NIOSH Agriculture, Forestry, and Fishing Safety and Health Program

National Academies Review

December 2006

Preface

The National Institute for Occupational Safety and Health (NIOSH) is seeking external review of its programs by the National Academies (NA) to assess its contribution to the public good and to improve its research and management. At the first meeting of the NA NIOSH Committee for the Review of NIOSH Research Programs on May 5, 2005, Dr. Lewis Wade, NIOSH senior science advisor, emphasized that these reviews should focus on evaluating their impact and relevance to health and safety in the workplace. Subsequently, the Framework Committee articulated the charge from NIOSH to the NA. It stated that NA evaluation committees should address the following:

- Progress in reducing workplace illness and injuries through occupational safety and health research through an analysis of relevant data about workplace illnesses and injuries for the program activity and an evaluation of the effect that NIOSH research has had in reducing illness and injuries.
- Progress in targeting new research to the areas of occupational safety and health most relevant to future improvements in workplace protection.
- Significant emerging research areas that appear to be especially important in terms of their relevance to the mission of NIOSH.

NIOSH believes that the framework developed by the Committee for the Review of NIOSH Research Programs will result in a fair and useful evaluation of its programs. NIOSH looks forward to supporting the NA so that workers everywhere will benefit from an improved Institute.

This report is the initial "evidence package" from NIOSH to the Agriculture, Forestry, and Fishing (AFF) Research Program evaluation committee assembled by the NA. We stress "initial" because we believe that the AFF Program review will be best-served by substantial communications between the program and the committee throughout the process. It is understood that the evaluation committee and the NA are charged with executing a thorough review of the program and that to do so it will need much information from the program. We have tried to anticipate those needs with this package. In addition, we look forward to an ongoing dialogue with the committee.

In the opening sections of this document, we provide an executive summary, an introduction to NIOSH, and an introduction to the AFF Program, including its research goals, its funding history, and a summary of its major accomplishments.

In this document, the AFF Program is organized into five general research goals. Some of those goals are divided into sub-goals. Within each goal section, there are up to seven parts:

- Challenge or Issue – the research need addressed by this part of the AFF Program
- Activities – the research activities undertaken
- Outputs – a description of the research outputs (e.g., reports and journal articles) and activities by the program to transfer the outputs to others

- Intermediate Outcomes – the actions of other groups after they receive the outputs of the research program. We chose to classify the actions of others to request our outputs (such as requesting a copy of a research report or visiting our hearing loss Web site) as intermediate outcomes. Other examples of intermediate outcomes are standards, technologies, training methods, analytic methods, and control strategies adopted by others as a result of program outputs.
- End Outcomes – changes in workplace hazard exposures, reductions in injuries, illnesses, or fatalities. In some cases, we claim that the AFF Program has contributed to measured changes on these parameters.
- External Factors – a summary of circumstances and conditions outside the program that impacted program efforts. These factors might have impacted any stage of the program – or all stages.
- Future Directions – activities planned to extend the research program and potential outputs and intermediate outcomes that may result.

Within each research sub-goal there is a **Selected Outputs** section that lists particularly important AFF program results. In addition at the end of each chapter there is a complete list of **Outputs** for the corresponding goal.

Table of Contents

Abbreviations

A

AFF ....Agriculture, Forestry, and Fishing
AFS ....Alaska Field Station
AHPS ....Agricultural Health Promotion System
AHS............................Agriculture Health Study
AJIM ....American Journal of Industrial Medicine
AMSEA......................Alaska Marine Safety Education Association
APA ....American Pulpwood Association
ASABE ....American Society of Agricultural and Biological Engineers
ASAE ....American Society of Agricultural Engineers
ASH-NET ....Agricultural Safety and Health Network
ASPS..........................Agricultural Safety Promotion System
ATR ....Alaska Trauma Registry
ATV ....All-Terrain Vehicles
AutoROPS ....Automatically deployed Roll-Over-Protection Structure

B

BLS ....Bureau of Labor Statistics
BSC............................Board of Scientific Counselors

C

CAIS ....Child Agricultural Injury Survey
CAMP ....Construction-Agriculture-Mining Partnerships
CARE Act ....Children's Act for Responsible Employment
CCDPF.......................Cancer Control Demonstration Projects for Farmers
CDC ....Centers for Disease Control and Prevention
CFIVSA ....Commercial Fishing Industry Vessel Safety Act
CFOI ....Census of Fatal Occupational Injuries
CFR............................Code of Federal Regulations
ChE ....Cholinesterase
CI................................Confidence Interval
CIB.............................Current Intelligence Bulletin
CLC............................Child Labor Coalition
CO..............................Carbon Monoxide
CPSC..........................Consumer Product Safety Commission
CROPS.......................Cost-Effective Roll-Over Protective Structures
CSTE..........................Council of State and Territorial Epidemiologists

D

DDT ....Dichlorodiphenyltrichloroethane
DHHS.........................Department of Health and Human Services
DOL ....Department of Labor

E
ED ....Emergency Department
EMF ....Electro-Magnetic Fields
EO ....End Outcome
EPA ....Environmental Protection Agency
ESA ....Employment Standards Administration

F
FAA............................Federal Aviation Administration
FACE ....Fatality Assessment and Control Evaluation
FDA............................Food and Drug Administration
FFA ....Future Farmers of America
FFHHS ....Farm Family Health and Hazard Surveillance
FISH...........................Fishing Industry Safety and Health
FLSA..........................Fair Labor Standards Act
FOPS..........................Falling Object Protective Structures
FRA ....Forest Resources Association
FTE ....Full-Time Equivalents

G
GC/MS ....Gas Chromatography/Mass Spectrometry
GMO ....Genetically Modified Organisms
GPS ....Global Positioning Systems
GTS ....Green Tobacco Sickness

H
HAI ....Helicopter Association International
HHE ....Health Hazard Evaluation
HO..............................Hazardous Orders
HPLC ....High-Performance Liquid Chromatography
HRSA.........................Health Resources Service Administration

I
IAWG.........................Interagency Working Group
ICD.............................International Classification of Diseases
IFISH..........................International Fishing Industry Safety and Health
IFQ ....Individual Fishing Quotas
ILO.............................International Labour Organization
ISO ....International Organization for Standardization

L
L&I.............................Department of Labor and Industry
LH ....Luteinizing Hormone
LSI ....Logging Safety Initiative

M

M-CAIS......................Minority Childhood Agricultural Injury Survey
MCHB........................Maternal and Child Health Bureau
MMWR......................Morbidity and Mortality Weekly Report
MOB ....Man Overboard
MOSH........................Maryland Occupational Safety and Health
MSD...........................Musculoskeletal Disorders
MSHA........................Mine Safety and Health Administration

N

NAGCAT...................North American Guidelines for Childhood Agricultural Tasks
NASC.........................NIOSH Agricultural Steering Committee
NASD.........................National Agricultural Safety Database
NASS ....National Agricultural Statistics Service
NAWS........................National Agricultural Workers' Survey
NACOSH...................National Advisory Committee on Occupational Safety and Health
NCASH......................National Coalition for Agricultural Safety and Health
NCBDDD..................National Center on Birth Defects and Developmental Disabilities
NCCAIP.....................National Committee for Childhood Agricultural Injury Prevention
NCCRAHS................National Children's Center for Rural and Agricultural Health and Safety
NCEH.........................National Center for Environmental Health
NCHS.........................National Center for Health Statistics
NCI.............................National Cancer Institute
NEISS ....National Electronic Injury Surveillance System
NFPA ....National Fire Protection Association
NHANES ....National Health and Nutrition Examination Survey
NHIS ....National Health Interview Survey
NIFS...........................National Institute for Farm Safety
NIH ....National Institutes of Health
NIOSH ....National Institute for Occupational Safety and Health
NOES ....National Occupational Exposure Survey
NOIRS........................National Occupational Injury Research Symposium
NORA ....National Occupational Research Agenda
NPFVOA....................North Pacific Fishing Vessel Owners Association
NSC............................National Safety Council
NTOF ....National Traumatic Occupational Fatalities
NVSS ....National Vital Statistics System
NYCAMH.................New York Center for Agricultural Medicine and Health

O

OEP............................Office of Extramural Programs
OHNAC ....Occupational Health Nurses in Agricultural Communities
OISPA........................Occupational Injury Surveillance of Production Agriculture
OMB ....Office of Management and Budget
OP ....Organophosphate
OSHA.........................Occupational Safety and Health Administration

OTTC ....Office of Technology Transfer and Commercialization
P
PART ....Program Assessment Rating Tool
PFD ....Personal Flotation Device
PMR ....Proportionate Mortality Ratios
PPE.............................Personal Protective Equipment
PRL ....Pittsburgh Research Laboratory
PTO ....Power-Take-Off

R
RF...............................Radio Frequencies
ROPS..........................Roll Over Protection Structure

S
SENSOR ....Sentinel Event Notification System for Occupational Risk
SMR ....Standardized Mortality Ratio
SMV ....Slow-Moving Vehicle
SOII............................Survey of Occupational Injuries and Illnesses

T
TISF ....Traumatic Injury Surveillance of Farmers
TRAC ....Tractor Risk Abatement and Control

U
USCG ....United States Coast Guard
USDA ....United States Department of Agriculture

W
WoRLD ....Work-Related Lung Disease Surveillance System
WSDLI ....Washington State Department of Labor and Industry

Y
YWH&S ....Young Worker Health and Safety Network

Executive Summary

Over the past twenty years, agriculture has moved from the third to the most hazardous occupational sector. Agricultural workers and their families encounter a disproportionate number of injuries and diseases associated with physical, chemical, and biologic hazards. The National Safety Council (NSC) estimates that an average of 740 people lose their lives annually and another 130,000 workers are temporarily or permanently disabled as the result of farm- and ranch-related injuries.

Loggers and fishermen face similarly high rates of injuries and death related to their work. U.S. data reported in 1989 indicated that fishing had a fatality rate of 80 deaths per 100,000 workers, five times the sector average of 21 deaths per 100,000 workers. Logging is often considered to be one of the most dangerous industry segments in the U.S.

Agricultural safety and health has been an important focus in NIOSH for more than 30 years. Our efforts intensified in 1990, when the NIOSH AFF Program was initiated. Our efforts are challenged by two social realities. The first is the loose organization of professionals engaged in agricultural safety and health. That has been improved significantly with the advent of the AFF Program. Secondly, OSHA's regulatory activity in the agricultural industry is limited. The AFF Program has strengthened the science base for OSHA regulatory activity in areas such as logging.

Overall, the AFF Program is driven by the pursuit of reduction of occupational diseases, injuries, and death among agricultural workers, loggers, and fishermen. Over the past 15 year history of the program we have made significant inroads in meeting this objective. Our impacts have been in actual reduction of disease and death, and in reduction of exposure through legislation, regulation, increased use of protective clothing, and equipment, innovative technology and effective communication/education.

Our most important end outcome is actual reduction of disease, injury, and death. We have been successful in reaching that outcome in a number of areas. A few of the more significant examples of that include:

- Between 1998 and 2004 the AFF SENSOR-Pesticides Program effort observed a decrease in the rate of acute pesticide poisoning in the agricultural industry (from 13.1% to 8.9%). We believe the surveillance data and research findings from our program are among the drivers in that reduction, particularly as related to supporting new Environmental Protection Agency (EPA) regulations.
- Our Childhood Agricultural Injury Prevention Initiative began in 1997. During the initiative, the total number of youths injured on farms has decreased from 37,800 in 1998 to 27,600 in 2004. For the same time period, the number of farm work-related youth injuries decreased by 51% from 16,695 down to 8,130.
- After release of the North American Guidelines for Childhood Agricultural Tasks in 1999, the work-related injury rate for farm household youth decreased from 14.1 to 9.1 injuries per 1,000 working household youth for the time period of 1998 to 2004.

- Since the initial release of the proposed OSHA Logging Standard in 1989, based largely on the NIOSH criteria document for a proposed logging standard, the national occupational injury and illness rate for the logging industry decreased from 19.5 cases per 100 full-time workers to 6.4 cases per 100 full-time workers in 2003.
- Since the intervention and implementation of the NIOSH-led Alaska Working Group's recommendations to prevent helicopter logging crashes in July, 1993, there has been only one additional helicopter logging crash in Alaska, which occurred in 1996.
- While the work-related fatality rate of commercial fishing fatalities in Alaska remains high, fatalities are decreasing. Since 1990, there has been a 74% decline in annual deaths to commercial fishermen there, due in some measure to our efforts.
- We continue to work closely with the Coast Guard in Alaska to implement new safety requirements. These safety requirements contributed to 96% of the commercial fishermen surviving vessel sinkings/capsizings in 2004, compared to only 73% surviving in 1991.
- AFF Program funding of a pilot eye injury prevention program in Florida between 2003 and the present resulted in reduced eye injuries (by 75%) among 500 workers. The project also found that the acceptance rate of using safety glasses increased from 65-75% post-intervention compared to 5% pre-intervention.

Other important impacts of the AFF Program have resulted from reduced exposure to hazards found on the job in farming, logging, and commercial fishing. Reduced exposure often correlates directly with reduced injuries, disease and death. We have made such impacts in strengthened legislation, new regulations, improved technology, increased use of protective clothing and equipment, and effective communication/education to prevent accidents. Examples of each of these outcomes follow.

Strengthened Legislation

- AFF investigators published an MMWR article in August 2004 describing a large outbreak of pesticide poisoning caused by a chloropicrin drift exposure from a farm in California. The article provided justification for legislation that was enacted just a month after the article appeared. It requires growers to reimburse any medical expenses incurred by the pesticide-drift victim.
- In both 2003 and 2005 the Youth Worker Protection Act was introduced in the U.S. Congress by Representative Tom Lantos. The bill would revise requirements relating to child labor and sets forth new requirements for the employment of minors. The requirements are largely based on the Hazardous Orders recommendations released by NIOSH in 2002.
- Wisconsin Act 455, passed in 1996, prohibits children younger than 16 years old from driving farm tractors on public roads until they complete a tractor and machinery certification course. This act was based on the results of the AHPS research in that state.

New Regulations

- Following the release of a MMWR article in November 1999 describing AFF Program findings on illnesses associated with efforts to control medfly infestations, our recommendations for accomplishing medfly control without the use of pesticides were adopted by the USDA, and the Florida Department of Agriculture. Since the adoption of these regulations, no infestations of medfly have been detected in the United States.
- Between July, l989 and October, 1990 NIOSH provided three sets of comments to OSHA supporting a proposed logging rule. In 1994 OSHA adopted its final logging standard which incorporated the majority of our recommendations including first-aid training requirements, prohibited felling practices, personal protective equipment use, and equipment training requirements.
- In 1998, the Coast Guard convened a task force to develop a national plan for fishing vessel safety. The final report called “Living to Fish, Dying to Fish” adopted eight of the 11 recommendations made by NIOSH.
- In 1999, the Coast Guard initiated a Dockside Enforcement Program to identify and correct safety hazards known to exist in the Bering Sea crab fisheries based on NIOSH findings. The program was proven effective and subsequently became “institutionalized” as their way of doing business.
- Subsequent to the AFF Program neurological effects study and taking into consideration other data, EPA banned the use of chlorpyrifos for residential use. This action was taken primarily to protect children. In addition, chlorpyrifos is no longer used as a termiticide, thereby eliminating its exposure to termite control workers.
- Based on our work on cholinesterase, in 2000 the Washington State Supreme Court mandated that the Washington State Department of Labor and Industries 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.
- With the help of industry, we successfully introduced a new American Society of Agricultural and Biological Engineers (ASABE) standard for the NIOSH Automatically deployed Roll-Over-Protection Structure (AutoROPS). This new standard is in draft form, and once issued, will give manufacturers criteria to build, test and sell AutoROPS to consumers. Their 1985 standard which recommended that all new farm tractors sold in the U.S. be fitted with a ROPS has resulted in compliance by more than 95% of all tractors manufactured after the adoption of this voluntary standard.

Improved Technology

- AFF Program surveillance data from Occupational Health Nurses in Agricultural Communities (OHNAC) and Farm Family Health and Hazard Surveillance (FFHHS) guided the development of an intervention project that has been shown to increase the use of Roll Over Protection Structure (ROPS) by farmers. In one intervention project, the use of retrofitted ROPS increased from 4 in 2 treatment counties to 81 in the 3.5

years after the intervention was initiated. Because of the very high prevention rates of human injuries by ROPS/seat belt installation and use, we believe that ROPS plus seat belt installation are plausible proxies for actual reduction of hazard.

- Six Cost-Effective Roll-Over Protective Structures (CROPS) designs have been developed by the AFF Program and have been shared with a ROPS manufacturer (FEMCO). Having an estimate of the potential market for each AFF Program design was helpful in getting FEMCO to pursue CROPS on a commercial basis.
- NIOSH has developed a prototype emergency shutoff switch system to be used in the event a fisherman is entangled around a winch. The new e-stop system was successfully tested during the 2005 Southeast Alaska salmon fishing season. The response from industry has been overwhelming with inquiries from fishing vessel owners and operators asking for information on how to obtain the device for their vessels.
- Thirty percent of commercial fishing fatalities are due to a worker falling overboard. The AFF Program has developed a prototype improved personal flotation device that has thin, flexible, illuminated patches which become illuminated once the Personal Flotation Device (PFD) or jacket is submerged, allowing for quick location and recovery of victims.
- Control of carbon monoxide emissions resulted in the development of automatic engine shut-off sensors to stop equipment operations before CO concentrations reach hazardous levels.

Increased Use of Protective Clothing and Equipment

- The AFF Program investigated four incidents of "scalping" from hair entanglement around the rotating secondary driveline of hay bailing equipment. A NIOSH Alert was published about this problem, with the result that retro-fitted machine guards, which were already in stock, sold out quickly and production of the guard has resumed.
- The Coast Guard in Alaska adopted a new "safety at sea" checklist in 1998 including a recommendation that fishermen wear a PFD at all times while on deck. This recommendation was made based on our research demonstrating the survivors of accidents were 7.5 times more likely to have worn a PFD in a vessel sinking.
- Many management and workers in wine grape production have adopted the smaller, lighter picking tubs that were developed by AFF Program researchers. Since our original study, these smaller tubs have become the most common type used in the Napa and Sonoma counties' hand harvest.
- In 1993 our survey showed that less than 1% of workers were using the ergonomically advantageous long-handled harvesting rakes for blueberries. A follow-up survey by the New England Agriculture Center in 2006 estimated that most of the work force now used the long-handled rakes and many use rakes with two handles.

Effective Communication/Education

- Evaluations of day camp programs supported by the AFF Program to educate farm youth demonstrate that the camp programs are effective in raising safety awareness

and behavior change in children. In 2006, such day camp program "Progressive Agriculture Safety Days" are projected to reach 59,000 children.
- The summaries and recommendations of our investigations into the leading causes of death in logging – being struck by falling objects and machinery events – have been distributed nationally by the American Pulpwood Association.
- In California, the AFF Program's Social marketing Farm Safety Diffusion Tool project conducted a TV, radio and newspaper media campaign to deliver safety information to farm workers and employers. Three hundred copies of a multi-media tractor safety and field sanitation package, Loteria del Manejo Seguro, have been sold in California as another part of the campaign. These training materials have been recognized in California and Arizona as effective training tools for non-English speaking agricultural workers.

