety." In late 2001, this program commenced under the leadership of Barbara Lee, PhD. An initial objective was to develop a knowledge base of core content with an outcome being the development of a guidance document.

Activities

A team of 10 national and international individuals representing key safety organizations, farm families, and trade corporations were identified and invited to participate in the consensus development project. These 10 individuals participated in numerous teleconference calls and attended an in-person meeting in February 2002 to formulate the project guidelines. Three months later, in March of 2002, the initial draft of the document was reviewed by farm parents of young children in New York, Iowa, and Wisconsin, as well as farm and ranch owners. At that time, the groups expressed concerns regarding specific sections of the draft document and the guidelines usefulness to farm families. These concerns motivated NCCRAHS to take a fresh look at the project to reflect the content required by playground and agricultural safety specialists as well as key information and design features recommended by farm parents.

Products and Technology Transfer-Output

In 2003, NCCRAHS published the set of guidelines entitled: *Creating Safe Play Area on Farms* in a 32-page two-color document. This was the first set of comprehensive guidelines for

designing and building a safe play area on farms and ranches applicable for children ages 2-10. Although guidelines existed for public playgrounds and residential play areas, no comparable information had been available regarding children's outdoor play on farms (or agricultural-related sites). Additional information was given on the areas of child development and elements of effective supervision. The document also offered the first clear definition of a safe play area as being a "carefully planned designated location with limited exposure to hazards such as traffic, agricultural production and environmental concerns." The booklet's target audience was safety professionals, farm and rural community leaders, and farm owners who want to learn about the important features of safe play areas for children who live on or visit farms. In 2004 a second printing of the booklet included full-color illustrations and a few minor corrections. These booklets are now available to download online at (http://.marshfieldclinic.org/safeplay/) and have been directly distributed to over 10,000 farm families and safety professionals in the United States and Canada.

Impact on Worker Safety and Health – Intermediate Outcomes

Since the release of *Creating Safe Play Areas on Farms*, the NCCRAHS has become the national resource for the Safe Play Areas on Farms movement. The NCCRAHS has embarked on a public promotion campaign to keep children out of farm worksites by creating and utilizing safe play areas. The center has collaborated with national and international colleagues to promote the safe play areas concepts. Resources have been developed to aid in the promotion/education of safety professionals and farm families regarding safe play areas, including a website devoted to the initiative, training modules, fact sheets, a how-to demonstrate a safe play area booklet (18 pages) entitled *Interactive Safe Play Area Demonstrations at Rural and Agricultural Events* and information on using safe play areas. All of these materials and additional information for the media can be found on the Safe Play website listed above. This site has experienced between 4,000 – 7,000 hits per month since the site's creation in 2003.

Interaction between Center and Stakeholders

In 2004 and 2005 the NCCARHS created and distributed calendars with monthly tips on keeping children safe on farms. These calendars were distributed to 18,000 farm families by NCCRAHS and other national safety organizations; including the Farm Bureau, Farm Safety 4 Just Kids, and Progressive Farmer. The NCCRAHS is currently developing a 2007 calendar to distribute to over 10,000 farm families.

One particularly significant project accomplished by the center was the construction of a 60' X 72' interactive safe play area at Wisconsin Farm Technology days in July of 2005. The life-size constructed play site included models of proper fencing, ground cover, and play structures. This event was attended by over 5,000 farm producers. At the event, our staff interviewed and surveyed families to determine the effectiveness of the demonstration and identification of barriers to creating safe play areas on farms. The overwhelming response from parents was requests for resources to assist them in constructing play areas for their children. After receiving similar results from colleagues in Pennsylvania and Iowa who had also held demonstrations of safe play areas at agricultural events, the NCCRAHS responded.

The NCCRAHS has begun to address farm families' concern over lack of resources by starting a new initiative to develop a play structure information resource that encompasses step-by-step how-to instructions for parents to build their own play area structures. This collection will include numerous play structure designs that parents can readily access online through the NCCRAHS website. Parents/farm owners will be able to choose the types of structures that will be physically and developmentally appropriate for their children.

The NCCRAHS has also provided funding to external colleagues (Penn State, National Safety Council, Farm Safety 4 Just Kids, and North Dakota Farm Bureau) for four safe play area-themed projects through the center's minigrant program. These projects included the funding of model safe play areas on three North Dakota farms, model demonstration at a farm event, and the development of safe play resources *(descriptions below).* Other projects have been supported to provide safe play area materials and guidance to special populations, including the Anabaptist.

