Appendix A2-09
Highlights of the Centers for Agricultural Research, Education, and Disease and Injury Prevention

Western Center for Agricultural Health & Safety Highlights (1990 -2005)

The High Plains Intermountain Center for Agricultural Health and Safety Highlights (1990-2005)

Great Plains Center for Agricultural Health Highlights (1990 – 2005)

Southeast Center for Agricultural Health and Injury Prevention Highlights (1992-2005)

Southern Coastal Agromedicine Center Highlights (1996-2005)

The Northeast Center for Agricultural Health Highlights (1992-2005)

Great Lakes Center for Agricultural Safety and Health Highlights (2001 – 2005)

Southwest Center for Agricultural Health, Injury Prevention, and Education Highlights (1995 – 2005)

Pacific Northwest Agricultural Safety and Health Center Highlights (1990 – 2006)

National Children's Center for Rural and Agricultural Health and Safety Highlights (1997 – 2005)

Western Center for Agricultural Health & Safety
Highlights (1990 -2005)

Relevance

The UC Agricultural Health and Safety Center at Davis has 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, has 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 include ergonomics of labor intensive crop work, respiratory hazards in dry climate farming, health of women and children in agriculture, and pesticide safety. 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.

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 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.

The range of research, intervention/prevention and education projects and activities in the Center reflects 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 follow 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.

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. It is important to identify 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.

Impact

Intervention/prevention projects have 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.

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.

Biomarkers and Pesticide Surveillance

Development & implementation of pyrethroid & paraquat immunoassays for human exposure monitoring

Immunoassays are a rapid, sensitive and cost effective method of analysis. For many of the epidemiology studies that occur within the Western Center for Agricultural Health & Safety, having a rapid and sensitive analytical method to assist with determining exposure or effect to pesticides or other toxins would be a useful tool. Toward this goal, we developed and validated a class-specific pyrethroid immunoassay for 3-phenoxybenzoic acid (3-PBA) in urine for human exposure monitoring. Pyrethroids are rapidly replacing organophosphates for insect control, and it can be anticipated that human exposures will occur. Use of this assay in a small sample set from a collaborator in Germany indicated that the assay was sensitive enough to detect this metabolite in an exposed population. We also improved upon an immunoassay previously developed in this laboratory for the herbicide paraquat and validated it for analysis of urine samples. Paraquat is utilized worldwide and although the acute oral toxicity of paraquat is well documented, the hazard to humans through inhalation and other routes of low level exposure is

not fully clear. The assay was applied to an epidemiology study that monitored for paraquat in the urine of Costa Rican farmworkers. This was part of the exposure component of a study designed to test the hypothesis that chronic paraquat exposure causes restrictive lung function among exposed workers. The assay could clearly distinguish between exposed and unexposed populations and provided useful information about relative exposure related to crop or use of personal protective equipment.

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

Progress has been made on providing data to standardize cholinesterase testing by clinical laboratories in California, resulting in the state's approval of some laboratories and not others as clinical test laboratories. This illustrates how a project can proceed step by step from an observation through bench research to a successful intervention. Efforts are underway to focus on several clinical laboratories, working closely with them to begin to link cholinesterase monitoring levels, field pesticide exposures and physician reports.

Farmer, Farmworker, and Family Health

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

We have shown that dust exposures among farmers are independently associated with increased respiratory symptoms, specifically persistent wheeze and chronic cough and phlegm (Schenker et al., 2005). Dust exposure was not associated with an observed increase in asthma, suggesting that the effect may have been mediated by non-allergic mechanisms. We have completed numerous preliminary studies on the exposures to mixed-dusts in California agricultural workers (Gamsky et al., 1992b; McCurdy et al., 1994; Schenker et al., 1994; Schenker et al. 1995b; Weinbaum et al., 1995; McCurdy et al., 1996; Nieuwenhuijsen et al., 1999). High exposures have been observed in various commodities and tasks. In grapes and citrus, two commodities with high levels of dust exposure, inhalable dust levels were higher than Threshold Limit Value (TLV) levels and respirable dust levels were slightly less than TLV levels.