While much has been accomplished, much remains to be done. In 2005, NIOSH named AFF as one of the eight industry sector groups to be addressed by the second ten years of NORA (http://www.cdc.gov/niosh/programs/agff/). In the coming years, the AFF Program, in conjunction with its partners and stakeholders, will rededicate itself to explore new areas of research, facilitate moving research to practice in the workplaces of agricultural workers, loggers and fishermen, and evaluate the impact of our program on reducing injuries, disease and death among these workers.

Chapter 1. Introduction to NIOSH

1.1 Overview

The National Institute for Occupational Safety and Health (NIOSH) is the Federal agency responsible for conducting research and making recommendations for the prevention of occupational injury and illness. NIOSH is part of the Centers for Disease Control and Prevention (CDC) in the Department of Health and Human Services (DHHS).

Surveillance data published by the U.S. Bureau of Labor Statistics (BLS) documents the burden of injury and illness associated with work. In 2002, there were 5,524 occupational fatalities in the private sector, an average of 15 per day [BLS 2002]. In 2003, there were 4.4 million non-fatal injuries and illnesses in the private sector [BLS 2003]. This human toll is accompanied by significant economic cost. The Liberty Mutual 2004 Workplace Safety Index estimated that direct costs for occupational injuries alone were $49.6 billion in 2002 [Liberty Mutual Insurance Company 2005].

Changes in the work place will likely create new challenges for preventing occupational injury and illness. As the U.S. economy shifts from manufacturing to services and industries shift from older to newer technologies, there are resulting changes in the distribution of jobs and their associated hazards. Work force demographics are also changing. By the year 2008, the U.S. workforce will grow to an estimated 155 million, with minorities constituting 28 percent of the workforce and women 48 percent. The work force is also aging. By 2010, middle and older age workers will outnumber younger workers. Finally, there have been important changes in the conditions under which work is performed. Longer work hours, longer shifts and compressed work weeks; part-time and temporary work; around the clock shift work; and reduced job security are all realities of the modern workplace. NIOSH must work not only to prevent the occupational injuries and illnesses of today, but also to anticipate and prevent those of tomorrow.

To meet the challenges of occupational safety and health, NIOSH is guided by its mission to provide national and world leadership to prevent work-related illnesses and injuries [NIOSH 2004]. In carrying out this mission, NIOSH adheres to a core set of values:

- Relevance – Our programs are responsive to the occupational safety and health problems that are found in today's workplaces and the workplaces of tomorrow.
- Diversity – Our employees reflect the full spectrum of diversity found in the U.S. workforce and our research and interventions reflect the diversity of solutions needed for the U.S. workplace.
- Quality – We utilize only the best science, the highest level of data quality, and the most transparent and independent peer-review.
- Partnership – We accomplish our mission in partnership with employers and workers as well as in academia, industry, government, and scientific and professional communities, both nationally and internationally. These partnerships are formed strategically to improve planning, execution, and review of NIOSH research. They also help translate and transfer research outputs to the workplace

- Access – Our customers can obtain all NIOSH products and services through expanded traditional and electronic access.
- Performance – Our programs are results-oriented.
- Accountability – Our programs are evaluated by how well they solve the occupational safety and health problems found in today's workplaces and the workplaces of tomorrow.

1.2 Legislative Foundations

The main legislative underpinnings of NIOSH are the Federal Coal Mine Health and Safety Act of 1969 (amended in 1977) and the Occupational Safety and Health Act of 1970. The "Coal Act" was passed in the aftermath of a devastating coal mine explosion that occurred in Farmington, WV in 1968. It took the lives of 78 miners and crystallized public opinion that stronger measures were needed to protect coal miners at work. The Coal Act specified a comprehensive set of preventive measures, including dust exposure limits; frequent mine inspections with fines for noncompliance with safety regulations, respirator approval for use in mines, health screening and job transfer of miners with coal workers' pneumoconiosis, and research. Activities required by the Coal Act were split between the Department of Health, Education and Welfare, which engaged in non-regulatory activities such as health screening and research; and the Mine Enforcement and Safety Administration in the Department of the Interior (DOI), which engaged in developing and enforcing workplace safety and health regulations in the mining industry. NIOSH subsequently assumed the health screening and research responsibilities specified under the Coal Act after its creation by the Occupational Safety and Health Act of 1970 (see below). When the Coal Act was amended in 1977, the Mine Enforcement and Safety Administration was replaced by the Mine Safety and Health Administration (MSHA) in the Department of Labor.

The Occupational Safety and Health Act of 1970 (Public Law 91-596 [US Congress 1970]; http://www.osha.gov/pls/oshaWeb/owadisp.show_document?p_table=OSHACT&p_id=3355 (Appendix 1-01) followed closely after the Coal Act. It created both NIOSH and the Occupational Safety and Health Administration (OSHA), which is in the Department of Labor and is responsible for developing and enforcing workplace safety and health regulations in industries other than mining.

Information pertaining to the responsibilities of NIOSH are found in Section 22 of the Occupational Safety and Health Act of 1970 [29 Code of Federal Regulations (CFR) § 671]. The Institute is authorized to:

- Develop recommendations for occupational safety and health standards
- Perform all functions of the Secretary of Health, Education and Welfare (subsequently Health and Human Services) under Sections 20 and 21 of the Act
- Conduct research on worker safety and health (Section 20)
- Conduct training and employee education (Section 21)
- Develop information on safe levels of exposure to toxic materials and harmful physical agents and substance
- Conduct research on new safety and health problems

- Conduct on-site investigations to determine the toxicity of materials used in workplaces (Health Hazard Evaluations [HHEs] - 42 CFR Part 85; and General Research Authority – 42 CFR Part 85a)
- Fund research by other agencies or private organizations through grants, contracts, and other arrangements

The Federal Mine Safety and Health Amendments Act of 1977 (which superseded the Coal Act of 1969) specified a number of authorities for NIOSH in coal mining health research. The Mine Safety and Health Law authorized NIOSH to:

- Develop recommendations for mine health standards for MSHA
- Administer a medical surveillance program for miners, including chest x-rays to detect pneumoconiosis (black lung disease) in coal miners
- Conduct on-site investigations in mines similar to those authorized for general industry under the Occupational Safety and Health Act
- Test and certify personal protective equipment and hazard-measurement instruments

Mining safety and health remain an ongoing concern of NIOSH. This year, the Mine Improvement and New Emergency Response (MINER) Act of 2006 was enacted in the wake of the Sago Mine explosion. The MINER Act amends the Federal Mine Safety and Health Act of 1977. The act creates regulations enforceable by MSHA to improve accident preparedness and response. The act also specifies that NIOSH create an Office of Mine Safety and Health. The purpose of the office is, "to enhance the development of new mine safety technology and technological applications and to expedite the commercial availability and implementation of such technology in mining environments." The office is to achieve this purpose through competitive grants, contracts, and by establishing an interagency working group for mine safety.

Thus, Congress has set a clear division between the research function of NIOSH; and the regulatory and enforcement functions of MSHA and OSHA. Although NIOSH works together with MSHA and OSHA to achieve the common goal of protecting worker safety and health, NIOSH simultaneously maintains its unique identity as the sole Federal government organization primarily charged to conduct occupational safety and health research.

Through its legislated authorities, NIOSH gathers information, conducts scientific research, and translates the knowledge gained into products and services. NIOSH's mission is critical to the health and safety of every U.S. worker.

1.3 Organizational Structure and Management

NIOSH is located within the CDC. CDC, in turn, is located within DHHS. The NIOSH Director is appointed by the DHHS Secretary and reports to the CDC Director. DHHS has recently implemented performance-based management, in which management responsibilities cascade through the administrative structure. Thus, each manager has formal responsibilities written into their performance plan specifically tailored to support the responsibilities of others higher in the management chain. Under this system of management, responsibilities ultimately derive from priorities established by the Office of Management and Budget (OMB), a component of the White House.

The administrative structural components of NIOSH are shown in Figure 1-1. The main organizational units are divisions and laboratories. These are a mixture of disease and injury-specific divisions (respiratory diseases, safety research), expertise-specific divisions (applied research and technology, laboratory research, surveillance and field studies, education and information dissemination), and industry-specific units (mining). The divisions and laboratories are geographically dispersed in Cincinnati, Morgantown, Pittsburgh, and Spokane. NIOSH leadership is located in Washington, DC, and Atlanta. To coordinate across these geographically dispersed units, NIOSH makes extensive use of modern information technology, including e-mail and video conferencing ("envision").

Table 1-1: NIOSH Program Portfolio
NORA Sector Programs (n=8)
Agriculture, Forestry and Fishing
Construction
Healthcare and Social Assistance
Manufacturing
Mining
Services
Wholesale and Retail Trade
Transportation, Warehousing and Utilities
NIOSH Cross-Sector Programs (n=15)
Authoritative Recommendations
Cancer, Repro and Cardiovascular
Communications and Information Dissemination
Emergency Preparedness/Response
Global Collaborations
Health Hazard Evaluation
Hearing Loss Prevention
Immune and Dermal
Musculoskeletal Disorders
Personal Protective Technology
Radiation Dose Reconstruction
Respiratory Diseases
Training Grants
Traumatic Injury
Work Organization and Stress-Related Disorders
NIOSH Coordinated Emphasis Areas (n=7)
Economics
Exposure Assessment
Engineering Controls
WorkLife Initiative
Occupational Health Disparities
Small Business Assistance and Outreach
Surveillance

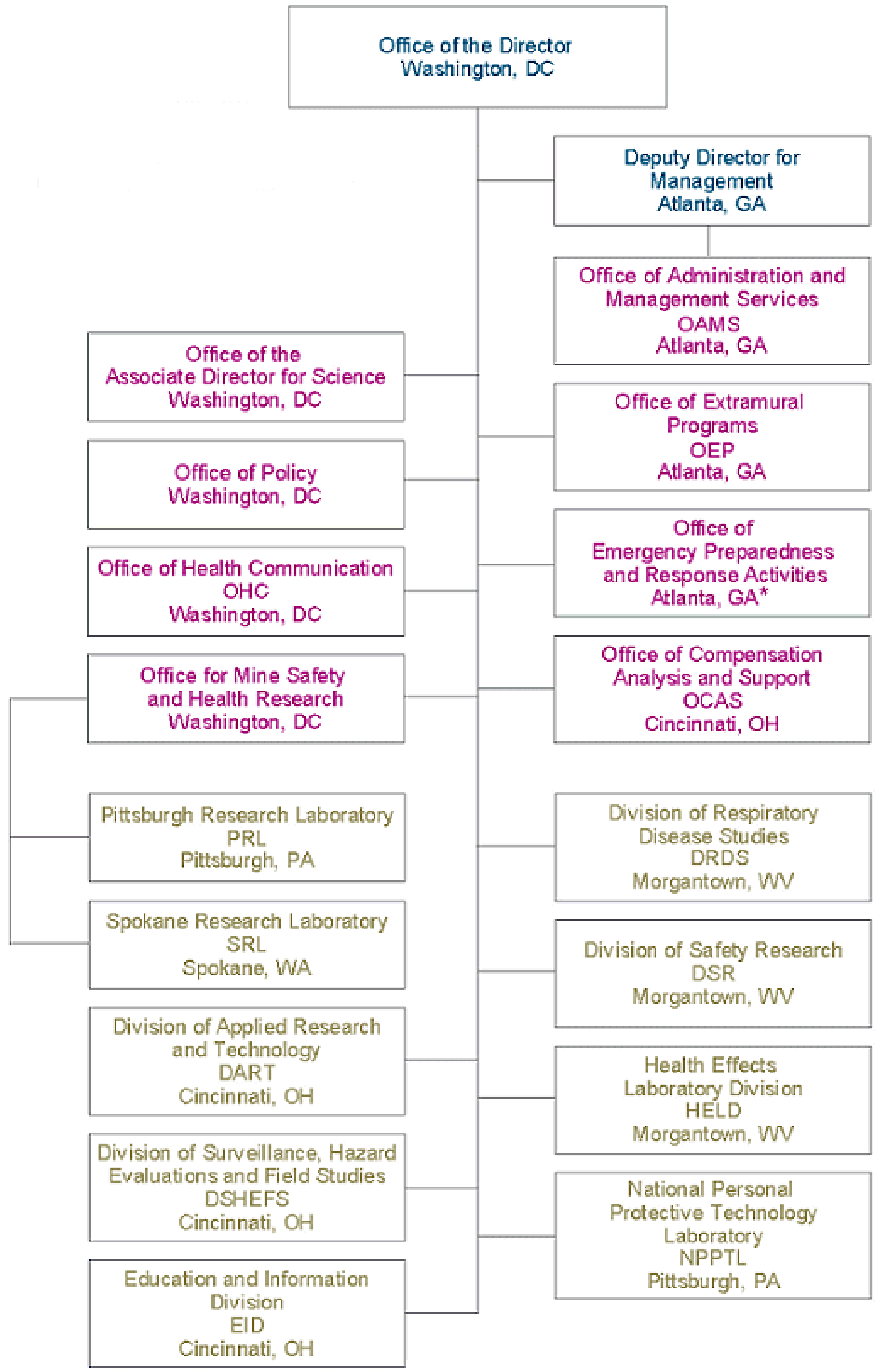


Figure 1-1. Organizational Components of NIOSH

Beginning in 2005, NIOSH developed and implemented a matrix management structure to coordinate cross-institute programmatic activities. This “Program Portfolio” created formal management for such activities. One of the industry sector activities within the matrix management structure is the Agriculture, Forestry, and Fishing (AFF) Program, which will be described in more detail in chapter 2. The industry sector, cross-sector, and the emphasis areas programs are listed in Table 1-1.

NIOSH is committed to performance-based management. It has recently developed several key performance indicators to track organizational performance. Examples include tracking of financial performance by establishing and monitoring the percent of total funding to divisions and laboratories used for discretionary purposes (i.e., not personnel, salary, and benefits). The NIOSH target is 25 percent discretionary by 2010. The FY 2006 ratio was 20 percent. Another example is optimizing the ratio of supervisory staff to non-supervisory staff. CDC established a FY 2006 goal of 1:10. In FY 2006, the NIOSH ratio was 1:13.

NIOSH management occurs within the context of broader federal management requirements and initiatives. The 1993 Government Performance and Results Act mandated that federal agencies develop multiyear strategic plans, annual performance plans, and annual performance reports.

Another management requirement is responsiveness to the OMB Program Assessment Rating Tool (PART) (Appendix 1-02) which is used by OMB to assess federal agency performance on a number of measures including strategic planning, program management, and program results. PART performance ratings are an important consideration in budget requests by the President. Current NIOSH key performance measures for PART were established in 2004. They target the following safety and health-focused achievements by 2014:

- 50 percent reduction in the respirable coal dust overexposures of operators of longwall and continuous mining machines, roofbolters, and surface drills
- 40 percent reduction in the number of workers being struck by construction vehicles and equipment in the road construction industry
- 75 percent of professional firefighters and first responders have access to CBRN respirators

NIOSH receives external guidance and advice from two Federal Advisory Committees. The Board of Scientific Counselors (BSC) is composed of external authorities from a variety of fields related to occupational safety and health. The BSC members provide advice and guidance to NIOSH in developing and evaluating research hypotheses, systematically documenting findings, and disseminating results that will improve the safety and health of workers. They also evaluate the degree to which NIOSH activities: 1) conform to standards of scientific excellence in accomplishing objectives in occupational safety and health; 2) address currently relevant needs in the field of occupational safety and health, either alone or in collaboration with activities outside of NIOSH; and 3) produce their intended results in addressing important research questions in occupational safety and health, both in terms of applicability of the research findings and dissemination of the findings. The Mine Safety and Health Research Advisory Committee performs a similar function, except it is focused on issues related to occupational safety and health in mining.

Another source of external input is the National Advisory Committee on Occupational Safety and Health (NACOSH). NACOSH was created under Section Seven of the Occupational

Safety and Health Act of 1970 to advise NIOSH and OSHA on occupational safety and health programs and policies. Members of the 12-person advisory committee are chosen on the basis of their knowledge and experience in occupational safety and health. Two members represent management, two members represent labor, two members represent the occupational health professions, two members represent the occupational safety professions and four members represent the public. Two of the health representatives and two of the public members are designated by the Secretary of Health and Human Services, although actual appointment of these members, as well as all other members, is by the Secretary of Labor. The members serve two-year terms. NIOSH and OSHA provide staff support for NACOSH. The Director of NIOSH and the Assistant Secretary of Labor for Occupational Safety and Health both usually attend NACOSH meetings. It is a vehicle not only for external input for the agencies but also a body to whom the agencies must be responsive. NACOSH meetings are held twice each year and are open to the public.

1.4 Resources

The NIOSH budget is a direct appropriation from Congress, as a specific line item in the DHHS/CDC appropriation. The Congressional language that accompanies the funding appropriation often contains specific directives about the intended use of portions of the funds. For example, these “earmarked” directives instruct NIOSH to use specific portions of the funds to conduct research which targets certain industries such as agriculture or construction, or to support research or surveillance initiatives such as the National Occupational Research Agenda (NORA), Emergency Preparedness, the Department of Energy special exposure cohort study, or the enhanced coal workers’ health surveillance program. In addition, Congress or DHHS may charge NIOSH to lead or participate in evolving public health activities such as the World Trade Center health surveillance efforts; however, funding is not always provided to support these efforts. Prior to fiscal year 2006, the CDC tapped a portion of the NIOSH budget to offset the cost of administrative and infrastructure support provided by the CDC and to fund the NIOSH portion of costs associated with business consolidations established under the President’s Management Agenda. Beginning in 2006, Congress moved the charges associated with business support services from the NIOSH appropriation and appropriated the funding directly to the CDC (approximately $35 million). Escalating personnel costs, combined with projections of diminished appropriations and continuing “earmark” obligations, create significant challenges to NIOSH as it strives to fulfill its mission and optimize its impact on occupational safety and health problems.

Table 1-2: NIOSH Budget, 1996 – 2006

NIOSH Budget: 1996 – 2006

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Budget (in millions)	**$161**	**$173**	**$184**	**$204**	**$226**	**$260**	**$276**	**$273**	**$277**	**$286**	**$255***
Adjusted (BRDPI)**	**$161**	**-**	**-**	**-**	**$199**	**$221**	**$227**	**$217**	**$212**	**$211**	**$182**

* In 2006, Congress redirected $35M from the NIOSH budget appropriation to CDC for Business Support Services.
** NIH-Biomedical Research and Development Price Index (BRDPI). Figures shown as millions of 1996 dollars.
- Data not provided to allow calculation of index: http://officeofbudget.od.nih.gov/UI/GDP_FromGenBudget.htm

In fiscal year 2006, $255 million was appropriated for NIOSH. Table 1-2 shows NIOSH funding for the years 1996 through 2006, with adjustments for inflation and application of the biomedical research index. The reduction between 2005 and 2006 reflects costs to NIOSH of CDC business consolidations. After adjustment of funding for the Biomedical Research and Development Price index, which adjusts not only for inflation but also for increased costs of conducting scientific investigation due to new technologies, etc., NIOSH has had only a modest increase in funding since 1996. Essentially all of the increase is the result of funding earmarked for NORA priorities.

The NIOSH staffing level is approximately 1413 Full-Time Equivalents (FTE). This level has fluctuated over the past decade from a low of 1364 FTE in 1996 to a peak of 1521 FTE in 2003 and then a subsequent steady decline to the current level. The increases leading to the peak in 2003 can be attributed, in part, to NIOSH absorbing the research teams of the former Bureau of Mines and the establishment of a new Health Effects Laboratory Division (HELD) and National Personal Protection Technology Laboratory (NPPTL). A breakdown of NIOSH research staff by professional discipline is shown in Figure 1-2.