Safe Play Area Model- North Dakota Farm Bureau
Principal Investigator: Gail Scherweit

This project provided resources for farm/ranch families to create safe play areas and to evaluate the usefulness of the "Creating Safe Play Areas on Farms document. By evaluation of the strategies contained within the document, insight can be gained for further marketing of this educational resource.

Safe Play Improvements on Family Farms- Farm Safety 4 Just Kids
Principal Investigator: Shari Burgus, MS

This project was designed to promote the implementation of safe play area modifications by pilot testing two incentive programs to encourage the use of the "Creating Safe Play Areas on Farms" document. It is also designed to increase the usefulness of the document through organizing two focus groups.

Promoting Safe Play Areas on Farms – National Safety Council
Principal Investigator: Sam Steele, EdD

This project coordinated training sessions at the National Education Center for Agricultural Safety (NECAS) for parents and grandparents of children living on or visiting farms and ranches. The curriculum was developed by the staff of the National Program for Playground Safety and NECAS and was designed to reiterate the importance of safe play areas and provide resources to attendees. In addition to the training sessions, attendees were offered play sets at a reduced price by a local lumber company.

Safe Play Areas on Farms Demonstration Evaluation – Penn State
Principal Investigator: Dennis Murphy, PhD

This project was designed to evaluate a planned demonstration of safe play areas on farms. The demonstration took place during the Pennsylvania Farm Show, an eight-day event that brings in farmers from all over the state. Collaborators on the project were the Pennsylvania Department

of Agriculture, Child Death Review Team Farm Safety subcommittee, the local chapter of Farm Safety for Just Kids, and the Pennsylvania Office of Rural Health.

Identification of Emerging Problems

The NCCRAHS offers support and guidance to external groups working to bring safe play area concepts to special populations. Such groups include Lancaster County Extension (Anabaptist), Penn State (Anabaptist), Migrant Clinicians Network (Migrant and Seasonal Farmworkers), the National Center for Farm Worker Health (Hispanic workers) and the University of Minnesota (Hmong). The NCCRAHS continues to support the effort by these groups and numerous others to protect children on the farm by providing resources, guidance, and technical assistance.

In the past three years great strides have achieved in the education and promotion of the safe play areas concepts to farm families, yet, many farms still do not have safe places for farm children to play. More research is warranted to determine barriers that keep farm families from creating safe play areas and the effectiveness of various incentive methods.

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Youth, Tractor's and Policy

Background and Resources

Farm tractors remain a leading occupational priority for childhood agricultural injury prevention. Farm tractors account for the majority of fatal injuries to youth working in agriculture and are also an important source of non-fatal trauma to youth on farms. However, there are no data available on the number of injuries or fatalities that occur when youth are operating tractors on public roads.

The traffic volume on rural roadways is growing as more people move to the country and commute to nearby cities. Many roads have been improved to allow for greater usage and higher speeds, increasing the speed differential between slow-moving vehicles such as farm tractors, and other motor vehicles. Thus, operating farm tractors on public roads is becoming increasingly hazardous for both youth and adults.

Goals and Findings

The National Children's Center for Rural and Agricultural Heath and Safety (NCCRAHS) developed a program to do policy-relevant research on youth and tractors. Since the development of this program three years ago, the center has focused its efforts on two major objectives.

Objective 1: To evaluate the effectiveness of one United States state law, Wisconsin Act 455, in reducing highway tractor crashes involving youth operators.

For this, the NCCRAHS partnered with experts in transportation, government policies, biostatistics, and agricultural research. This project was a policy outcome evaluation involving review of a retrospective case series involving youth (under 16 years of age) highway tractor crashes in Wisconsin for the years 1994-2003 that resulted in a fatality, injury, and/or property damage. The research focused on describing and modeling the tractor crashes before and after the enactment of the law, and to evaluate the relation between circumstances contributing to the crash and content mandated in tractor certification courses.

The results from this project showed that there was no significant change in number of youth operator crashes, nor any reduction in the rate in which youth operators were designated at fault. An interesting finding was that the major factors contributing to youth tractor crashes were not adddressed in the tractor certification course, lending to the need for this curriculum to be updated. These findings should not be construed to suggest that public policy, in general, is an ineffective strategy for the prevention of pediatric agricultural injuries. Negotiating a balance in public policy debates will be a challenge, but it is clear that future policy initiatives need to identify and implement the right policy for the right problem. The results of the evaluation of Wisconsin Act 455 have been shared with the Marshfield Clinic Government Relations Office and a meeting with the Agriculture Committee of the Wisconsin Legislature is pending.