It is important to note that dust exposures in the agricultural workplace are commonly mixtures of organic and inorganic dusts, and it is not always possible (or valid) to attribute observed health effects to one component or the other, particularly based on epidemiologic studies (Lee et al., 2004). Nevertheless, these studies support efforts to reduce occupational and non-occupational exposures to agricultural dusts in the farm working population. Unfortunately, our research suggests that the hazards of agricultural dusts are not recognized, and that effective methods to reduce exposure are not utilized (Schenker et al. 2002).

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.

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.

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

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.

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.

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.

Outreach and Education

The Educational projects of the Center are 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.

The Center maintains 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.

Social Marketing: A Farm safety Diffusion Tool

300 copies of multi-media tractor safety and field sanitation packets have been purchased. Loteria del manejo Seguro has been recognized as an effective training tool for non-English speaking agriculture workers who visit California and Arizona insurance companies and law enforcement agencies. Multi-media campaigns and 30 Public Service Announcement addressing on-farm safety and off-farm safety regarding motor vehicles have been continuously aired over the past 1.5 years

Information Exchange and Interaction on Agricultural Health Issues

Collaboration with AgSafe proved to be successful to provide extended dissemination throughout the agricultural community. AgSafe disseminated its Tailgate Training series in Spanish and English as well as the Cal OSHA required model agricultural Injury Illness Prevention Program, a tractor safety Training Guide and safety training resource materials.

Delivering Safety Training and Hazard Awareness Information to Agriculture Workers

The Pesticide Safety Lottery has been shown to be highly useful training tool. It has been widely distributed through the University of California Agricultural Personnel Management Program. Investigators have consulted with organizations and individuals from other states to help them develop similar tools for agriculture safety programs.

Pacific Northwest Agricultural Safety and Health Center Highlights (1990 – 2006)

The PNASH Center provides a 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 input, research partnerships, and research dissemination.

Relevance

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 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 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.

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.

Impact

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. While we are not able to credit 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.

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 (The Well Being Project), 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.

Direct Impacts

Additional impacts described below are from specific projects in six program areas:

Pesticide Exposure Assessment Methods

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 implementation 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.

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

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 Washington State Department of Agriculture's (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.

Traumatic Injuries

Orchard Injuries - 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.

Orchard Injuries - 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.

<u>Musculoskeletal Disorders</u>

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

As mentioned above in the area of Traumatic Injuries, the Technology Roadmap also impacts musculoskeletal disorders. 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."*

<u>Noise and Vibration Exposure</u>

A study on noise and vibration exposure in forestry workers 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

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

Southwest Center for Agricultural Health, Injury Prevention, and Education
Highlights (1995 – 2005)

Relevance

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.

An early focus was placed on a project with Oklahoma State University to reduce injuries related to cattle-handling which 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.

A project in 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.

Impact

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.

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.

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.

Tools and Approaches

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. There were 158 people who were linked from 5 locations and nine sites 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.

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.