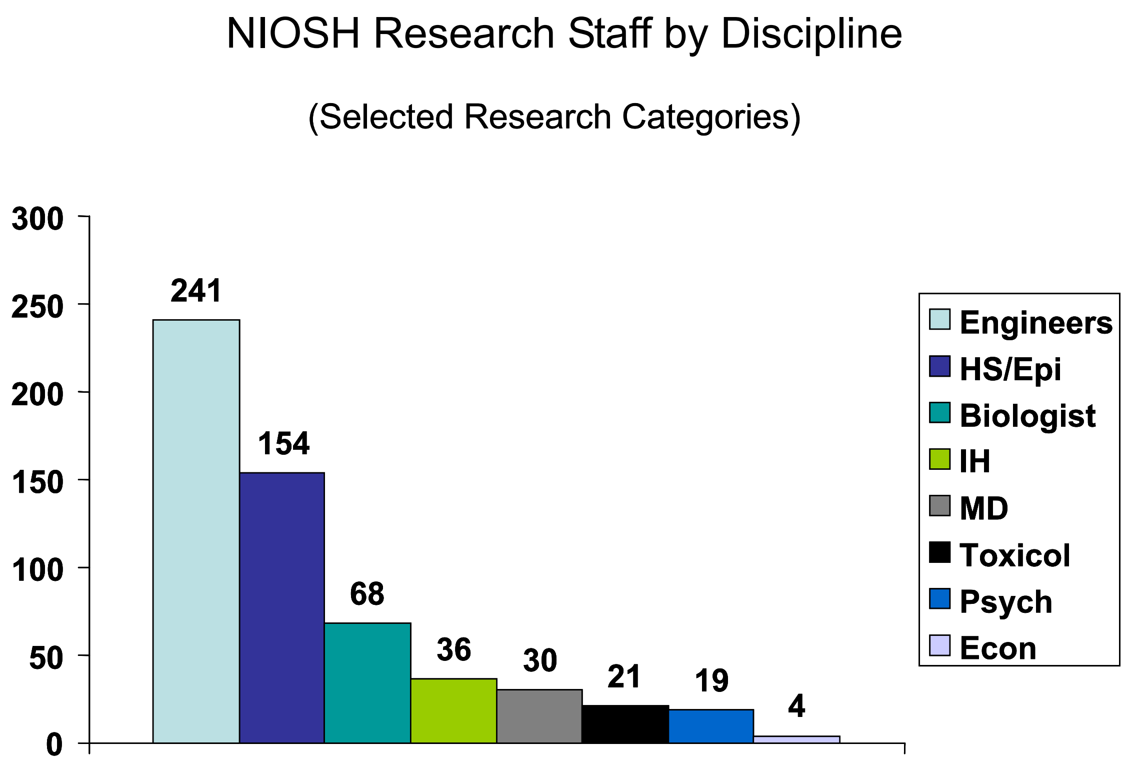


Figure 1-2: NIOSH research staff by discipline

1.5 Planning and Logic Model

NIOSH has a long history of organized planning to optimize its relevance and impact. During the 1980s, NIOSH conducted a series of national symposia on the leading causes of occupational-related illness and injury. Those meetings resulted in 10 written strategies for prevention that guided NIOSH research programs during the early 1990s (including occupational lung diseases). In April 1996, NIOSH and its partners unveiled NORA, a framework to guide occupational safety and health research into the new millennium—not only for NIOSH but for the entire occupational safety and health community. Approximately 500 organizations and individuals outside NIOSH provided input into the development of NORA. The NORA process resulted in a list of 21 research priorities in occupational safety and health (www2a.cdc.gov/nora/). Teams of researchers and other stakeholders were organized primarily according to types of health problems or disciplinary approaches for each of these priority areas. Many of the teams published agendas for research. NIOSH researchers were prominent in those efforts.

During the NORA process, NIOSH developed a strategic plan from 1997 and followed it until 2002 (http://www.cdc.gov/niosh/gpran1a.html). A new plan has been developed for 2004 to 2009 (http://www.cdc.gov/niosh/docs/strategic/). The strategic goals of this plan are to:

- Conduct research to reduce work-related illnesses and injuries
- Promote safe and healthy workplaces through interventions, recommendations and capacity building
- Enhance global workplace safety and health through international collaborations

NORA is being updated to address the needs of another decade (http://www.cdc.gov/niosh/NORA/). The second decade of NORA is being organized to prepare research agendas primarily along the lines of major industrial sectors. As was the case in the initial NORA process, research agendas are being developed with broad involvement and input from all parties with an interest in occupational safety and health. This renewal for NORA is intended to bring NIOSH even closer to the problems of U.S. industries and workers.

NIOSH has developed an operational logic model to assure that its strategic planning activities are logical, appropriate, and optimize NIOSH's relevance and impact (Figure 1-3). The logic model formally depicts the planning process. It moves from left to right across the chart, beginning with production and planning inputs. Those inputs lead to NIOSH research activities. The outputs of NIOSH research activities lead to customer activities. Some NIOSH customers are intermediaries who use or adapt NIOSH outputs before they reach the final customers: employers, employees, industries, educators, and regulators. Their actions help NIOSH to contribute to the improvement of safety and health in the workplace. This process is affected by a variety of external factors including economic and social conditions and the regulatory environment.

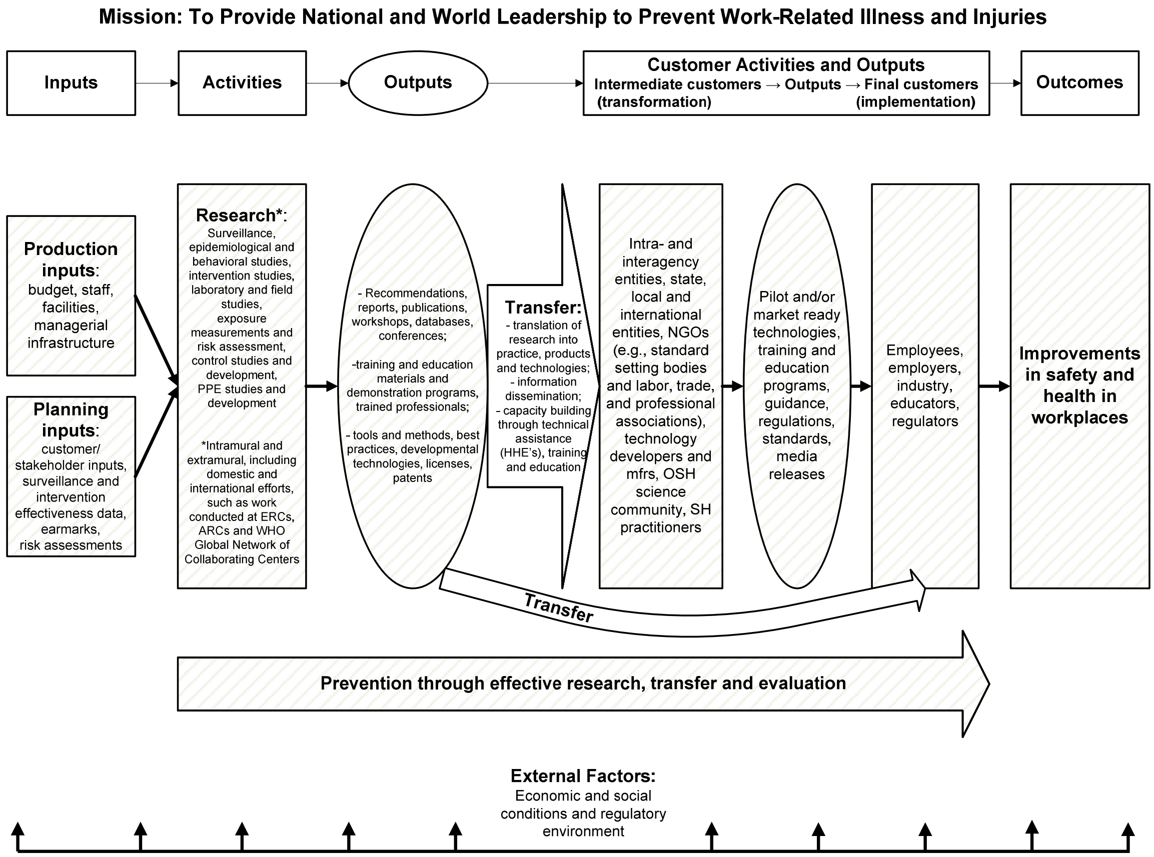


Figure 1- 3. The NIOSH Operational Logic Model

A brief discussion of logic model elements follows.

Planning inputs are data that guide NIOSH to research action. Many sources, in addition to NIOSH sources, build these data summaries. They come from workplaces, surveillance, risk assessments, intervention effectiveness data, and from the Institute's stakeholders and customers. One of the major planning activities for NIOSH is the collection, analysis, and interpretation of health and hazard data. NIOSH uses illness, injury, fatality, exposure, and hazard data for those purposes. NIOSH actively engages in surveillance to obtain data that can guide its efforts. The "NIOSH Worker Chartbook," now in its second edition, is an important source of occupational health surveillance data (Appendix 1-03).

An often-overlooked issue is that inputs do not only turn activities on. They also serve to turn off activities that have been completed, have become lesser priorities, or have otherwise outlived their usefulness.

Activities encompass a broad range including many types of research; field investigations of work places; surveillance; policy development; and health communications.

There are over 1,000 active research projects being conducted at NIOSH. In broad terms these projects encompass a large number of areas and disciplines, such as:

- Hazard control development and testing, epidemiology, behavior, toxicology, biology, and risk assessment
- Development and testing of personal protective equipment for the workplace
- Development of environmental sampling and testing methods
- Performance of both laboratory-based and field research: intramural, extramural, domestic, and international
- Developing practical workplace interventions, testing them, and when they are effective, promoting their adoption in the workplace

Another type of activity is the Health Hazard Evaluation (HHE) Program. Under Section 20 of the Occupational Safety and Health Act of 1970, NIOSH performs inspections and investigations into workplace hazards. This activity frequently results in development of research knowledge that is beneficially applied in the workplace. All programs contribute to this effort, and a broad range of expertise is required. The goal is to assist employers and employees by evaluating and recommending solutions to workplace safety and health issues. Typically between 300 and 500 HHE requests are received annually. HHE reports are available to other customers and stakeholders.

Another NIOSH activity is operation of two programs in fatality investigations, one in fire fighter fatality investigation and prevention and another in fatalities among other groups of workers. In 2003, the latter program focused on deaths of workers under 18 years of age, deaths in roadway construction zones, and deaths involving machinery. This program is currently active in 21 states. In both programs, investigators assess the circumstances around each fatality to formulate prevention strategies. Plans are then designed for the dissemination of those strategies.

Another activity supported by NIOSH is training. NIOSH-supported training prepares professionals in occupational safety and health and also serves the function of transferring NIOSH research into the workplace. NIOSH developed university-based Education and Research Centers (originally named Educational Resource Centers) in 1977 to meet the needs for trained safety and health professionals. NIOSH currently funds 16 Education and Research Centers at leading universities to provide graduate and continuing education programs in occupational medicine, occupational health nursing, industrial hygiene, safety, and other related disciplines. These centers also serve as regional resources for all those involved with occupational safety and health including industry, labor, government, academia, and the general public. The centers are funded for up to five years through a competitive peer-review process. NIOSH also supports approximately 40 smaller training project grants that are also focused on providing qualified professionals for the field.

Outputs and Transfer: The result of research is new knowledge. New knowledge serves society by providing practical guidance on matters of importance to the population. Research programs are obligated to contribute to the advancement of society by integrating this new knowledge. NIOSH carries out the responsibility to disseminate results of its research with a variety of outputs such as: reports, publications, recommendations, workshops, databases, tools and methods, training and education materials, demonstration projects, best practices, developmental technologies, and licenses and patents.

Efforts to maximize the impact of NIOSH outputs through effective transfer to customers are coordinated by the Office of Health Communications. This office works with each research program to plan and execute communications strategies designed to reach a variety of customers for those outputs. Customers include employers and their groups, employees and their groups, standards-setting organizations, professional associations, and the general public. NIOSH researchers publish in peer-reviewed publications and present their work at conferences. They also publish NIOSH documents and other information products. The NIOSH publications office stocks more than 4,200 NIOSH document titles. It distributed nearly a million printed publications and CD-ROMs in 2003. A survey of four occupational safety and health professional organizations indicated that NIOSH is effectively reaching several of its intended audiences with credible and useful information.

A special kind of output is NIOSH documents, testimony, and other communications on criteria for recommended standards for safety and health hazards in the workplace. These criteria represent the formal link between NIOSH and OSHA or MSHA; and between research and rule-making. For example, NIOSH scientists recently testified to OSHA about their proposed new rule on hexavalent chromium, a carcinogen and skin irritant. In FY 2003, NIOSH prepared science-based comments on 15 regulatory activities at the Departments of Labor, Transportation, and Justice. NIOSH also provided testimony for CDC at two Congressional hearings in 2003, one on the subject of aircraft cabin air quality and one on anthrax detection and sampling.

Since its inception, NIOSH has been strongly committed to transferring its outputs to customers. In recent years, newer electronic media has enhanced this effort. NIOSH has a Web site that supports approximately 500,000 user sessions (and about 2.8 million page views) per month. NIOSH also operates a technical information inquiry service that includes an 800 number and an internet inquiry response service. In FY 2003, NIOSH responded to more than 100,000 inquiries by phone and almost 3,800 by Internet.

In 2004, NIOSH created an Office of Research and Technology Transfer to provide formal administrative support for the concurrently developing NIOSH Research to Practice (r2p) Initiative. The office and r2p policies help ensure that NIOSH considers these issues in making funding decisions and that NIOSH researchers consider issues such as translating their research findings into best practices, products, and technologies and dissemination of those products from the very beginning of their research projects.

Outcomes: As NIOSH research is transferred, the Institute often moves into more dependent partnerships with others, and has less control of what happens. The resources required to have an affect are less predictable, the outcomes are less sure, and the results harder to verify. These partners include employers, labor and industry groups, and regulatory bodies. In addition, there are manufacturers who adopt new NIOSH technologies as products for the marketplace, or help develop them further. These *customer activities and outputs* are crucial to NIOSH having real-world impact. Influencing and motivating the actions of others is an *intermediate outcome*.

An *outcome* is a NIOSH contribution to reducing morbidity or mortality due to occupational injuries or diseases. Especially for diseases of long latency, such as induction of cancer by carcinogens, objective evidence of reduction in causative exposures may be considered a surrogate outcome, as in the NIOSH PART goal specifying reduction in coal mine dust exposure.

In many instances it is difficult to effectively trace the contribution of NIOSH to end outcomes. Many groups contribute to reducing occupational injuries and illnesses and to creating safer places to work. Still, NIOSH is strongly committed to developing objective measures of its real-world performance. If the best measures of performance relate to motivating and enabling others to make work safer, this in no way diminishes the importance of the accomplishment.

1.6 References Cited

Bureau of Labor Statistics [2002]. National Census of Fatal Occupational Injuries in 2002. [http://www.bls.gov/iif/oshwc/cfoi/cfnr0009.pdf].

Bureau of Labor Statistics [2003]. Workplace Injuries in Illnesses in 2003. [http://www.bls.gov/news.release/pdf/osh.pdf].

Liberty Mutual Insurance Company [2005]. Despite 6.2 percent fall in the number of serious workplace injuries, their financial impact on employers remains huge. [http://www.libertymutual.com/omapps/ContentServer?cid=1029415782133&year=2005&prid=1078448761279&pagename=ResearchCenter p2FPage percent2FPressReleaseOrange&C=Page].

NIOSH Strategic Plan. [http://www.cdc.gov/niosh/docs/strategic/].

US Congress [1970]. Occupational Safety and Health Act of 1970, Public Law 91-596, 29 USC 651, SEC. 2-B.

Chapter 2. Agriculture, Forestry, and Fishing Program Overview

More than 3.1 million workers were employed in the agriculture, forestry, and fishing industry during 2001. Compared with all industries, agriculture employed proportionately more workers aged 16-19 (7.2% versus 5.1% for all industries) and workers aged 55 and older (22.9% versus 13.6% for all industries) [BLS 2001b]. Farm tractors accounted for 2,165 fatal occupational injuries during 1992-2001 and were the leading source of these deaths in agriculture, forestry, and fishing. Trucks and fishing boats were also major sources of death in this industry and accounted for 795 and 434 fatal occupational injuries, respectively [BLS 2002a; Myers 2003]. During 1992-1997, machinery caused 1,021 fatal occupational injuries and was the leading cause of these deaths in agriculture, forestry, and fishing as reported on death certificates. The next leading causes of these deaths were motor vehicles (624 fatalities) and falls (235 fatalities) (NIOSH Worker Health Chartbook, 2004).

Fatalities

In 2004, Agriculture, Forestry and Fishing industries recorded 659 fatal work injuries. The majority of fatal injuries in these industries occurred in crop production (Table 2-1) (Bureau of Labor Statistics Census of Fatal Occupational Injuries Summary, 2004).

Table 2-1. Fatal occupational injuries* by private industry † and selected event or exposure, 2004

Sector / program	Fatalities		Selected event or exposure §			
	No.	%	Highway	Homicide	Falls	Contact with Object
Agriculture, Forestry and Fishing	659	12	15	1	5	21
Crop production	317	6	15	1	4	17
Animal production	141	2	15	-	11	10
Forestry and logging	106	2	17	-	3	60
Fishing, hunting and trapping	37	1	-	-	-	-
Agriculture and forestry support activities	45	1	16	-	-	11

* Totals include data for industries not shown separately.
† Based on the North American Industry Classification System, 2002.
§ The figure shown is the percent of the total fatalities for that industry group.
Source: BLS 2004

Workers in the agriculture, forestry, and fishing industries face a host of challenges that increase their risk of exposure to hazardous agents, injury, illness, and death. Agriculture ranks as the highest risk sector for occupational fatalities in the United States [NIOSH 2004]. Moreover, agricultural workers and their families have encountered a disproportionate number of injuries and diseases associated with physical, chemical, and biologic hazards.

Most farm workers receive low pay and perform strenuous work outdoors in all kinds of weather [BLS 2006], and they often perform their jobs in isolation. The fishing and forestry industries encounter equally challenging working conditions. For instance, Alaska's commercial fishermen work in one of the world's harshest environments, enduring isolated fishing grounds, high winds, seasonal darkness, frigid water and icing, and short, pressured fishing seasons. Fatigue, physical stress, and financial pressures confront most Alaska fishermen throughout their careers [Dzugan 1994; Committee on Fishing Vessel Safety 1991]. U.S. Data reported in 1989 indicated that fishing had a fatality rate of 80 deaths per 100,000 workers—five times the sector average of 21 deaths per 100,000 workers [Murphy 1992]. Logging is often considered to be one of the most dangerous industry segments in the United States, and wildland firefighting is a high-risk occupation [Langley 1997].
In the agriculture industry, age of workers is a factor in injury incidence as well. Compared with other industries, agriculture workers are overrepresented at both ends of the age continuum. In 2001, agriculture employed proportionately more workers aged 16–19 (7.2% versus 5.1% for all industries) and workers aged 55 and older (22.9% versus 13.6% for all industries) [BLS 2001]. An estimated 1.08 million children and adolescents under age 20 resided on farms in 2001, with approximately 593,000 of these youth performing work on the farms. In addition to the youth who live on farms, more than 400,000 children and adolescents were hired to work on U.S. farms in 2001 [NIOSH 2006].