Objective 2: To collect and summarize state laws regulating youth who operate farm tractors on highways in the United States.

The first stage of the program area was to identify policies pertaining to youth driving tractors on road ways in the United States. By working closely with technologists, policy experts, and injury prevention specialists a systematic method was used that included an initial Lexis-Nexis database search for tractor related policies by state. In cases when the results obtained were unclear or missing, the researchers followed-up with internet searches in combination with email and telephone calls to state officials. The findings show that 14 states have legislation addressing youth who operate farm tractors on highways. The content of these statutes varies, but includes driver's license or educational requirements, as well as regulations concerning the ages, locations, and/or times of day when youth may operate farm tractors on highways. The results were posted on the internet to assure readily available access by all safety and injury prevention specialists.

The NCCRAHS is continuing to disseminate the results of these studies through presentations and publications. Additional studies in the area of youth, tractors, and policy are currently being considered. The center continues to serve as a national resource in the area of tractor safety for children and provides technical assistance to extension officials and safety specialists on a monthly basis.

Outputs

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Childhood Agricultural Health and Safety Workshop for Journalists

The media remain a constant source of news and information for the agricultural community. Minimal attention is generally given to childhood farm health and safety issues in the media. When coverage is provided, it is often after a horrific event or to promote questionable safety approaches and inappropriate roles of children.

The National Children's Center for Rural and Agricultural Health and Safety has undertaken an initiative to provide a two-day immersion workshop for journalists in the area of childhood agricultural safety and health. The workshop entitled "Kids on Farms: Telling the Story" uses mini-lectures, panel discussions, interviews, and field trips to educate journalists on current agricultural issues such as unsafe work traditions and hazardous exposure to children. Faculty includes farmers and experts from the media, safety, health, agriculture, and child development. Journalists apply to attend the workshop by sending a cover letter, resume, and samples of their work. As part of the program, journalists are given the resources/contacts to write at least two stories. Journalists are also given opportunities to interview regional experts/national experts and interact with farm families.

Each year one workshop has been held at a convenient location for up to 12 journalists for the purpose of increasing the frequency and depth of media reports regarding childhood agricultural health and safety. In the programs first two years of existence, 20 journalists participated. These journalists have made a commitment to become childhood agricultural safety advocates and are encouraged to continue to interact with each other and the center after the event. As a result of the workshop and subsequent contacts, numerous childhood agricultural articles have been published in well-known farm publications.

Results from the 2004 and 2005 workshops were:

In the six months following the workshop, the nine journalists who participated in the evaluation attributed a total of 47 stories to their participation in the workshop.

A significant outcome of this program is the development of a cadre of journalists who understand the scope of the childhood agricultural injury problem, high-impact intervention, socially acceptable practices, and common misconceptions about safety. These journalists as a whole have elevated the level of discussion regarding the complexities of children's work and play.

Quotes from attendees

"The Workshop was extremely valuable to me as a journalist and farm communicator. We got the latest research on child and youth farm safety and health, from the people doing the research--and met with farmers, first responders, and other health care professionals. The workshop and resources of the National Children's Center have helped me report more effectively on issues of crucial importance to the well being of children and farm families. I came away better informed, and full of story ideas and resources. Discussing challenges and opportunities with other journalists was another helpful aspect of the workshop."
- Lorraine Merrill, writer, Hoard's Dairyman

"For journalists to accurately and effectively report on a topic, they need to see it up close, with their own eyes. That's the value in something like the Journalists Workshop. It gave those reporters in attendance a chance to meet and talk one-on-one with professionals who are experts in childhood farm safety issues. It gave the journalists a chance to visit with farm families who cope with those safety issues every day as they struggle to run their farm businesses. It's a very powerful learning opportunity for the journalists, who then can multiply that knowledge to their vast audiences."
- *Gene Johnston, editor, Successful Farming*

"This workshop permanently changed my attitude" and opened his eyes to complex issues involving children and farms
– Les Kletke, a veteran writer for the Manitoba Co-operator

Attendees' evaluation comments
"The panel discussions and farm visits were insightful and practical"
"This format and process was quite successful"
"Networking with other journalists was very valuable"
"I have so many new angles for stories"

As a result of the overwhelming success of the "Kids on Farms: Telling the Story", other national organizations have recognized the benefit of working directly with the media to promote safe agricultural practices. There are currently organizations seeking funding to develop journalist workshops to address other issues of agricultural health and safety.