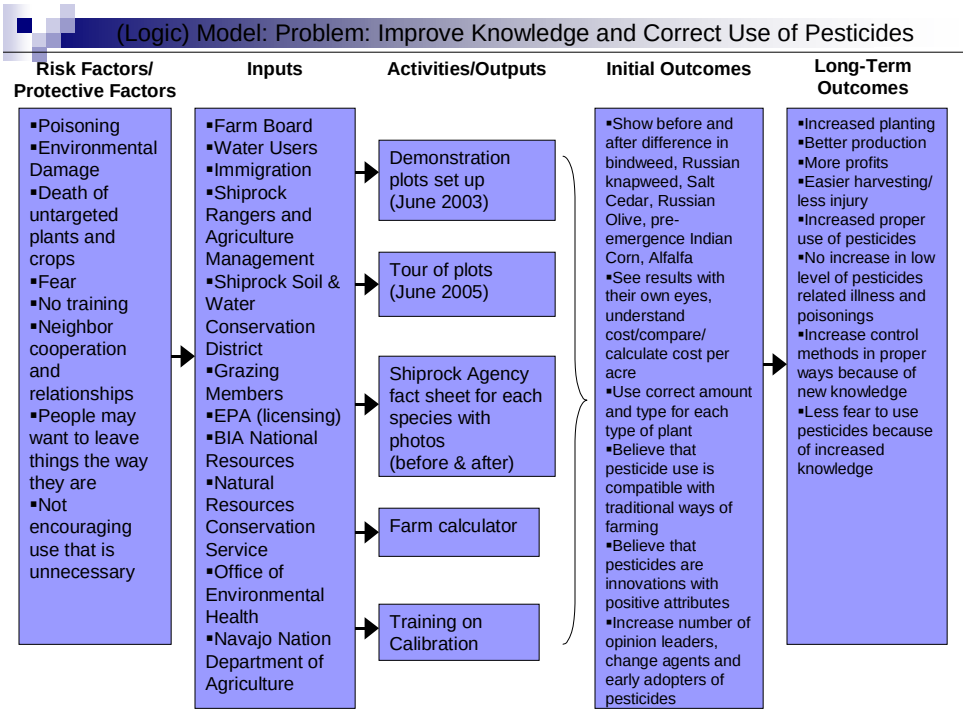
<u>Understudied/Under-Represented Populations</u>

- 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.

Great Lakes Center for Agricultural Safety and Health Highlights (2001 – 2005)

Relevance

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 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 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.

Impact

Research Tools and Approaches—Intervention Effectiveness Research

Adapting the ASHBMP for the Insurance Industry

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. 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

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.

A 17-minute ROPS safety video was produced titled, "A Tractor Accident Can Happen to Anyone". A summary article appeared in the November 2005 GLCASH NewsletterThe video is being distributed globally. A flyer was developed to market the video to agricultural safety and

health professionals. The 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. 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. Over 400 videos have been distributed, and 43 individual farmers have asked for a copy. Assistance was provided to 15 respondents who called the 1-800 # listed in the video asking for information on ROPS for their model tractor. ROPS had been located for 13 of the 15 who requested assistance.

Effectiveness of Sun Safety Intervention Approaches to Change Sun Safety Behavior of Agricultural Workers

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.

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.

The Sun Safety 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. A national train-the-trainer program was developed for sun safety and skin cancer prevention. 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

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.

Based on reports to the Sentinel Event Notification System for Occupational Risks (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.

The following guidance document was prepared: MIFACE Hazard Alert #6, "Fatal Asthma Attack While Cleaning Bulk Milk Tank". Many attendees at the AgExpo 2005 collected the information in the form of Asthma Fact Cards, Project Information Brochures, 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.

Research Tools and Approaches—Risk Management

Field Test of the Farm Grain Engulfment Hazard Assessment Tool

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 assess whether or not contributing factors are present.

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.

To date, data has been collected from more than 200 assessment responses from Illinois farm owners/operators and more than 20 responses from commercial grain-handling sites. 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. 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

The objective of the GLCASH Fellows Program is to increase the level of evaluation for impact conducted related to agricultural/rural safety and health outreach and educational programs. Evaluation for impact is the documentation of the effect 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.

An online web-based course was developed. 18 modules were put online. Continual monitoring and assessment of program has resulted in monthly live online chat sessions for fellows and mentors.

HOSTA Train-the-Trainer

During FY 2005, the Center supported train-the-trainer programs for the Hazardous Occupations Safety Training in Agriculture (HOSTA) project in Ohio. Ten sessions were conducted 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. For more information please contact GLCASH at 1-800-678-6129 or e-mail greatlakescenter@osu.edu.