A principal challenge for the AFF Program is intervening on behalf of a largely unregulated sector of the United States workforce. OSHA lacks authority for most of the agricultural workforce since much of that work force is self-employed or consists of unpaid family labor, and OSHA is restricted from inspecting farms that employ fewer than 11 workers at those worksites [OSHA 1992].

To address the situations described above, the AFF Program is conducting a planned program of research to promote safety and health in agriculture, forestry, and fishing. The AFF Program focuses on five areas of research: surveillance, priority populations at risk, health effects of agriculture exposures, control systems, and health promotion systems.

This evidence package presents the events that influenced the development of the AFF Program, describes the program as it has matured, presents both quantitative and qualitative inputs for the program, discusses the AFF Program activities and associated outputs, and sets forth the intermediate and end outcomes of the program.

Future plans are presented regarding the sector-based approach in the second decade of NORA. NIOSH has selected agriculture, forestry, and fishing as one of eight sectors for this approach and is emphasizing an agenda with research goals, objectives, and action plans. This agenda will provide guidance to the agricultural safety and health community for moving from research to practice on farms and in other agricultural workplaces.

2.1 Program Characteristics

The AFF Program has been planned and executed consistent with the purpose set forth in the Occupational Safety and Health Act of 1970: "to assure so far as possible every working man and woman in the Nation safe and healthful working conditions and to preserve our human resources." The implementation of the program was essentially bottom-up: given the problem, the researcher or intervener could better judge the actions necessary to prevent the problem. Since NIOSH is a research organization and can often only intervene indirectly, it depends on direct interventions by others.

The program's first of two phases extended from 1990 to 1996, when it was launched and matured. The second phase began with the start of NORA in 1996 [NIOSH 2005]. Projects begun in the first phase continued into the second phase, and some completed actions in the first phase had a latent and sustainable impact on outcomes in the second phase and beyond. Overall, the program was driven by the goal of reducing occupational diseases and injuries.

2.2 Program History

Two social factors contributed to the initiation of the AFF Program in 1990: a loose network of professionals engaged in agricultural safety and health and the insufficiency of OSHA's regulatory activity in the agriculture industry.

2.2a Loose Network of Safety and Health Professionals

The network of agricultural safety and health professionals drew elements from the agricultural community, the medical community, and the public health community. Connections between the groups were episodic and infrequent.

Beginning with a circular published in 1931 by the Nebraska Cooperative Extension Service on farm-related-injuries [Jewell 1931], the involvement of the agricultural community spread from State-level organizations to the NSC and the National Institute for Farm Safety (NIFS). The American Society of Agricultural Engineers (ASAE) developed consensus safety standards for farm equipment. In 1972, Congress appropriated $1 million to establish safety extension agents in each State [Murphy 2003]. That annual funding level continued until 2005 when the funding ended. In Fiscal Year 1990, when the AFF Program began, NSC had an Agricultural Division, NIFS was active, the ASAE maintained a safety standards committee, and a system of United States Department of Agriculture (USDA) safety extension agents existed.

Within the medical community, the focus was on injuries associated with farm machinery and livestock [Young and Ghormley 1946] and diseases such as those following ammonia exposure including inhalation [Kass et al. 1972; Helmers et al. 1971] and farmers' lung [Williams 1963; Festenstein et al. 1965]. With time, a preventive approach developed with a broader view of agricultural safety and health including zoonosis control, toxicology, safety, and sanitation [Berry 1965]. In Iowa and Wisconsin, special medical centers developed knowledgeable professionals as experts in these diseases. The National Farm Medicine

Center was established in 1981 in response to occupational health problems seen in farm patients coming to the Marshfield Clinic in Wisconsin [Mazza 2006]. Likewise, the Institute of Agricultural Medicine and Occupational Health was established in Iowa, the Institute of Rural Environmental Health at Colorado State University, the New York Center for Agricultural Medicine and Health in Cooperstown, NY, and the Centre for Agricultural Medicine in Saskatoon, Saskatchewan, Canada [Nat. Coalition for Ag. Safety and Health 1988; Dosman and Cockroft 1989; Murphy 2003].

The public health network included NIOSH and its predecessor organizations, other parts of the U.S. Public Health Service, State and local health departments, and schools of public health. Safety and health hazards of working in agriculture were recognized as a public health problem as early as 1935 [Legge 1956].

2.2b Insufficient Regulation

During the 1970s Congressional debate and farm group testimony that led to agriculture's current exemption from OSHA enforcement efforts, regulation foes made use of the "Agrarian Myth." The myth portrays farmers as the bedrock of democracy, suffering so that society may prosper and living a benign and natural life away from the artificiality and evils of cities. In reality, agriculture is one of the most hazardous occupations in the world: adults and young children are engaged in hazardous work with dangerous knives, machetes, tractors, and other farm equipment and are exposed to toxic agrochemicals. However, the low salaries and long work hours that are universal in farm work are not always readily apparent [Kelsey 1994].

The Organization for Economic Cooperation and Development notes that while the agrarian myth is a potent symbol, it confuses modern commercial agriculture with rural heritage and suggests that agricultural policies serve to uphold fundamental social values. Agricultural interests and political pressure can exploit agrarian myths to generate public support for existing programs and to forge common bonds around otherwise unrelated narrow policy benefits. Once persuaded to support vested agricultural interests politicians may have a stake in ensuring that the public is convinced of the worth of their policy actions [Brooks 2003].

2.2c Beginnings of the AFF Program

Agricultural safety and health has been an important focus in NIOSH for more than 30 years. Data from National Traumatic Occupational Fatalities (NTOF) program, begun in 1980, identified agriculture as one of the highest risk occupations as shown in Figure 2-1 [Myers and Hard 1995]. Subsequent research in the 1980s examined the health effects of pesticide exposures and the nature of farm-related lung disease [Olenchock et al. 1986] and also confirmed that the farm tractor was the principal cause of machine-related fatalities across all occupations.

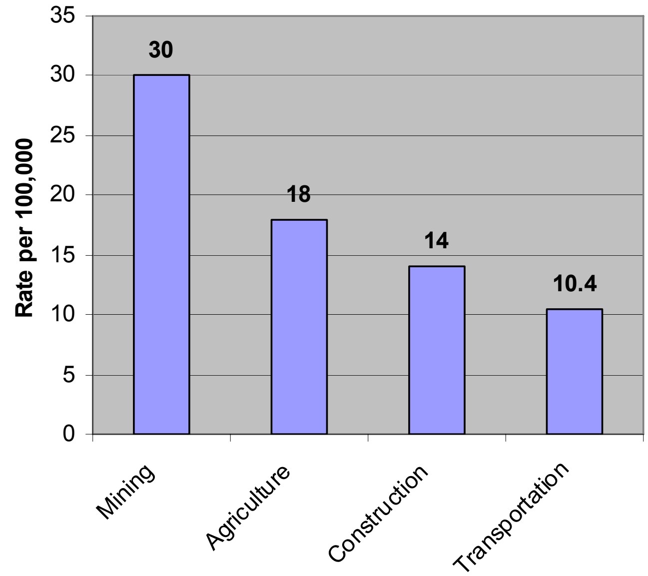


Figure 2-1: Occupational fatalities by four highest industry rates, 1990

In 1988, NIOSH representatives participated in the National Coalition for Agricultural Safety and Health (NCASH), which published a report recommending research initiatives specific to NIOSH [National Coalition for Ag. Safety and Health 1988] (Appendix 2-01). This report spurred funding of a major initiative at NIOSH for agricultural safety and health, as did high death rate and frequency data for agriculture from the NIOSH NTOF database [Murphy 1992].

In 1990, Congress funded the AFF Program to undertake and lead a series of initiatives in surveillance, research, and intervention, which when sustained over a period of time, would significantly and measurably reduce diseases and injuries among rural Americans. This initiative also included activities related to timbering and commercial fish harvesting [NIOSH 1993]. The appropriations language is attached in Appendix 2-02.

NIOSH launched the AFF Program in 1990. It grew in funding over three years to $21.6 million, three-fourths of which was dedicated to extramural funding. Five programs were initiated: a survey of farm family health and hazards in several States, a surveillance and intervention program based on a community nurse model, a land grant university program, a demonstration program using medical contacts as an intervention for recognizing and preventing cancers among rural residents, and agricultural research and intervention centers. Much of the research was focused on lung diseases, pesticides, and engineering controls [Fine 1995].

Efforts to assist this highly varied workforce distributed throughout the Nation have encountered substantial challenges. Many of the workers lived and worked in rural or remote areas, far from services. They worked long hours, often self-employed or working for a small employer. Furthermore, the science of preventing agricultural injuries was only starting to take root in the United States. Safer tractor designs had only recently been required on new equipment, and numerous new agricultural chemicals were being deployed in fields and used on livestock each year.

No single division of NIOSH was fully prepared to deal with such a wide range of problems. NIOSH is organized into functional divisions, each one focusing on one type of worker illness or injury, or offering one major category of services (see Figure 1-1). The range of problems to be addressed in agricultural safety and health encompassed or at least touched all NIOSH divisions, so projects were started in multiple divisions, with no formal structure or vertical management for this large and growing program. Projects, per the general practice at NIOSH, were primarily investigator-initiated, proposed to fulfill needs described in general plans, but with very little tactical planning or programmatic management.

Despite the advantages of investigator-originated research, this approach can also lead to critical gaps and distribution of effort and resources that are out of proportion to the observed scale and need for each problem. In general, the programs that have had the most success (e.g., establishing surveillance systems and the child agricultural safety initiative) have been those with strong coordination within the AFF Program and with extramural partners. In other cases, the results have been less uniform. For example, our tractor safety program has led to technological innovation, but with limited penetration of these new technologies (e.g., autorops) into the market or workplace.

Beginning in 1991, the AFF Program established Agricultural Safety and Health Centers by cooperative agreement to conduct research, education, and prevention projects to address the Nation's pressing agricultural safety and health problems. The Centers have five major tasks: 1) develop model programs to prevent illness among agricultural workers and their families; 2) develop model educational programs on agricultural safety and health for workers in agriculture; 3) evaluate agricultural injury and disease prevention programs implemented by agricultural extension programs, State health departments, Federal agencies, and others; 4) conduct applied research and evaluations of engineering and ergonomic control technology and procedures developed by Federal and private agencies; and, 5) consult with researchers, safety and health professionals, agriculture extension programs, and others [Senate Report 1990] (Appendix 2-02).

The AFF Program also established a program for OHNAC in collaboration with State health departments, identifying 30 to 50 rural hospitals to provide ongoing responsive surveillance of agriculture-related disease and injury problems. The nurses conducted active surveillance of illnesses and injuries affecting farmers, farm workers, and farm family members and used the information for prevention [Connon et al. 1993].

In addition, the AFF Program established a national Agricultural Health Promotion System (AHPS) in 1990 at 15 land grant universities in cooperation with the Cooperative Extension Service [Hard et al. 1992]. The aim of this system was to disseminate prevention information and conduct other activities to prevent injury and illness among agricultural workers and their families.

Because farmers have an increased risk for certain cancers, the AFF Program initiated in 1990 the Cancer Control Demonstration Projects for Farmers (CCDPF) to devise an early detection strategy to reduce the number of cancer deaths. The program established cooperative efforts with rural hospital systems to identify and treat cancer cases [Senate Report 1990] (Appendix 2-02). By 1993, we had awarded eight cooperative agreements in as many States to identify barriers to cancer control that farmers may face and to develop and implement interventions to mitigate these barriers [Connally 1993].

The FFHHS program, also started in 1990, focused on identifying health risks to farm families. It responded to concern in Congress that agricultural workers and their families experience a disproportionate share of disease and injury associated with the chemical, biological, physical, ergonomic, and psychological hazards of agriculture [Frazier 1991].

In 1991, the Surgeon General's Conference on Agricultural Safety and Health was convened, bringing together more than 700 participants representing a variety of stakeholders [Myers et al. 1991] (Appendix 2-03). The Conference led to injury surveillance and research that emphasized machine-related injuries, special populations at risk including children, protection against agricultural chemical exposures, an emphasis on education as an intervention, and the evaluation of intervention effectiveness.

In 1992, a Childhood Agricultural Injury Prevention symposium held in Marshfield, Wisconsin [Lee and Gunderson 1992] established a core of 42 persons who formed the National Committee for Childhood Agricultural Injury Prevention (NCCAIP). Members of the committee wrote a national action plan released in 1996 to address the problem of childhood agricultural injuries [Natl. Committee for Childhood Ag. Injury Prevention 1996] (Appendix 2-04). The national action plan specifically recommended that NIOSH serve as the lead Federal agency in preventing childhood agricultural injuries.

The action plan led to a funding increase for the AFF Program of $5 million in 1997 [Natl. Committee for Childhood Ag. Injury Prevention 1996]. Through a cooperative agreement, the program supported a National Children's Center for Rural and Agricultural Health and Safety [Castillo et al. 1998]. The Center also receives funding from the Maternal and Child Health Bureau. The Center provides a range of services related to children and adolescents living in rural areas and working in agricultural environments [Marshfield Clinic 1997].

In 1991, NIOSH opened an office in Alaska that focused on the hazards of commercial fishing and of logging [Bender 1994].

In 1995, we engaged an eight-member external committee to review the aforementioned five extramural cooperative agreement programs of the AFF Program [Recommendations 1995] (Appendix 2-05). The evaluation addressed programs that Congress specified but did not address more traditional extramural programs that expanded into agricultural issues such as FACE and SENSOR-pesticides. In addition, it did not address research and training grants.

In response to an external review, the OHNAC program was reconceptualized as a more practical research effort in 1996. The Community Partners for Healthy Farming Intervention

Research Program (Community Partners) was designed to evaluate and implement existing or new interventions to reduce agriculture-related injuries, hazards, and illnesses. Programs were funded in 14 States [Ehlers and Palermo 2005].

In 1996, as a result of the external review, the Director of NIOSH established an internal NIOSH Agricultural Steering Committee (NASC). With representatives from all divisions engaged in the agriculture program, this group met annually and identified eight priorities for which research could have an impact [NIOSH 2000]. However, the NASC did not manage existing projects or approve new ones, so participation waned. NASC has not met since 2003.

In 1995 and 1997, the AFF Program supported Tractor Risk Abatement and Control (TRAC) efforts to prevent the principal cause of fatalities related to tractor-related incidents in agriculture. It was thought that the recommendations from the 1997 conference, if implemented, could save 2,000 lives by the year 2015 [Myers 2002]. The AFF Program supported a meeting in 2003 sponsored by the Agricultural Health and Safety Centers, which formulated a national agenda for preventing tractor-related injuries. A National Tractor Safety Initiative was published in 2004 [NIOSH Ag. Safety and Health Centers 2004], and the AFF Program funded projects consistent with that initiative in 2005.

In 1996, NIOSH rolled out its focus for future research, NORA. With its inception, NIOSH soon initiated projects in 21 disease, injury, and research methods interest areas. NORA coupled with expanded funding of the Agricultural Safety and Health Centers to each major region of the United States made the landscape more complicated, involving hundreds of scientists and educators from a variety of disciplines.

In its 2000 evaluation of the AFF Program, the NIOSH BSC [2000] (Appendix 2-06) made several recommendations, including an ongoing surveillance effort of nonfatal injuries and focusing research to support objectives consistent with a strategic planning process for agriculture. In 2005, NIOSH named AFF as one of the eight industry sector groups to be addressed by the second ten years of NORA. The AFF Program and other stakeholders will form a sector research council to draft research goals, objectives, and action plans for the sector to facilitate moving research to practice in the workplaces of these industries.

2.3 Goals

Congressional appropriations language that provided for the initiative in agricultural safety and health stated five major goals:

2.3a Surveillance

Reduce injuries and illnesses in the agriculture, forestry, and fishing workforce by understanding the characteristics of those injuries and illnesses so as to target research and interventions that reduce hazardous exposures.

2.3b Special Populations at Risk

Reduce injuries and illnesses of special populations of workers in these sectors by determining their significant risk factors and identifying and recommending interventions.

2.3c Health Effects of Agricultural Agent Exposures

Reduce injuries and illnesses by understanding the long-term, chronic effects of exposures from agriculture-related chemical or physical agents to farmers, their families, and applicators so as to implement controls that prevent harmful exposures.

2.3d Control Systems

Reduce injuries and illnesses resulting from work-related exposures by developing, demonstrating, and making available control systems that eliminate, guard against, or warn of the hazard.

2.3e Outreach

Reduce injuries and illnesses by informing and educating employers and employees in AFF about occupational safety and health hazards and control systems.

2.4 Program Stakeholders and Partners

Stakeholders in the AFF Program include any individual or organization with an interest in AFF occupational safety and health issues. Stakeholders include farmers (many of whom include husband and wife partnerships), hired farm workers, unpaid workers (including neighbors and family members), children as workers or bystanders, forestry workers (including loggers), and fishers. Stakeholders also include organizations such as the Grange, the Farm workers of America, Farm Safety 4 Just Kids, and the National Institute for Farm Safety, Inc. Enterprises such as equipment manufacturers, insurance companies, commodity groups, and organizations with an interest in reducing the cost of workers' compensation are also stakeholders. Government entities constitute the fourth group of stakeholders. This group includes extension agents of USDA, the United States Coast Guard (USCG), and EPA.

Stakeholders may or may not be involved in the AFF Program. Program collaborators are partners. In addition to farmers and their families, the AFF Program is involved with five other types of partners: other government agencies, academia, nonprofit organizations, for-profit enterprises, and, indirectly, through participation at annual conferences of organizations with goals similar to those of the program.

Government partnerships with the AFF Program began with USDA's State Safety Extension Agents at Land Grant Universities to promote safety and health and with State health departments to create community nurse networks to identify sentinel cases and broadly disseminate protective information. State health agencies not only gained funding for community nursing programs through these partnerships, but also for health and hazard surveys and fatality and pesticide poisoning surveillance.
Some university programs predating NIOSH, such as medical schools with an interest in injury and disease prevention, became immediate partners. With the opportunity for funding, university safety and health centers were established, cancer control programs implemented, and land grant university safety extension agents enlisted. Investigator-initiated grants were another aspect of university partnerships in the AFF Program.

Nonprofit organizations, including Farm Safety 4 Just Kids, the ASAE, the American Thoracic Society, FFA (formerly the Future Farmers of America), the Farm Foundation, and the NSC also partnered with the AFF Program for research purposes and/or for related conferences. Other partners include logging companies and fishing companies.

Partnerships with for-profit enterprises have resulted in adding shields to power-take-offs [NIOSH 1994], lowering the cost of ROPS for tractors, improving protective cab enclosures on tractors for protection from pesticide exposure, and using program-produced documents by insurance companies.

2.5 Program Logic Model

The logic model for the AFF Program is depicted by Figure 2-2. The model is consistent with the NIOSH logic model. The first sequential element of the model is inputs, followed by activities of the program and its partners. Those activities produce outputs that influence the behavior of stakeholders who then may take actions to extend influence into the workplace (intermediate outcomes). These actions produce end outcomes of improved safety and health for workers in agricultural safety and health or reduced exposures to hazards. External factors affect every stage of the process. Each element is described below.

2.5a Inputs

The program has two types of inputs: planning inputs (surveillance data, stakeholder needs, partner aims, information resulting from relationships including symposia and conferences, program evaluations, and program goals) and production inputs (budget, staff, facilities, the management structure, extramural entities, and partners). These inputs guide and set boundaries of the program.

Planning Inputs

Surveillance Data

Over the last 20 years, agriculture has moved from the third highest to the most hazardous industrial sector based on fatality rates. Injury and disease associated with physical, chemical, and biologic hazards occurred disproportionately among agricultural workers and their families. NSC estimates that an average of 740 people lose their lives annually and another 130,000 workers are temporarily or permanently disabled as the result of farm-and ranch-related injuries. Farming is one of the few industries in which the families (who often share the work and live on the premises) are also at risk for fatal and nonfatal injuries [NIOSH 1997].

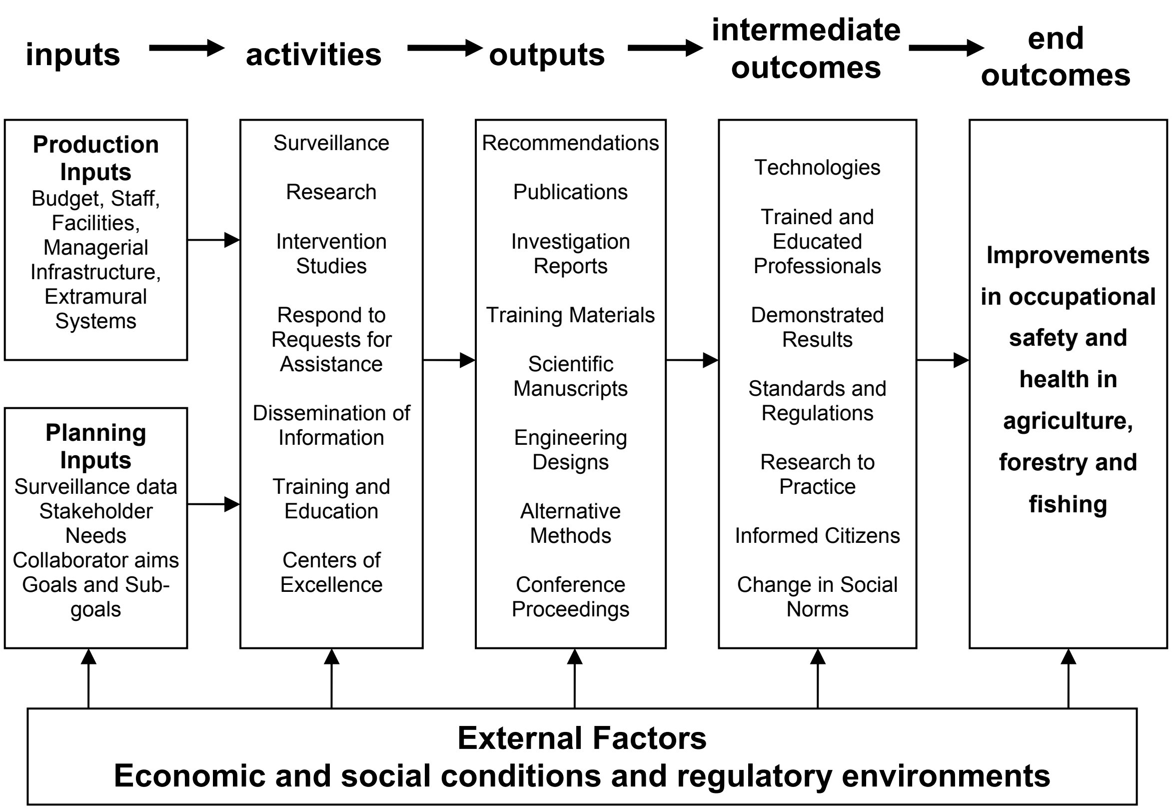


Figure 2-2. The AFF Program Logic Model

Fatalities

In 2003, the AFF sector experienced 713 occupational fatalities, which was 13% of the total number of occupational fatalities for the United States; this sector employs only 2% of the workers [BLS 2003]. As shown in Figure 2-3, agriculture remains the highest risk sector for occupational fatalities [BLS 2004].

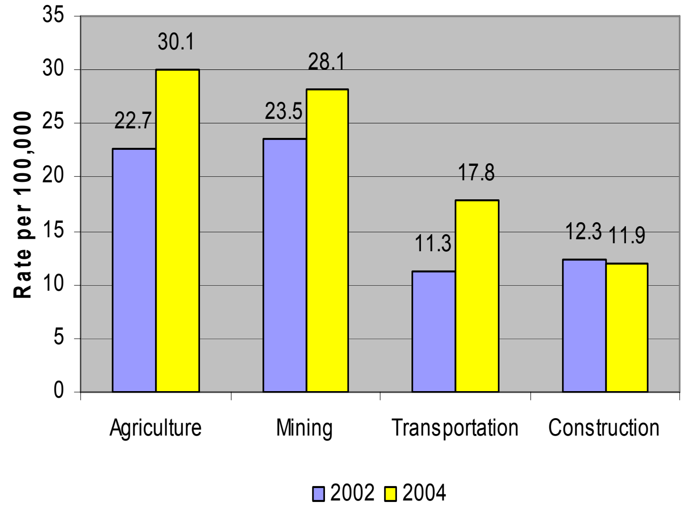


Figure 2-3. The four highest occupational fatality rates by industry sector, 2002 and 2004. (Note: 2002 is base on SIC industry codes while 2004 is based on NAICS industry codes)

Fatal occupational injury rates in the agriculture sector averaged more than four times the rate for the private sector during 1992-2002 as shown in Figure 2-4, with an annual average of 806 fatal occupational injuries. The AFF sector and the private sector both show declining rates of fatal occupational injuries since 1994 [NIOSH 2004].

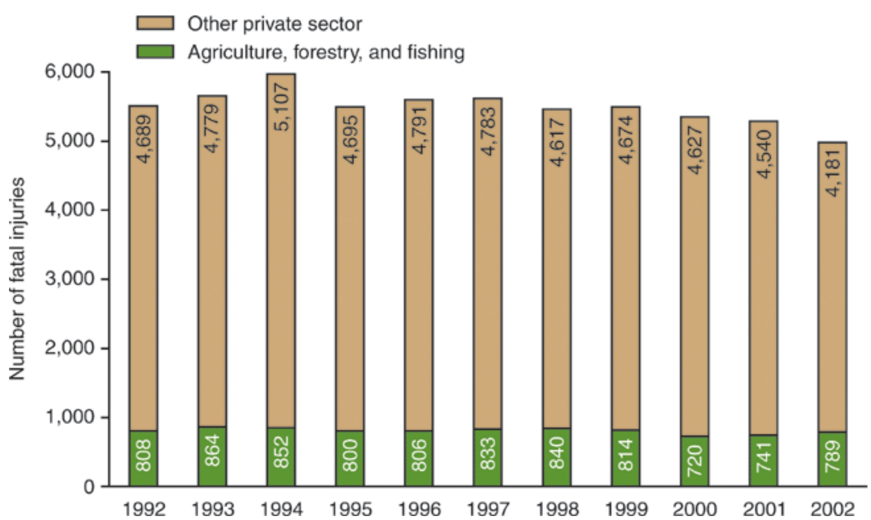


Figure 2-4. Fatal occupational injuries in agriculture, forestry, and fishing and the private sector, 1992–2002. Fatal occupational injuries in agriculture, forestry, and fishing industry ranged from 864 (16.2% of the total) in 1993 to 720 (13.5%) in 2000. *Sources: [BLS 2003; Myers 2003].*

Figure 2-5 shows the comparison of deaths from injuries by paid and self-employed workers and by subsector. More than 60% of the fatalities in this sector occur to self-employed workers.

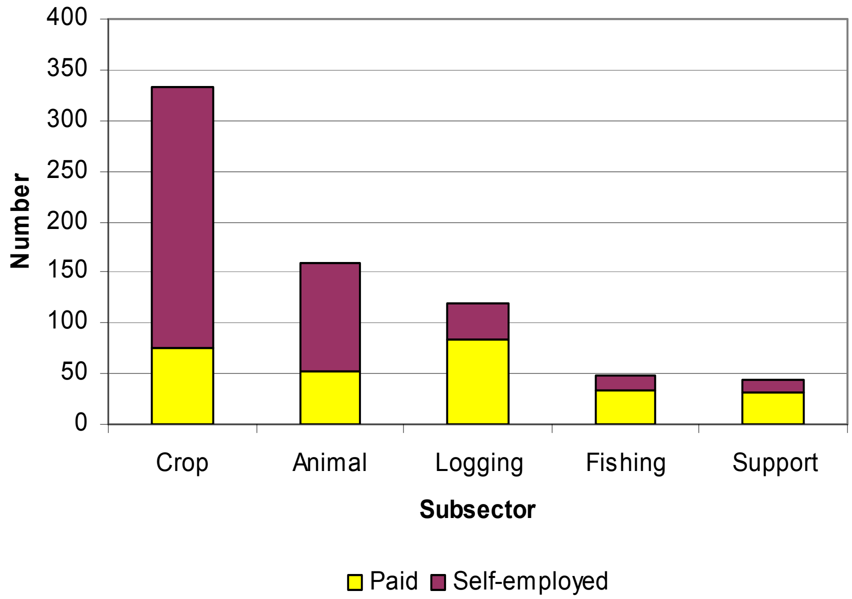


Figure 2-5. Number of agricultural fatalities, 2003

Injuries and Illnesses

Rates for nonfatal occupational injuries also declined, from 11.7 per 100 full-time workers in 1992 to 7.2 in 2001 as shown in Figure 2-6. The AFF industry is classified into five subsectors, and Table 2-2 gives the employment numbers (not including owners and operators) and the injury and illness rates for 2004. The highest injury rates occurred in animal production and forestry/logging, whereas the highest illness rates occurred in crop production.

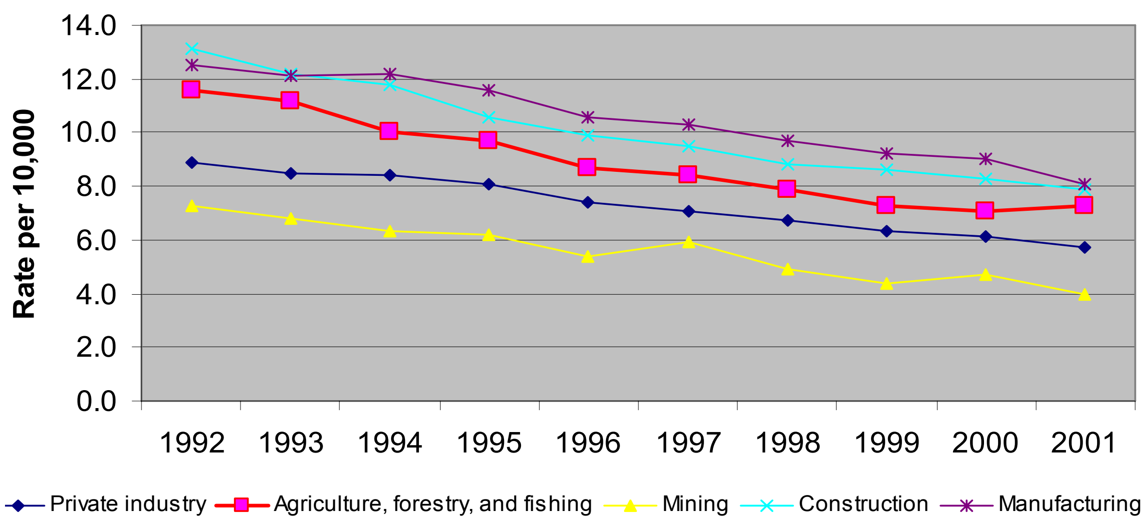


Figure 2-6. Trends of injury and illness rates by year

Table 2-2. List of Agriculture, Forestry, and Fishing Subsectors, 2004*

NAICS Code*	Agriculture, forestry, and fishing subsector	Employment 2003	Rates, 2004‡	
			Injury	Illness
111	Crop production	430,800	5.4	65.7
112	Animal production	139,300	7.8	31.9
113	Forestry and logging	72,800	6.0	23.7
114	Fishing, hunting, and trapping	10,100	1.5	44.0
115	Support activities for agriculture and Forestry	311,900	5.1	31.3
11	Total	965,000	5.8	46.3
	All industries		4.7	30.7

**Excludes farms with fewer than 11 employees; also excludes self-employed workers. The total employment in this sector in 2003 was 2,209,000.*
‡ injury rate is per 100 and illness rate is per 10,000 full-time workers per year
Source: BLS

Hazards

Farm tractors were the leading source of fatal occupational injuries in agriculture during 1992–2001, accounting for 2,165 fatal occupational injuries during this period. A major cause of these fatalities—an average of 110 fatalities per year—was tractor overturns. These deaths might have been prevented by ROPS [Myers 1989]. As shown in Table 2-3, trucks (those used on farms and between farm and processor) and fishing boats were also major sources of death in the AFF sector. They accounted for 795 and 434 fatalities, respectively. Farm tractors were the leading source of fatal occupational injuries in agriculture during 1992–2001, accounting for 2,165 fatal occupational injuries during this period. A major cause of these fatalities—an average of 110 fatalities per year—was tractor overturns. These deaths might have been prevented by ROPS [Myers 1989].

Table 2-3. Leading sources of fatal occupational injuries in the agriculture, forestry, and fishing industry, 1992–2001.

Source	Number of Deaths
Farm tractors	2,165
Trucks	795
Fishing boats	434
Ground	403
Trees, logs	357
Harvesting machine	253
Animals (mammals)	242
Mowing machine	228
Bullet	226
Water	209
Agricultural machine n.e.c.	168

Source: [NIOSH 2004]

Although the work-related fatality rate for commercial fishermen in Alaska is still very high, it is decreasing: since 1990, there has been a 76 % decline in deaths to commercial fishermen in Alaska.

Most logging deaths occur in four occupational groups: logging occupations (for example, fellers, limbers, buckers, and choker setters), truck drivers, general laborers, and material machine operators. An estimated 59% of all logging-related deaths occurred when workers were struck by falling or flying objects or were caught in or between objects. Other hazards include tools and equipment used in logging, such as chain saws and logging machines [NIOSH 1995].

Conferences

The strategy for AFF Program implementation at NIOSH was to assign the mandated elements of the program to the various divisions so that the division directors would be the stewards of the resources appropriated to the AFF Program. Conferences were the principal mechanism for evaluating progress. They convened the extramural and intramural investigators so as to maintain accountability over progress and engender coordination through opportunities to network. A sample of those conferences includes the following:

National Fishing Industry Safety and Health Workshop

First NIOSH Agricultural Safety and Health Conference, 1993
The AFF Program convened a Symposium on Efforts to Prevent Injury and Disease among Agricultural Workers in 1993 in Kentucky. The purpose of this symposium was to report on progress made by intra- and extramural AFF Program researchers in surveillance, research, and intervention.

Farm Flood Response Workshop: Implications for Agricultural Safety and Health, 1993

First National Conference for NIOSH-sponsored Centers, 1994

Second NIOSH Agricultural Safety and Health Conference, 1994

Third NIOSH Agricultural Health and Safety Conference, 1996

National Action Plan: Childhood Agricultural Injury Prevention, 1996

Second National Fishing Industry Safety and Health Workshop, 1997

TRAC: the Policy Conference, 1997
1997 TRAC: the Policy Conference addressed four major policy issues: how to assure that every tractor needing a ROPS has one; preventing tractor-related collisions on the roads; preventing injuries from tractor-related runovers; and eliminating tractor-related injuries among youth [Myers 2000].

Construction-Agriculture-Mining Partnerships (CAMP) Workshop, 1999
In December 1999, the AFF Program organized the CAMP workshop for approximately 100 NIOSH researchers interested in developing and sharing ideas that could lead to major research activities incorporating all three of the work sectors. Removing barriers to building effective partnerships across NIOSH divisions and laboratories to address cross-cutting

issues in the three sectors was an important goal of this workshop. The attendees were charged to identify significant cross-cutting problems. After review and deliberations by the NIOSH Lead Team and the Agriculture and Construction Coordinators, NIOSH awarded several FY00 projects to intramural investigators who crossed sectors. For example, a project to use new technology to increase ROPS on tractors is expected to produce results that could be useful in construction, agriculture, and mining

International Fishing Industry Safety and Health Conference, 2000

Second International Fishing Industry Safety and Health Conference, 2003

Using Past and Future to Map Future Actions: ASH-NET Agricultural Safety and Health Conference, 2001
This Agricultural Safety and Health Network (ASH-NET) Conference led to nine recommendations in 2003 that built on the first 15 years of collateral efforts in agricultural safety and health, including those at NIOSH. Among the recommendations were to develop a specific Federal research and surveillance agenda with measurable goals and objectives to reduce agriculture-related injuries, illness, and disease; and implement strategies to improve the living and working environment of migrant and seasonal farm workers.

National Symposium on Agricultural Health and Safety, Keystone, CO, 2004
The AFF Program collaborated with the Agricultural Safety and Health Centers, the North American Agromedicine Consortium, and NIFS in this conference. Their collective purpose was to serve those who work in production agriculture [Buchan 2005].

Third International Fishing Industry Safety and Health Conference, India, 2006

Program Evaluations

Five formal evaluations have been conducted during the life of the AFF Program. A summary:

1. **Progress Review Workshop, 1992**
   NIOSH convened the first comprehensive meeting to review progress of the program in 1992. The meeting included a review of progress and objectives. Among the recommendations were to explore different ways for service providers to reach a diverse farming population, and to consider opportunities for insurance companies to provide incentives to farmers for safe operations.
2. **Project Facts Evaluability Assessment, 1992**
   A NIOSH document presented each intramural and extramural agriculture project with an assessment by the project officer. The assessment was to develop criteria for evaluating dissemination effectiveness, impact on target audiences, and associated outcomes [NIOSH 1992].
3. **Extramural Committee to Review the Extramural Cooperative Agreement Programs, 1994-1995 [Recommendations 1995]**
   The challenge was to consolidate and build on successes and work towards ensuring program stability in order to achieve reductions in occupational diseases and injuries.

Among the recommendations were to continue support the Agricultural Centers for Research, Education, and Prevention; expand the Occupational Health Nurses in Agricultural Communities Program to include targeted interventions and health promotion; and to fund the Farm Family and Health and the Hazard Surveillance programs for two additional years. (Appendix 2-05)

4. **NIOSH Agriculture Steering Committee, 1996**
   As mentioned earlier, in May 1996, the NIOSH Director named a NIOSH Agricultural Steering Committee to review the intramural and extramural research program and make recommendations for future research areas.
5. **NIOSH Board of Scientific Counselors: Review of the Agriculture Intramural Program, 2000** The report by the BSC summarized AFF program's strengths and achievements, weaknesses and gaps, and the reviewers' recommendations for six research areas: surveillance, exposure assessment, child agriculture research, pesticide research, intervention research, and communications and information dissemination. (Appendix 2-06)

Overall recommendations included that the AFF Program should formulate a strategic planning process and sponsor an international workshop on agriculture health and safety research and prevention needs to support its strategic planning effort.