The Northeast Center for Agricultural Health
Highlights (1992-2005)

Relevance

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. 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 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). These twelve states contain 170,000 farms occupying 26.5 million acres. 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.

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).[1] 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.

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.

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).

Impact

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,**Error! Bookmark not defined.** migrant injury,**Error! Bookmark not defined.** child injury,**Error! Bookmark not defined.**[,5] musculoskeletal injury, **Error! Bookmark not defined.**,**Error! Bookmark not defined.** hearing loss,**Error! Bookmark not defined.** and injury from mechanical equipment.**Error! Bookmark not defined.** 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;[6] and numerous others.[7,8,9,10,11,12,13] 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.[5] NEC is directing eight projects, feasibility efforts and collaborations at this issue. To date, these have resulted in three publications[14,15,16] and a large USDA grant for the entire redesign of the nation's tractor certification program.[17] 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**Error! Bookmark not defined.** and validated survey instruments**Error! Bookmark not defined.** 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[18,15] and two submitted papers.[19,20] 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.

<u>NEC Programs</u>

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	Agrichemicals
Child Injury	Migrant Injury
Safety Training	Musculoskeletal / Ergonomic
Personal Protection	

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.

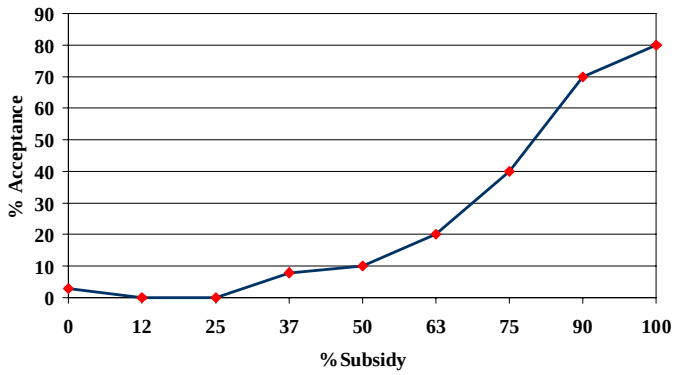
Tractor Safety Program

The safety of farm tractors has been an area of research and attempted intervention at the Northeast Center for more than a decade. 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.

Figure 1. Farmer Response to Financial Incentives



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. **Error! Bookmark not defined.**

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. 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.[21] 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 an attempt to put into place the social marketing efforts outlined in the NIOSH Ag Center Directors' call for a National Tractor Safety Initiative[22]. 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;[23] 3) an exploration of farmer attitudes toward ROPS retrofitting;[24] 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;[25] 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:

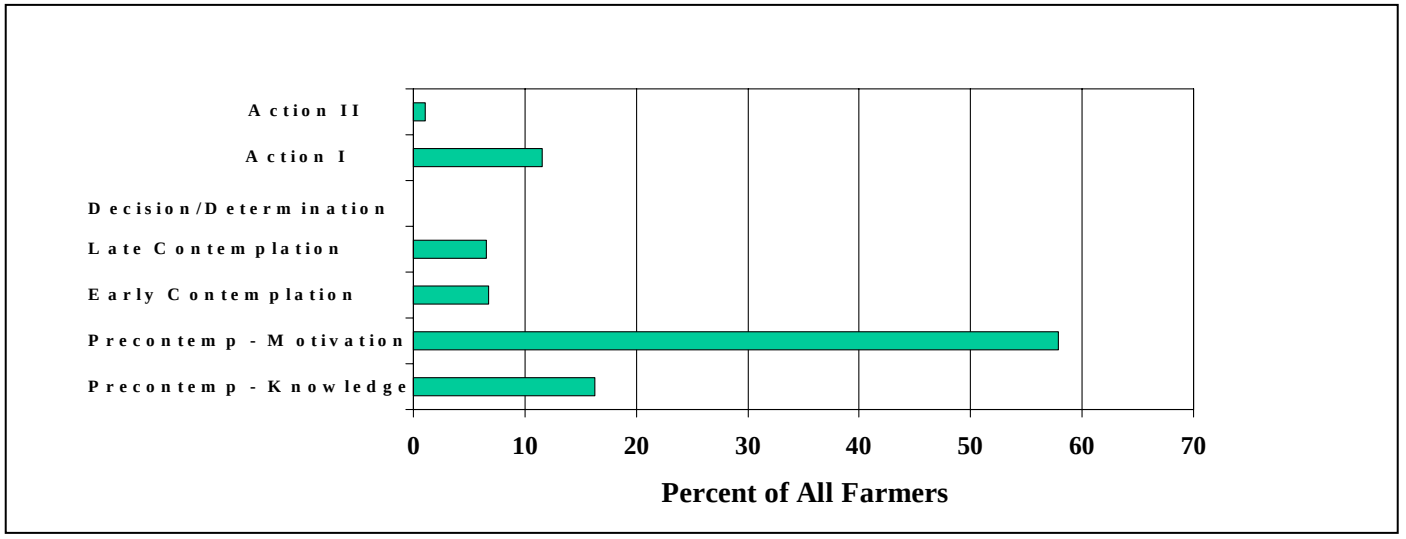
- The proportion of no-ROPS tractors in NY is declining – approximately nine percent over the past decade
- Of 147,000 tractors in these five commodities (86% of all NY farms), 76,000 (52%) have no ROPS .
- 18% of the state's farms have all tractors with ROPS. There are no ROPS tractors on 24.6% of NY 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%).

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.

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.

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.[26] 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.

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).[27]

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).

"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. 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. 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) 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.

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. 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.

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;

Safety Training Program

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

Personal Protection Program

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.[28] Similarly, we and others have measured dust exposures to dairy farmers which on occasion vary from high to incredibly high.[29,30] 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.[31,32] 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%).[33]

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.[34] In the NY FFHHS, 42% of 1215 participants used hearing protection when working with noisy farm equipment.[4]

<u>NYCAMH / NEC PPE Sales</u> - 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.

<u>Protective Equipment Sales Tax Exemption</u> – 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).[35]

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

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.

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

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

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. 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 n 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.

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

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.[36,37,38]

Projects were conducted on the following topics:

- Hip – Knee Arthritis in Dairy Farmers
- Ergonomics of Dairy Farming
- Ergonomic exposures in apple harvesting
- Orchard Ergonomics Pilot Project
- Ergonomic Problems in Fishers
- NEC Ergonomic Apple Bucket
- Ergonomics in Mushroom Growing

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

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

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Southern Coastal Agromedicine Center
Highlights (1996-2005)

Relevance

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).

Impact

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.

Specific accomplishments for selected projects are given below.

Human Metabolism of New and Emerging Pesticides

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. Studies on the metabolism of endosulfan using human liver microsomes demonstrated that endosulfan is metabolized in humans to endosulfan sulfate.

Ergonomic Interventions In The Agriculture Industry

The overall project involves:

- Identification of high risk jobs/tasks

- 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)
- Prototyping of ergonomic interventions for the reduction of exposure to these ergonomic risk factors
- Laboratory assessment of the effectiveness of these solutions
- Fabrication of field-ready ergonomic interventions
- Field evaluation of these solutions.

Innovations from the project include: (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), (10) Agricultural Job Task Ergonomic Survey Instrument, (11) Clinic Intake Form, (12) Work related musculoskeletal discomfort (WMSD) Prevention and care brochure (Spanish and English versions)

Hydration Methods in Preventing Heat Disorders in Field Workers

This study is to assess the 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 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.

Educating Agricultural and Health Practitioners About the Agricultural Health Study

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.

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.

Timber Medic Certification

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 Timber Medic Training project developed 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 was delivered through the community college system. There was also a "Train the trainer" component to provide adequate numbers of instructors.