Production Inputs

Funding

The AFF Program received funding levels over a 3-year period (1990–1992) of $11,452, $18,887, and $21,548 million. In 1997, an additional $5,000,000 was received to implement a national plan for childhood agricultural injury prevention initiatives, including research, public education, professional training, community and family services and policy enforcement. NIOSH has absorbed numerous government rescissions, and indirect cost increases for business services provided by CDC since the time that these funds were initially received. These expenses have impacted NIOSH's overall budget, and have been applied across all NIOSH programs, such that the current targeted funding level for Agriculture and Child Agriculture is $23 million.

Detailed data on AFF Program budgets and personnel are only available from 1997 to present, so the remaining charts and figures cover that timeframe.

Inflation

These funds lose their purchasing power annually because of inflation, which has a negative impact on available resources. $18.6 million in 1990 is equivalent to $12.2 million in 2006. To keep pace with inflation, the 2006 budget would have to be increased to $28.9 million.

Proportion of NIOSH Budget

In fiscal years 1990, 1991, and 1992, the agriculture initiative budget represented 13.2%, 18.6%, and 18.3%, respectively, of the total NIOSH budget [NIOSH 1993]. By 2005, the budget for the AFF Program represented 6.5% of the NIOSH budget (8.2% when the child agriculture funding is included). A breakdown of the total AFF Program budget ($237,750,550) from 1997 to 2006 for intramural projects, Centers program, and other extramural projects is depicted in Figure 2-7.

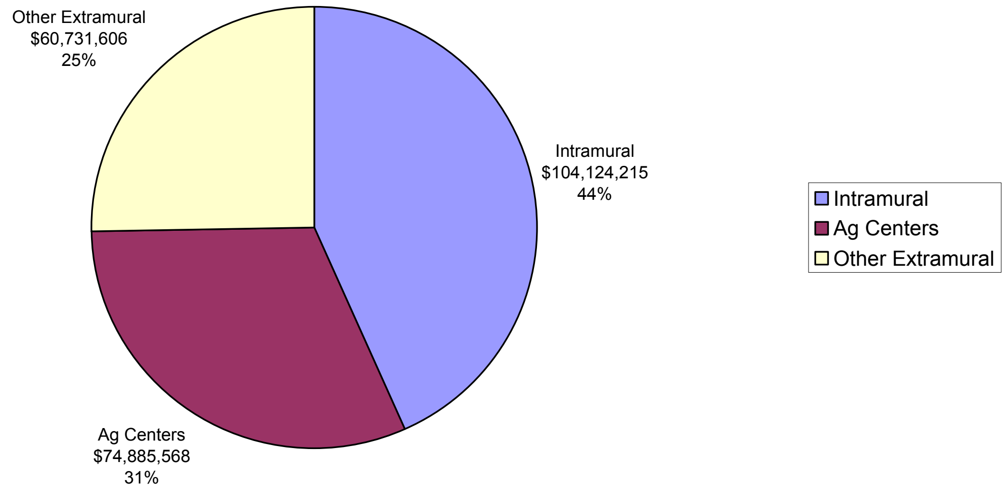


Figure 2-7: Intramural vs. Extramural total budget, 1997-2006

An annual breakout of these same budget figures over the period from 1997 to 2006 is shown in Figure 2-8.

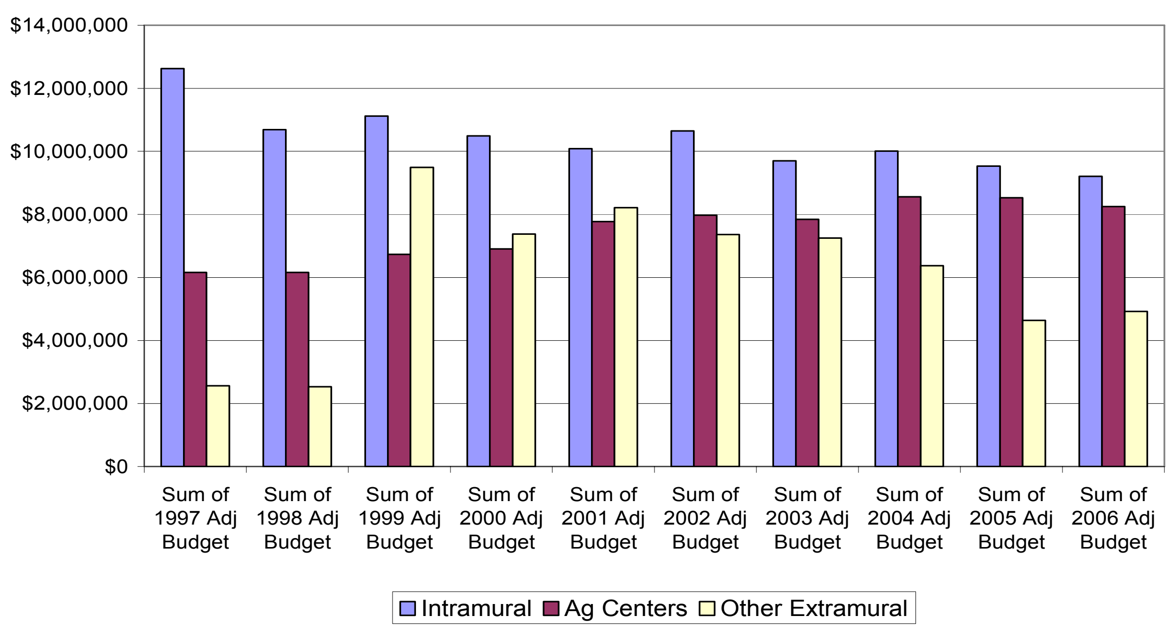


Figure 2-8: Annual agriculture budgets by intramural and extramural activities from 1997-2006

A breakdown of the intramural and extramural project budgets by the five major goals, general administrative and research support, and the Ag Centers is displayed in Figure 2-9. To illustrate the amount of funds expended by each NIOSH division, laboratory, and office (see Figure 1-1 for names of these units) over the period from 1997 to 2006, Figure 2-10 displays a stacked bar made up of the amounts in each of the five goals, support, and Ag Centers.

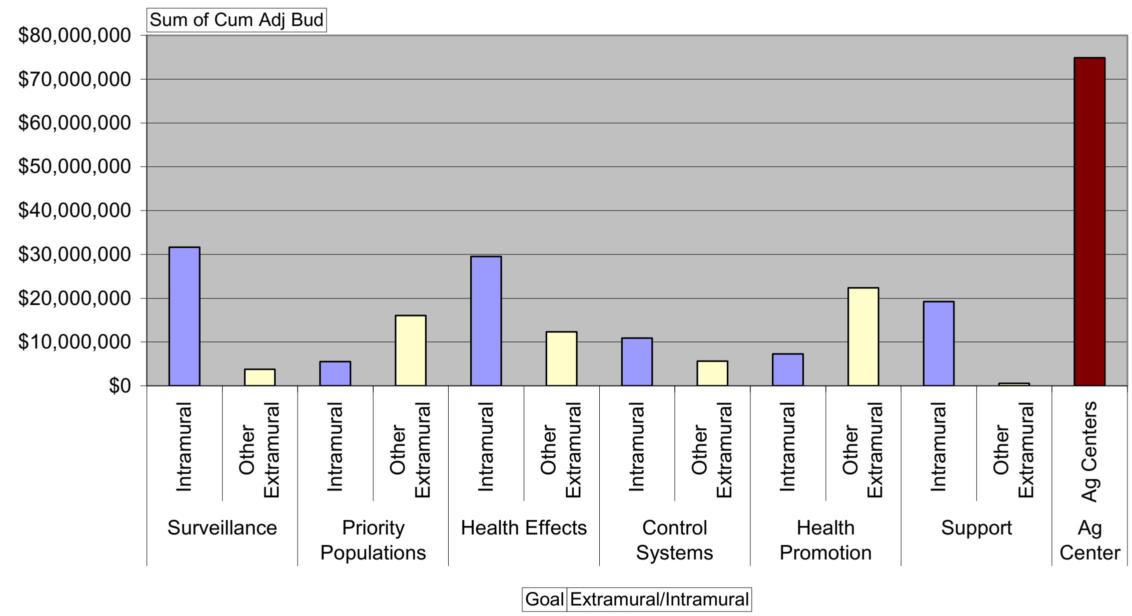


Figure 2-9: Intramural and extramural project budgets by five goals and support activities, as well as ag centers, 1997-2006

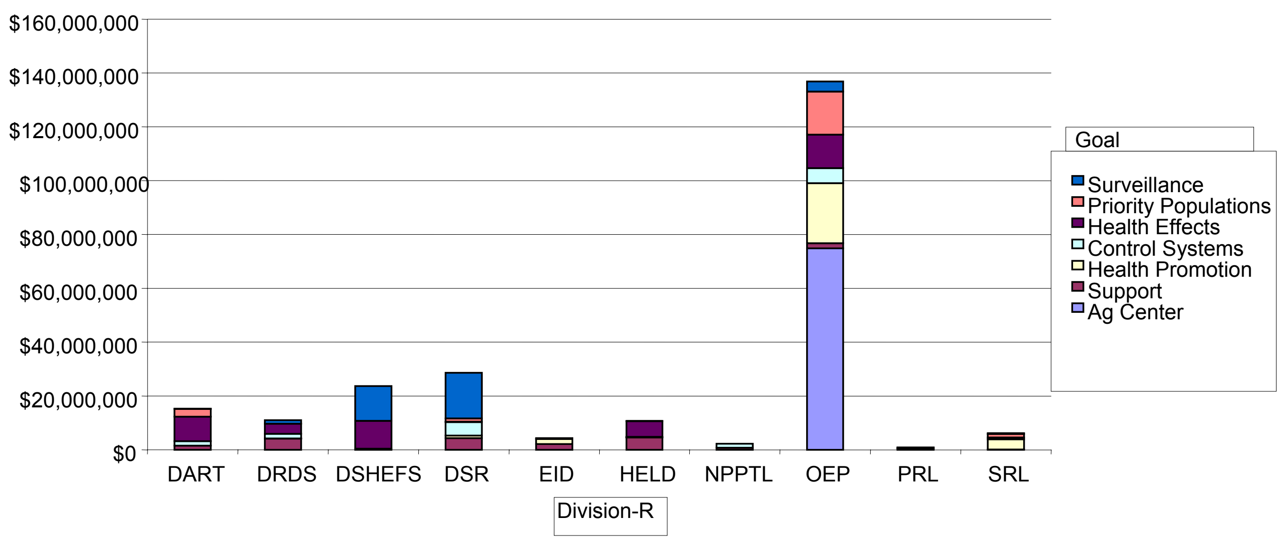


Figure 2-10: Division/Lab/Office composite budgets, 1997-2006. Stacked by goal

Total Ag Centers budget is displayed on an annual basis in Figure 2-11.

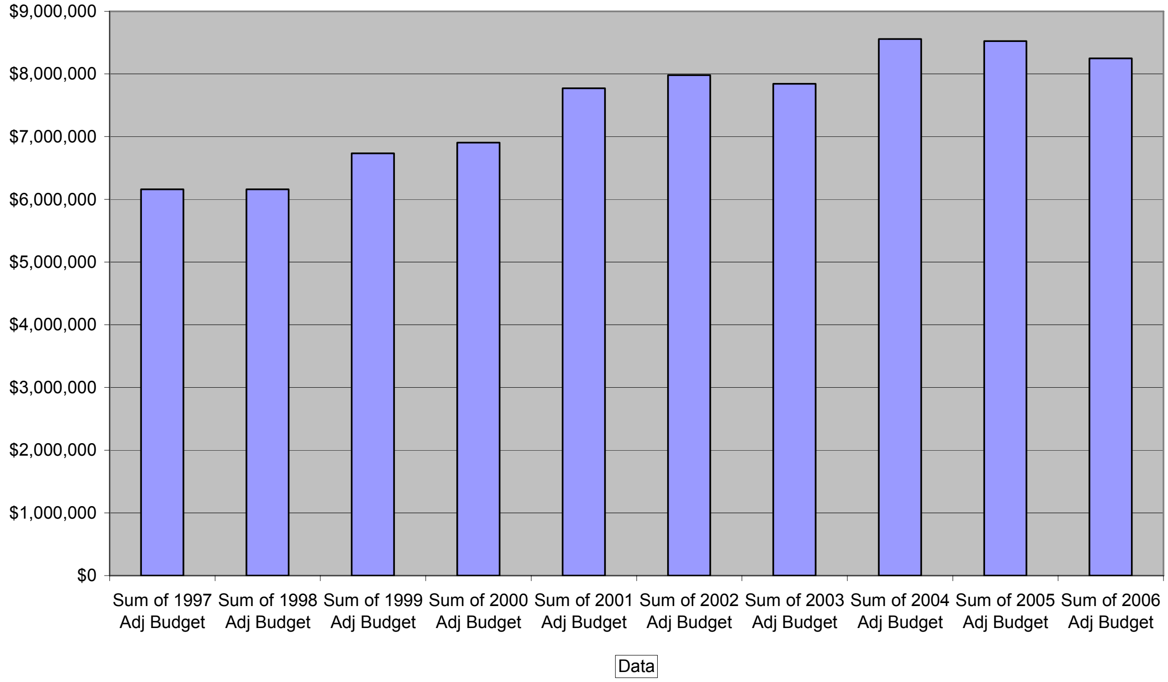


Figure 2-11: Total agricultural centers annual budgets from 1997-2006

As indicated earlier, the AFF Program includes a focus on concerns about children on farms, and a breakout of the total budget into the Ag and Child Ag components is shown in Figure 2-12.

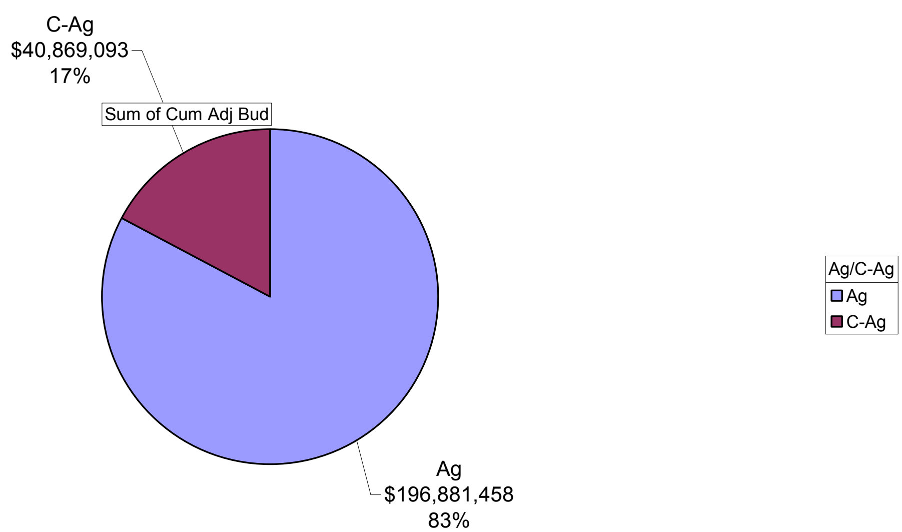


Figure 2-12: Ag Expenditures vs. Child Ag Expenditures, 1997-2006

Personnel

By FY1993, 50 FTE positions were assigned to the program, with one FTE assigned to National Center for Health Statistics (NCHS) and another FTE assigned to National Center for Environmental Health (NCEH). For the period from 1997 to 2006, Figure 2-13 shows the FTEs within the AFF Program by year.

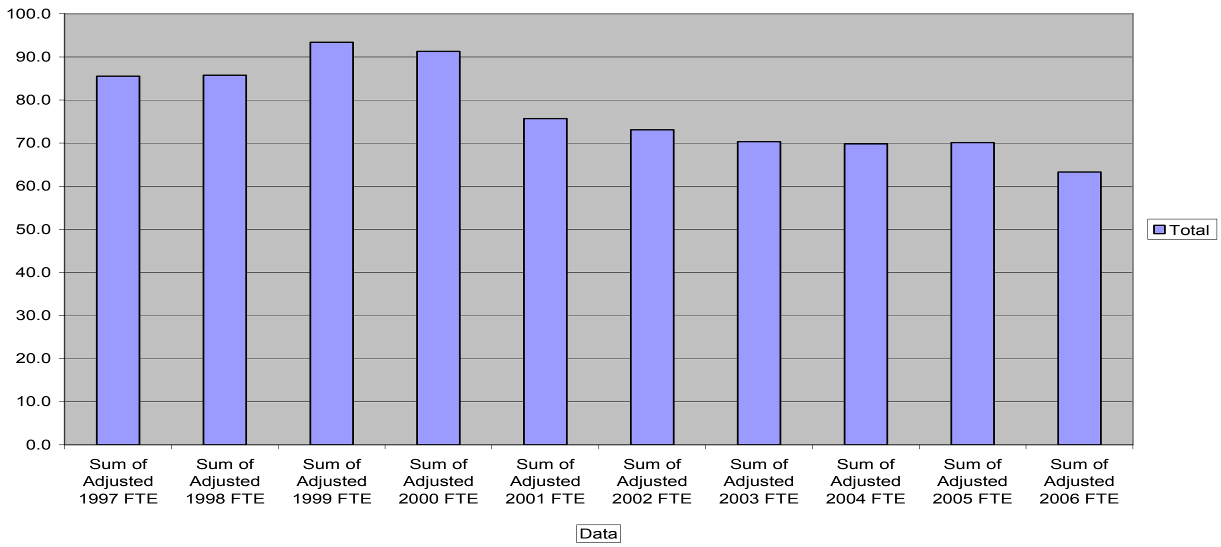


Figure 2-13: Number of NIOSH FTEs working on agriculture, 1997-2006

The breakdown of FTEs by AFF Program Goals is shown in Figure 2-14.

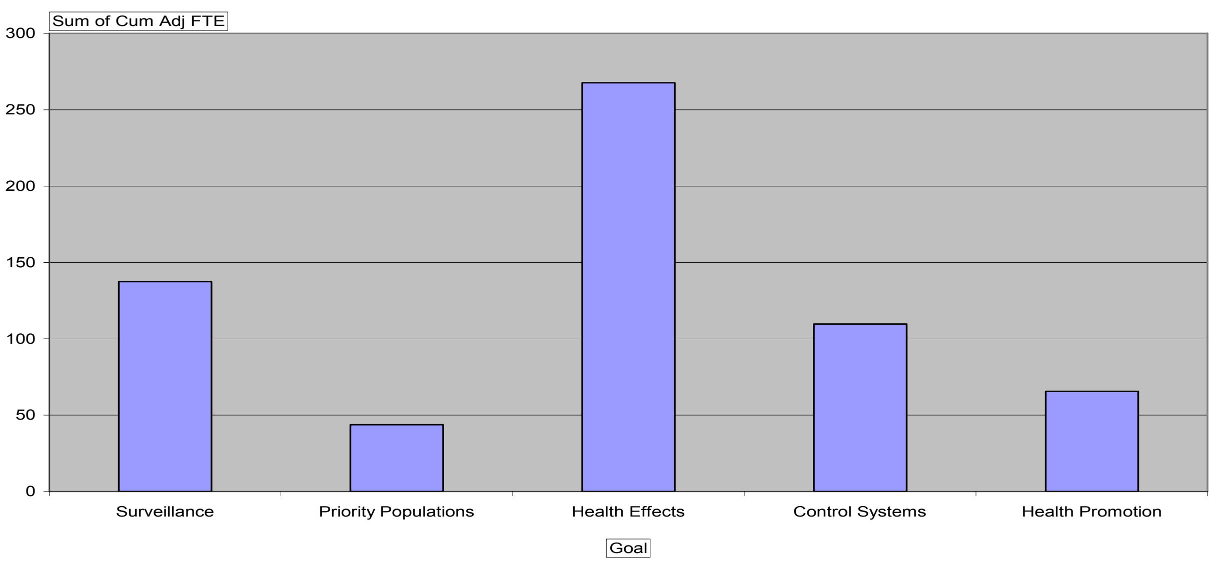


Figure 2-14: Total FTEs by AFF program goals, 1997-2006

A compendium of biosketches for NIOSH investigators who are included in the above FTE numbers is in Appendix 2-07.