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 overviewing 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.

Expansion and Maintenance of the National Agricultural Safety Database (NASD)

Statistics indicate that the number of people using NASD continues to increase (see Table below). 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).

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

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.

Agromedicine at the Grassroots

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.

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.

Mountain Pesticide Education and Safety Outreach – A Pilot Program for Christmas Tree Worker Safety in Western North Carolina

Feedback from the Pesticide Education and Safety Outreach (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.

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

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.

Southeast Center for Agricultural Health and Injury Prevention Highlights (1992-2005)

Relevance

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.

Impact

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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Great Plains Center for Agricultural Health
Highlights (1990 – 2005)

Relevance

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.

Impact

Keokuk County Rural Health Study

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

Agricultural Pesticide Exposure Projects

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.

Agricultural Respiratory Disease Prevention Projects

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.

Toxicology Core

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.

Childhood Agricultural Injury Prevention Projects

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.

Intervention Projects

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.

Training, Education, and Outreach Projects

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.

The High Plains Intermountain Center for Agricultural Health and Safety Highlights (1990-2005)

Relevance

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.

Impact

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.

Organic Dusts

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).

Tractor Safety

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. 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.

Roll Over Protective Structures (ROPS) have been designed for Ford, Farmall, John Deere, and Allis Chalmers (AC) 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). Tests have been collaborated with Saf-T-Cab and FEMCO as well as relevant tractor manufactures. 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.

A survey in 1995 indicated that of 70 most popular tractor models in the United State 50.4% were pre-ROPS tractors (Myers and Snyder, 1995). Therefore, 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 the following table.

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.

Outreach

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.

The translation of knowledge discovered from projects 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.

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.

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 fostered the development of 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. HICAHS has changes the approach within the Agricultural Extension Model. Instead of the traditional technology transfer, or top down approach from the university researcher to the farmer, emphasis is now on 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.

Examples of regional education activities that were co-sponsored by HICAHS are:

- South Dakota used funding to provide a Farmedic Instructor course to train rescue workers on proper response techniques.
- North Dakota developed safety education materials to supplement the Tractor Safety School Program; the topics included hearing loss prevention, respiratory health, diseases on the farm, agricultural first aid, hazards on the farm, chemical safety on the farm, personal reaction time. In addition, 5 farm safety day camps were held.
- Utah developed a presentation designed to educate youth on the dangers associated with agriculture and injury and fatality prevention, which was designed for schools and 4-H.
- Montana conducted a training program for county extension agents and community leaders to conduct farm safety youth camps and provided two “Extraction from Farm Equipment” training programs for emergency service personnel.
- Wyoming provided various programs on priority safety issues to youth, including Hispanic minorities, in both traditional and non-traditional educational settings.
- Montana developed a series of accident prevention kits that counties can use to teach farm safety at day camps. Training was provided to agents on how to use the kits effectively. Funding was also used to provide the following additional training: emergency responders in extrication from farm equipment, agent training to conduct tractor and machinery operation clinics to youth under 16 years of age, and specialized training on safe livestock handling.
- Utah conducted a needs assessment for secondary agricultural education teachers and safety education materials in order to develop priorities for the future production and distribution of educational materials.
- North Dakota conducted farm safety training at five (5) tractor and Machinery Safety Schools, and mini-grants in the amount of $250.00 were awarded to 12 counties for conducting Farm Safety Day Camps.
- The Colorado State University Extension agent performed a needs assessment of youth farmer safety programs is the first year and is currently developing a manual outlining planning and development of youth Farm Safety Day Camps. The manual will contain

information that will assist area Extension Agents in the planning process as well as resources that are available for Day Camps.

National Children's Center for Rural and Agricultural Health and Safety
Highlights (1997 – 2005)

Relevance

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.

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]

Impact

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.

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 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 visits. A five-year assessment of the impact of NAGCAT was conducted in March 2005.[6] Results 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 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 in 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 that 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.