2.5b Activities

Activities are efforts that use the inputs to accomplish the objectives and goals of the program. These efforts involve AFF Program intra- and extramural staff and partners. Activities include surveillance, research, and intervention development and testing.

2.5c Outputs

Outputs are the products of the activities and include publications, investigation reports, conferences, databases, methods, engineering designs, guidelines, recommendations, education and training materials, patents, and scientific manuscripts. Dissemination of these products is considered part of outputs.

2.5d Intermediate and End Outcomes

Intermediate outcomes are responses by AFF Program stakeholders to its products. These responses include public and private policy changes, repackaging or application of outputs, using program research in the workplace, adopting program-developed technologies or recommended actions, changes in public attitudes, diffusion of knowledge that results in change.

End outcomes are reduced injuries, deaths, illnesses, or hazardous exposures that result from either the outputs or intermediate outcomes of the AFF Program.
A summary follows of the major intermediate and end outcomes of the AFF Program. The complete sets of outcomes by goal and sub-goal are presented in Chapters 3 through 7.

<u>Surveillance</u>

Illness and Hazard Surveillance

OHNAC and FFHHS data and trusted networks are helping to guide intervention research and outreach to promote the use of ROPS on tractors by a wide range of stakeholders not involved with the AFF Program. In addition, a decrease has been observed in the rate of acute pesticide poisoning in the agricultural industry, and we believe that the AFF Program made a contribution to the decrease, particularly by publishing several influential MMWR articles.

Nonfatal Injury Surveillance

Engineers used nonfatal injury data collected under the TISF program to develop CROPS that were subsequently investigated for tractor market development by FEMCO, a ROPS manufacturer. TISF and CAIS data has also been requested by DOL for their rulemaking processes.

Traumatic Fatality Surveillance

The AFF Program, in conjunction with State FACE colleagues in Minnesota, developed a Hazard ID on the fatality risks associated with using tractors to move large hay bales. Since the release of this document, the fatalities associated with round bales in this State have decreased from an average of 1.57 deaths per year between 1993 and 1999 to 0.66 deaths annually between 2002 and 2005.

The AFF Program partnered with the Agricultural Health Nurse Program of New York State in 1991 to investigate scalping incidents involving entanglement around the rotating secondary driveline of hay baling equipment. A NIOSH Alert was issued that (among other things) recommended installation of a driveline guard. The manufacturer reported that the entire stock of the retrofit guards had been exhausted and production of the guard had resumed.

A State-FACE investigation in Nebraska revealed that an micotil, an antibiotic routinely used to treat shipping fever in cattle, caused the death of a farmer who accidentally injected himself. After dialogue between the State, NIOSH, the drug manufacturer (Elanco), and FDA, Elanco provided additional warnings to all micotil purchasers. NIOSH plans to publish a Workplace Solutions document on micotil soon.

Special Populations At Risk

Protection of Children on Farms (4.1d)

Surveillance

The estimates of youths farm injuries produced by the AFF Program have also been cited in proposed Congressional legislation. In 2005, the CARE Act (HR 3482) was submitted in the House of Representatives by Representative Roybal-Allard. The CARE Act proposed changes to child labor laws in agriculture and identified the youth farm injury data collected by the AFF Program Child Agricultural Injury Survey (CAIS) as one source of data that would be used to develop an annual report on occupational injuries to youths working on farms in the United States. At this time, no action has yet been taken on this proposed bill within Congress.

Child Labor Hazardous Orders

As part of a cost-benefit analysis of proposed changes to Child Labor HOs for youths working on farms, a contractor for DOL requested data from the AFF Program in 2004. The contractor, SiloSmashers, asked for information about estimates of youths under age 20 working on farms, estimates of working youths who operated farm tractors on farms, work-related injuries occurring to these youths, and nonwork injuries occurring to youths on farms. SiloSmashers concluded that the AFF Program CAIS surveillance data were the only source of these data, and were critical to conducting the cost-benefit analysis requested by DOL. This work is still in progress.

In March 2003, the YWH&S released its report, NIOSH Recommendations for Changes to the Federal Child Labor Regulations: A Response from Members of the Young Worker Health and Safety Network. The network is a subcommittee of the Occupational Health and Safety section of the American Public Health Association, composed of public health professionals, advocates, educators, and government agency staff. More than 25 persons from a variety of disciplines, including representatives of NIOSH, collaborated to develop the network's response to the NIOSH HOs recommendations [Young Worker Health & Safety Network 2003]. The YWH&S Network agreed with all NIOSH recommendations pertaining to the existing HOs for agriculture, and flagged four agricultural HOs as top priorities for regulatory action.

In 2003, the Farmworker Justice Fund called for DOL to revise the HOs for youths in agricultural occupations, citing the AFF Program's recommendations as the basis for these revisions [Farmworker Justice Fund, Inc. 2003].

In 2005, the CLC prepared a report entitled *Protecting Working Children in the United States: Is the Government's Indifference to the Safety and Health of Working Children Violating an International Treaty?* [Child Labor Coalition 2005]. The CLC is a group of nongovernmental organizations whose mission is to end child labor exploitation in the United States and abroad and to protect the health, education, and safety of working minors. The CLC report was submitted in June 2005 to the ILO Committee of Experts, an independent body charged with examining the application of ILO conventions in member States. In the report, the CLC questions whether the United States is in compliance with ILO Convention No. 182 (Elimination of the Worst Forms of Child Labour), with particular emphasis on HOs and children working in agriculture. Several pages of the report are devoted to a discussion of needed revisions to agricultural HOs, with data and rationale from the AFF Program HOs report used as the primary justification for changes. The report urges ESA to take action on AFF Program recommendations, particularly those which focus on the agricultural HOs.

At the 2006 annual meeting of the ILO in Geneva, Switzerland, the Conference Committee on the Application of Standards discussed the U.S. application of Convention No. 182 as it relates to children performing hazardous work in agriculture. The Committee of Experts report used as a resource by the ILO Conference Committee mentions the AFF Program recommendations on HOs, noting that the U.S. Government has indicated that it is "in the process of determining which recommendations concerning the Hazardous Orders will be presented in a first round of proposed rules" [International Labour Organization 2006].

The CLC followed the action by the ILO Conference Committee with a letter to Secretary of Labor Elaine Chao requesting that forthcoming proposed changes to child labor laws focus on agriculture. The letter references the 2002 NIOSH report recommending changes to HOs, and the discussions at the 2006 annual ILO meeting questioning United States compliance with ILO Convention No. 182 in relation to children working in agriculture:

The Child Labor Coalition strongly urges the Labor Department to make agricultural HOs a top priority within the anticipated child labor regulatory action in 2006. Given that the lead advocacy group (CLC) and the lead group of health and safety experts on child labor (YWH&S Network); and the government's lead agency on occupational safety and health (NIOSH) recognize the pressing need to strengthen the agricultural HOs, it would be deplorable if the 2006 proposed child labor regulations do not include agriculture in the scope of proposed rulemaking. Furthermore, in light of increased attention by the ILO on the issue of children in hazardous agricultural employment and their request for more information related to measures taken or envisaged, it would certainly not be overlooked if the DOL's regulatory changes in child labor exclude or minimize agriculture [Child Labor Coalition 2006].

In 2003 and again in 2005, Representative Tom Lantos (D-California) introduced the Youth Worker Protection Act, which would amend the FLSA of 1938 to revise requirements relating to child labor and to set forth new requirements for the employment of minors. The Act included a provision directing the Secretary of Labor to promulgate a rule relating to particularly hazardous occupations for children between the ages of 16 and 18, specifying that this rulemaking was justified based on the HOs recommendations released by the NIOSH in 2002 [GovTrack.us 2006a,b].

Child Labor End Outcomes (see 4.1e)

During AFF Program activity, the total number of youths injured on farms has decreased from 37,800 in 1998 to 27,600 in 2004. For the same time period, the number of farm work-related youths injuries decreased by 51% from 16,695 to 8,130. (Source: NIOSH CAIS.) Injury rates for household youths show that farm injury risks have decreased in all regions of the United States. (Source: NIOSH CAIS.) Work-related farm injuries to youths living on the farms have decreased from 11,600 injuries in 1998 to 6,400 in 2004. The work-related injury rate for household youths decreased from 14.1 to 9.1 injuries per 1,000 working household youths for the same period (Figure 4-7). (Source: NIOSH CAIS.) Males account for 58% of the household youths who work on farms, and have traditionally accounted for most of the work-related youths injuries occurring on farms. Farm injuries to young males on farms decreased 50%. A major part of this decrease was seen for work-related farm injuries to males that decreased from 11,800 in 1998 to 5,000 in 2004. (Source: NIOSH CAIS.) The AFF Program feels it has made a contribution to this reduction in work-related farm injuries to youth.

Minority Populations Intermediate Outcomes (see 4.2d)

Testimonials of Intended Use from extramural AFF Program efforts included:

After a 2006 pesticide training workshop:

> "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."

Logging Safety

Logging Safety Intermediate Outcomes (see 4.3d)

OSHA used a NIOSH criteria document for a proposed logging standard [NIOSH 1976] as the basis for the 1994 OSHA logging standard [29 CFR[1] 1910.266]. Additional NIOSH recommendations for first-aid training requirements prohibited felling practices, personal protective equipment use, and equipment training requirements were adopted by OSHA in their logging standard.

Our findings from investigations of helicopter logging fatalities provided the basis for the development of interventions by the Alaska Interagency Working Group for the Prevention of Occupational Injuries in the summer of 1993 to prevent similar crashes in the future. These interventions included helping agencies such as the FFA, U.S. Forest Service, and the Alaska Department of Labor to share information about helicopter logging operations and thereby provide the basis for implementing these recommendations.

In March 1995, the Alaska Interagency Working Group for the Prevention of Occupational Injuries and the AFF Program cosponsored a Helicopter Logging Safety Workshop resulting in an improved prevention matrix for use in the logging industry. Additional workshops were held in 1996 and 1997 [NIOSH 1998]. Building on Alaska's leadership in this area, a Helicopter Logging Safety Committee was formed under the auspices of the Helicopter Association International (HAI) in January 1997. The goal of the committee is "to help promote the safe use of helicopters in all aspects of the helicopter logging industry." The committee has established its own helicopter logging guidelines, which address four issues: 1) general helicopter safety for forestry operations, 2) integration of ground and flight activities, 3) helicopter specific planning, and 4) a pre-accident plan [HAI 1997].

On the basis of HAI activities initiated by the AFF Program, the insurance industry has become involved by substantially discounting helicopter insurance costs for operators adhering to standards developed by the HAI Helicopter Logging Safety Committee.
In 1997, the Instituto Mexicano Del Seguro Social, through the Pan American Health Organization's Center for Human Ecology and Health, requested assistance from the AFF Program to evaluate logging and wood processing plants in the Mexican State of Durango. In addition, the AFF Program was asked to provide training on how to plan and carry out injury and fatality investigations. The Program assigned the lead FACE logging investigator to Durango. During this assignment, nine site assessments were conducted with a class of 35 Mexican occupational medicine residents as part of the training process. These sites included active logging areas, sawmills, wood products processing facilities, and a paper mill. Hazard assessments were conducted for each site, and recommendations for hazard remediation were provided to the Instituto Mexicano Del Seguro Social.

Beginning in 1989, NIOSH decided to export the FACE model to the State level through its cooperative agreement and grants process. This resulted in the establishment of the State-FACE program. The primary purpose of State-FACE is to provide State health departments

[1] Code of Federal Regulations. See CFR in references

and other appropriate State agencies with the necessary training and resources to conduct FACE investigations for occupational fatalities occurring within their State. Since its inception, 22 States have participated in the State-Face program

The Forest Resources Association continues to distribute the findings of NIOSH scientific research to its members. The Technical Release (05-R-31) *Mechanized Felling Reduces West Virginia WCI Claims* [NIOSH 2005-2] (based on the *Journal of Safety Research* publication) won an award in the FRA Appalachian Region Technical Writing Award Competition. It was also featured in their *Forest Operations Review* publication and featured in the July 2005 issue of *Occupational Hazards,* a general safety publication.

Intervention evaluation research by the AFF Program has shown that mechanized logging systems decrease injury rates in hardwood harvesting operations in the State of West Virginia. On the basis of these results, the West Virginia Workers' Compensation Board is holding meetings on incentives for logging companies, including establishment of a lower separate rate for mechanized logging companies. These lower rates could be instituted as early as January 2007.

Logging Safety End Outcomes (see 4.3e)

Since the initial release of the proposed OSHA logging standard in 1989, the national occupational injury and illness rate for the logging industry decreased from 19.5 to 6.4 cases per 100 full-time workers in 2003

Nationally, occupational fatality rates have decreased from between 1984 and 2001, based on data from the NTOF surveillance system. Trends identified within NTOF are supported partly by logging fatality rates based on the BLS CFOI. The 6-year average logging fatality rate before OSHA promulgated a national logging standard (based largely on the 1976 NIOSH criteria document [NIOSH 1976]) decreased 30% when compared with the 6-year period 1996-2001. The AFF Program activities and outputs contributed to these declines.

Since the intervention and the implementation of the Alaska Working Group's recommendations to prevent helicopter logging crashes in July 1993, only one additional helicopter logging crash has occurred in Alaska. This July 1996 crash resulted in one fatality. No additional crashes have been reported in the State since that time.

AFF Program FACE investigations and reports conducted between 1991 and 1997 targeted two of the leading causes of death in logging—being struck by falling objects and machinery events. The summaries and recommendations were distributed nationally through the APA. Stuck by falling object rates decreased 38% and machinery deaths decreased 48% from the 6-year period 1984−1989 to the 6-year period 1996−2001. AFF Program activities are likely to have contributed to that outcome.

Fishing Safety

Fishing Safety Intermediate Outcomes (see 4.4d)

Pre-season Dockside Inspection Program

In follow-up to the working groups from the 1997 FISH Workshop in Seattle, the USCG in Alaska designed and implemented a Pre-season Dockside Inspection Program. USCG personnel had participated in the vessel loss prevention working group and took the lead in designing a plan to prevent vessels from sinking. USCG vessel safety examiners developed a comprehensive “at-the-dock” boarding and inspection program to identify and correct safety hazards known to exist in the Bering Sea crab fisheries. These fisheries were chosen based on NIOSH findings identifying the crab fishery with the highest fatality rate of any fishery in Alaska. Bering Sea crab fishing requires the use of crab “pots” that are 600-800 lb. steel cages to catch crab on the ocean floor. A vessel improperly loaded with crab pots, or a vessel that is covered in ice, may become dangerously unstable and capsize.

This Pre-season Dockside Inspection Program examines a large number of vessels within the fleet prior to the crab fishery opening. The examiners review vessel stability information with vessel masters and check lifesaving equipment required by the CFIVSA. If the vessel is not loaded properly, or if there is a lack of lifesaving equipment, a Captain of the Port Order is issued and the vessel is not able to fish until the discrepancy is corrected.

Marine Safety Training

The CFIVSA regulations include a requirement that fishermen conduct monthly emergency drills, and that a Certified Drill Conductor observes these drills. In 1993, the Alaska Marine Safety Education Association (AMSEA), a NIOSH AFF grantee, received its first NIOSH TPG, to help train fishermen to meet the requirement to be qualified to become Drill Conductors for these required monthly drills.

AFF Program scientists found that victims of commercial fishing vessel sinking were 7 times (95% CI 1.9, 27.4) more likely not to have worn an immersion suit, and 15 times (95% CI 4.6, 50.8) more likely not to have used a life raft. Being trained on how to use this equipment quickly and efficiently is necessary. AMSEA uses this information to seek funding and to promote their courses.

AMSEA has used AFF Program reports of commercial fishing fatalities and injuries to better understand the nature of the problems in the industry. AMSEA reports that this has been extremely useful for strategically planning in what areas of the fishing industry to focus training efforts. Since 1992, AMSEA has held more than 1,000 classes and trained more than 15,000 fishermen.

Technical Assistance for Fishery Management

This section highlights AFF Program input into fishery management regime decisions since 1992.

In 1995, IFQs were implemented. The IFQ program awarded vessel owners an allowable catch limit or quota based on catch records from the previous five years. Also, they had from April to September to catch their share of fish. In 1997, the Ocean Studies Board of the National Research Council asked the AFF Program to provide testimony regarding the implications this change in the management of the halibut/sablefish fishery had on safety. We analyzed USCG data and showed that Search and Rescue missions significantly declined by 63% ($p=0.009$) after implementation of the IFQ system. We also reported that 9 fishermen died while fishing for halibut during 1992-1994, but since implementation of the IFQ's, no fatalities had occurred in the fishery.

Another quota-based management system was recently implemented in the Bering Sea crab fisheries. Although our personnel did not provide testimony in person, our publications on the safety record of this fleet were used as foundation evidence that this is a dangerous fishery. The NIOSH AFS AFF Program researchers were cited in the member package which was distributed at one or more of the meetings where this proposed system was debated.

Fishing Safety End Outcomes (see 4.4e)

While the work-related fatality rate for commercial fishermen in Alaska is still very high, fatalities are decreasing. Since 1990, there has been a 74% decline in deaths of commercial fishermen in Alaska, and a 51% decline in the annual fatality rate.

The crab industry strongly supports this dockside enforcement initiative. Fishing fatalities continued to decline through 2005. In particular, these fatalities declined among crab fishermen. In Winter 2005, the USCG requested that we assist them in the evaluation of the Pre-season Dockside Inspection Program. We showed that since its implementation in October 1999 until 2005, there had only been 1 fatality in this fishery, which was due to a fall overboard. In January 2005, however, another fall overboard occurred and the fishing vessel “Big Valley” sank, resulting in 5 fatalities.

Health Effects of Agriculture Exposures (see 5.4 Intermediate Outcomes)

Extent of Exposure (see 5.4a)

Exposure Biomonitoring: Results of our biomonitoring studies have been used by the EPA to re-evaluate uncertainty factors used in risk assessments and have applied them to new risk assessments and dose-response models [Environmental Protection Agency 2006]. Researchers at the Utrecht University, The Netherlands, and the University of Iowa have used results from our take-home pesticide study to further their research in this field. At Utrecht University, researchers have conducted preliminary work on take-home pesticides. Discussions have been on-going with them to conduct additional pesticide take-home work among farmers in the Netherlands based on their preliminary results and from the NIOSH take-home pesticide study results [Heederik 2006].

Research developing standards for measurement of blood cholinesterase demonstrated that widely used commercial kits and procedures to measure ChEs in the rat and human are not conducted under optimum conditions and in some situations may yield grossly inaccurate results. Our work led to an approach to optimize the colorimetric assay which has been adopted by the State of California into their guidelines for clinical laboratories.

Further results of our work on cholinesterase have had a demonstrable impact in Northwest agricultural safety and health. In 1995, a TAG formed by the Washington State Department of Labor and Industry (WSDLI) found that a cholinesterase monitoring program was technically feasible and necessary to protect worker health. 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 [Washington State Department of Labor and Industries 2006].

In 2000, the Washington State Supreme Court mandated that the WSDLI 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 [reference].

Engineering Controls: AFF engineering control studies resulted in the development of voluntary standards by equipment manufacturers, based primarily on the EPHB particle size data, for cabs manufactured in the United States (American Society of Agricultural Engineers Standard S525). An international committee has been formed including U.S. equipment manufacturers such as John Deere, Case / International Harvester, and AGCO, to promote the ISO adaptation of similar standards for production of agricultural enclosures worldwide.

Control of CO emissions resulted in the development of automatic engine shut-off sensors to stop small internal combusition engines, e.g. those used in power washers to clean barn floors and equipment operation, before CO concentrations reach hazardous levels.

Adverse Reproductive Effects (see 5.4b)

The project on Reproductive Health Assessment of Agriculture Workers and Their Families has helped direct further research in this area. In addition, a commercial diagnostics company (PerkinElmer) adapted two immunoassays developed by the program for manufacture and sales

Neurological Effects (see 5.4c)

Subsequent to the AFF Program neurological effects study and taking into consideration other data, EPA banned the use of chlorpyrifos for residential use. This action was taken primarily to protect children. In addition, chlorpyrifos is no longer used as a termiticide, thereby eliminating its exposure to termite control workers [Environmental Protection Agency 2002].

Control Systems

Tractor Safety (see 6.1d)

ROPS Development
In 1985, ASAE adopted the voluntary standard S318.10, which recommended that all new farm tractors sold in the United States be fitted with a ROPS. We estimate that more than 95% of all tractors used on farms manufactured after the adoption of this voluntary standard have ROPS. The use of these newer ROPS–equipped tractors accounts for most of the 12% increase in ROPS use on farms.

A new standard for AutoROPS, Standardized Deployment Performance of an Automatic Telescoping ROPS for Agricultural Equipment (ASABE–X599), is in draft form and has undergone its first review by ASABE. This standard, once issued, will give the manufacturers criteria to build, test, and sell AutoROPS to consumers.

Anthropometry
Anthropometry data from the AFF Program are being used by the SAE J2194 standard committee to examine updating the tractor cab dimension standard, which will have a potential impact on the design of the next generation tractor cabs, affording better protection to the estimated six million tractor/farm machine operators in the United States.

Surveillance
Tractor data collected through the TISF survey were used by Colorado State University. Engineering research was conducted to evaluate the ability of pre-ROPS tractors to withstand the forces of a tractor overturn if ROPS were designed and mounted on them. TISF tractor prevalence data were used to identify common tractors by manufacturer and model for ROPS retrofit evaluations (e.g., Ford 8–N). The TISF data were the only information source for prioritizing these research evaluations.

Control Systems: Ergonomic Interventions (see 6.2d)

AFF extramural researchers in California redesigned nursery pot carriers to reduce ergonomic hazards for workers moving nursery pots. The nursery pot handles are now being sold through Gemplers, an agriculture products mail order catalog.

AFF Program researchers promoted six different safer, more profitable dairy farming practices among all dairy farmers in Wisconsin (~20,000) from 1997 to 2005. Questionnaires were used to measure the degree of adopting the new practices. Results showed that the likelihood of adopting barn lights, silo bags, and calf care feeding sites all increased significantly among northeast Wisconsin dairy farmers [Chapman et al. 2005]. Over this same period, there were also increases in the awareness of barn lights and the calf feed sites

Control Systems: End Outcomes (see 6.14)

Management and workers in wine grape production adopted the smaller, lighter picking tubs (>3000 tubs in 2002 and 3400 in 2003) developed by AFF Program researchers. The only incentive for adoption was improved working conditions. Since the study, these smaller tubs have become the most common type used in the Napa and Sonoma counties' hand harvest. We presume that exposures have been reduced.

Health Promotion Systems

AFF Program intervention efforts with Cooperative Extension Services at the State level influenced several States to fund ongoing or expanded occupational safety and health services for the farm sector

National nonprofit organizations and workers' compensation companies in Missouri, New York, Ohio, California, Kentucky, and North Carolina have adopted AFF Program curricula, tools, and reports for and about farm workers. In particular, schools, extension agents, universities, and farm bureaus in numerous States used promotional materials about the benefits of ROPS that were developed by the University of Kentucky.

The University of South Florida, the Farmworker Association, and the U.S. Sugar Corporation used an eye injury prevention program developed by an extramural AFF Program researcher. Their efforts showed a 75% decline in eye injuries in their study population of citrus workers. This project also built occupational safety and health capacity at a historically black college.

Management and workers in wine grape production adopted smaller, lighter picking tubs (>3,000 tubs in 2002 and 3,400 in 2003) developed by AFF Program researchers. The only incentive for adoption was improved working conditions. Since the study, these smaller tubs have become the most common type used in the Napa and Sonoma Counties' hand harvest. Thus, those exposures have been reduced.

In 1993, the AFF Program investigated cases of "raker's tendonitis," which was reported among seasonal harvesters who raked wild blueberries in Maine. The AFF staff recommended a redesign of the rake to give it a long handle. A report of this study was published in the New England Journal of Medicine (1994) and the American Industrial Hygiene Association Journal (1996). A fact sheet on the new rake was also published in *Simple Solutions: Ergonomics for Farm workers* (2001). The Maine Agricultural Safety and Health Program developed a pamphlet about the rake that they distributed in schools and then evaluated the incidence of musculoskeletal disorders. Their report was published in the American Journal of Public Health (1996). The Maine Department of Human Services, the Maine Agricultural Safety and Health Program, and the C&D Corporation were partners on the rake project. In 2006, Lynae Hawkes of the New England Agriculture Center estimated that most of the workforce uses the long-handled rakes and many use rakes with two handles.

External Factors

Figure 2-2 indicates that external factors influence every sequence of the program and its effects. These factors include social and economic conditions and the regulatory environment, and they can present opportunities or challenges for the program.

Social Conditions

A major challenge for the AFF Program is acting to improve the safety and health of a largely unregulated workforce. Through NIOSH, the AFF Program recommends criteria to OSHA for the promulgation of workplace standards. However, many agriculture workers are excluded from OSHA coverage. The program has provided information to support new OSHA standards related to logging, field sanitation, air contaminants (remanded in 1992), and ergonomics (repealed in 2002) [Luginbuhl 1997]. Moreover, the program sought out other opportunities for supporting Federal regulations including the Coast Guard's implementation of the Commercial Fishing Vessel Safety Act of 1988 [Sicks 1994], EPA's promulgation and enforcement of the pesticide Worker Protection Standard [Harris 1997], and Department of Labor revisions to child labor hazardous orders [NIOSH 2002]. But there has been little regulatory activity in agriculture safety and health.

The AFF Program partners are another social condition that acts as an external factor. We tried to use the USDA's extension service model to enhance prevention: information from research activities is distributed to State-level extension specialists, who redistribute it to county-level extension agents who are known to be trusted advisors to the farmer. The AFF Program experimented with the extension model using the State safety extension specialists, but over time, we moved toward applying the community health nurse model in rural settings augmented with an active surveillance component [Freund et al. 1991].

Similarly, the AFF Program has partnered with the medical community to deliver cancer prevention messages directly to patients and with its university-based centers to change norms in local communities through client interactions. The emphasis under this model is to provide better technical solutions to resolve client problems. Thus, recognizing barriers to change and solutions for removing these barriers is an active part of research, e.g., lower cost interventions. But physician cooperation may be partial or uneven.

The acts of stakeholder organizations are similarly unpredictable. Corresponding with AFF Program efforts, several stakeholders launched new programs too [Donham and Storm 2002]. The NSC renamed its annual Farm Safety Week the Farm Safety and Health Week and later established the National Education Center for Agricultural Safety in Iowa. The ASAE established priorities for agricultural safety and health and initiated the publication of the Journal of Agricultural Safety and Health [Murphy 1995]. The Farm Foundation established an agricultural safety work group [Armbruster 1994], and the major tractor manufacturers launched their at-cost program to encourage the retrofits of ROPS on older tractors [Penn State 1997; National Safety Council 1997]. OSHA participated with NIOSH in presentations at several venues to educate the agricultural community about their proposed air contaminants standard (later vacated by a court). The Kellogg Foundation funded several grants related that targeted interventions that had the potential for sustainability among special populations. This network of grantees emerged into a coalition named ASH-NET [Donham and Storm 2002]. All of these steps by stakeholders were positive, but they were unplanned by the program.

Economic Conditions

According to the 1997 Census of Agriculture, the vast majority of farms in this country (90%) are owned and operated by individuals or families. The next largest category of ownership is partnerships (6%). "Corporate" farms account for only 3% of U.S. farms, and 90% of those are family owned. The term "family farm" does not necessarily equate with "small farm"; nor does a "corporate farm" necessarily mean a large-scale operation owned and operated by a multinational corporation. Many of the country's largest agricultural enterprises are family owned. Likewise, many farm families have formed modest-sized corporations to take advantage of legal and accounting benefits. In spite of the predominance of family farms, there is strong evidence of a trend toward concentration in agricultural production. By 1997, 46,000 of the two million farms in this country accounted for 50% of sales of agricultural products. That number was down from almost 62,000 in 1992. In 1935, the number of farms in the U. S. peaked at 6.8 million as the population edged over 127 million citizens [USDA 2006].

As the number of farmers has declined, the demand for agricultural products has increased. This increased demand has been met (and exceeded) with the aid of large-scale mechanization, improved crop varieties, commercial fertilizers, and pesticides. The need for human labor has declined as evidenced by the increase in agricultural labor efficiency — from 27.5 acres per worker in 1890 to 740 acres per worker in 1990. As the U.S. farm population has declined, the average age of farmers has risen. Nearly 56% of the farmers in this country are 55 years old or older [USDA 2005]. A characteristic of U.S. agriculture is the advanced age of self-employed principal farm operators. About 27% of farm operators report their age as 65 years or more. Only 6% of all principal farm operators were under age 35. Thus, many farmers may phase out of farming gradually over a decade or more. Younger farmers enter the business at a slow rate, which tends to increase the average age for farmers as a whole. Operator age varies considerably by farm type, and educational attainment varies sharply by type of farm [USDA 2006]. Production agriculture has shifted to agribusiness with low profit margins to compete globally. As a result, the farm movement has focused on short-term economic survival rather than longer-term safety and health issues [Donham and Storm 2002]. The graying of the farm population has led to concerns about the long-term health of family farms as an American institution.

Two major changes occurred between 1989 and 2003. First, farm size shifted toward the smallest and the largest sales classes. Second, production shifted sharply to very large family farms and nonfamily farms. Shifts in production away from farms in the $10,000 to $249,999 sales class are likely to continue, given their negative operating profit margin and the large (and growing) share of their operators who are at least 65 years old [USDA 2006].

Small farms tend to specialize in raising beef cattle, other grazing livestock, and various crops. Poultry, hogs, and high-value crops tend to be produced on larger farms. Medium-sales small farms and large family farms are most likely to specialize in grain. Beef cattle are by far the most common specialization among small farms, accounting for 35% to 41% of limited-resource, retirement, residential/lifestyle, and low-sales farms. High value crops can generate large sales per acre, but they require substantially more labor than cattle and they may require more effort to market. Only 22 % of U.S. farms produced more than two commodities in 2003. Sixty-five percent of U.S. farms produced only one or two commodities in 2003, and 13 % had no production at all. Farms become more diversified as size increases. Many small farms specialize in a single commodity or produce nothing at all. Medium sales farms and large-scale farms are more likely to produce multiple commodities: three-fifths of farms in these groups produce three or more commodities [USDA 2006].

Farm equipment dealers have resisted legislation but have also been important interveners for farm safety, especially as they see opportunities to sell protective accessories. However, this network is changing towards fewer but larger enterprises. Many dealers are going out of business, and tractor manufacturers are encouraging competitor dealers to sell their makes and models of tractors and equipment.

Current Regulatory Environment

Regulation of the AFF sector is spread across several Federal agencies and has sometimes been described as patchy at best. Agricultural operations are addressed in specific OSHA standards for agriculture and the general industry [OSHA Ag. Operations Standards 2006-1]. However, a 1976 farming rider to the appropriations act provides that none of the funds appropriated to OSHA shall be used to prescribe, issue, administer, or enforce any farming regulations for operations that do not maintain a temporary labor camp or that employ 10 or fewer people [OSHA 1992]. The same limitation applies to commercial fishing [Noll 1994].

EPA's Worker Protection Standard for Agricultural Pesticides is a regulation aimed at reducing the risk of pesticide poisonings and injuries among agricultural workers and pesticide handlers. It offers protection to approximately 2.5 million agricultural workers and pesticide handlers who work at more than 600,000 agricultural establishments. The standard contains requirements for pesticide safety training, notification of pesticide applications, use of personal protective equipment, restricted-entry intervals after pesticide application, decontamination supplies, and emergency medical assistance. It requires employers to take any necessary steps to prevent too much heat stress while personal protective equipment is being worn [EPA 2003].

The Federal Fair Labor Standards Act applies to migrants and local residents regardless of farm size or number of person-days of farm labor used on that farm. However, these standards do not apply to youth working on family farming operations. There are prohibited hazardous occupations in agriculture for persons under age 17. Numerous occupations have been declared hazardous in 11 categories of employment: operating tractors of more than 20 power-take-off (PTO) horsepower; operating or assisting to operate corn pickers, grain combines, hay movers, potato diggers, trenchers or earthmoving equipment, or power-driven circular, hand or chain saws; handling or applying certain agricultural chemicals; and handling or using a blasting agent such as dynamite or black powder [DOL 1994].

The Migrant and Seasonal Agricultural Worker Protection Act (29 CFR Part 500 and 29 CFR Part 501) provides that employment-related protection for migrant and seasonal agricultural workers is administered and enforced by the DOL Employment Standards Administration. Every nonexempt farm labor contractor, agricultural employer, and agricultural association must post information about worker protections at the worksite, ensure that provided housing complies with Federal and State safety and health standards, and ensure that each transportation vehicle meets applicable Federal and State safety standards and insurance requirements and that each driver be properly licensed [OSHA Migrant Season 2006-2].

The USCG has the responsibility for promulgating and enforcing standards under the Commercial Fishing Vessel Safety Act of 1988, *46 CFR Part 28*. This Act requires that each vessel be equipped with specified safety gear that can be used in the event of a vessel casualty, e.g., sinking [USCG 2006; Commercial Fishing Vessel Safety Act 1988].

OSHA has jurisdiction over fishing vessels within State territorial waters where the USCG has not issued regulations [Noll 1994]. General Industry Standards under *29 CFR 1910* and Maritime Standards under *29 CFR 1917-1919* apply to these fishing vessels.

Aerial crop dusting/spraying with pesticides or fertilizers is regulated by the Department of Homeland Security, Federal Aviation Administration (FAA), and EPA [Struttman and Marsh 2004]. Aerial operations of helicopter logging [Manwaring et al. 1998], aerial firefighting, and aerial fish spotting are regulated by the FAA.

NIOSH promulgates regulations for respirators under *42 CFR Part 84*, which are used in agricultural environments for confined spaces and dust and pesticide exposures [NIOSH 42 CFR 84]. This is the only regulatory role for NIOSH.

Regulating at the State level has been ineffective, with the exception of rules in 49 States to require slow-moving vehicle (SMV) signs on farm vehicles traveling below 25 mph. Efforts to update these rules with improved SMV signage and add lighting marking for better nighttime visibility, based upon improved ASAE standards, have met with resistance [Aherin 2001].

Most farmers, ranchers, fishers, and agricultural workers are not covered by workers' compensation programs or not required to report injuries or illnesses to OSHA. Thus, little data are available to estimate the economic losses associated with workplace injuries and illnesses [Murphy 2003; Daberkow and Fritsch 1979].

2.6 Program Extramural Efforts

NIOSH extramural funding for the AFF Program fall into two categories: agriculture centers and research projects. A listing of the announcements for extramural funding opportunities from 1996 to 2006, grouped by the two categories is in Appendix 2-08. For all of the announcements, the requirements for contents of an application were stipulated and review criteria were defined.

Before 1996, intramural staff within research divisions managed the extramural activities for the AFF Program in expectation of substantial interaction of intra- and extramural staff. This management responsibility moved to the NIOSH Office of Extramural Programs (OEP) gradually from 1996 to 2000 as the different programs completed their project periods. As this transition occurred, involvement by intramural scientists changed from the role of both partner and government program official to just partner. An OEP scientist administrator took on the role of government program official to separate the scientific management of grants and cooperative agreements from the scientific collaborations. The action reduced the potential for conflicts of interest related to protection of intellectual property and personal scientific bias in regard to official decisions about funding and modifications to the awards. Thus, intramural scientists may now work with external investigators as co-investigators or consultants, and the OEP scientist administrator works with CDC business officials to manage awards, including resolving scientific issues with the external investigators.

In the early years of the program, an internal objective review process was used to evaluate applications. As the program shifted to OEP, peer review by external consultants was used to evaluate applications, and the review process followed the guidelines of the National Institutes of Health (NIH).

The following initiatives were supported from 1991 to 1995:

- Centers for Agricultural Disease and Injury Research, Education, and Prevention
- Farm Family Health and Hazard Surveillance
- Occupational Health Nurses in Agricultural Communities
- Agricultural Health Promotion Systems
- Cancer Control Demonstration Projects

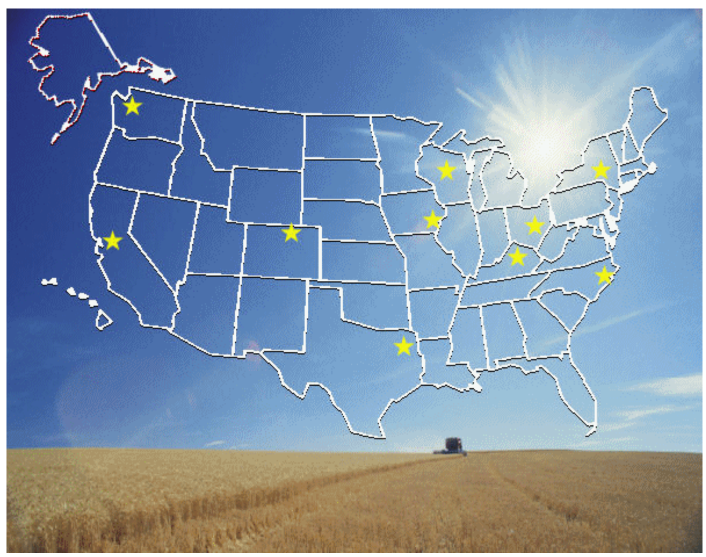
As a result of the 1996 Kennedy Committee review of the extramural portion of the AFF Program, several recommendations were made to improve the program. One recommendation was to establish an additional extramural initiative, which would enable external investigators to propose innovative studies or demonstration projects for interventions, educational initiatives, health promotion activities, or other community-based prevention strategies.

The Centers program is broadly described in 2.6a, and the other initiatives are described in other chapters of this report.

2.6a Centers for Agricultural Research, Education, and Disease and Injury Prevention

As part of the overall effort to protect the safety and health of every agricultural worker, the AFF program funded Centers of Agricultural Research, Education, and Disease and Injury Prevention to conduct applied preventive agricultural research and education, outreach, and intervention (http://www.cdc.gov/niosh/agctrhom.html). In 1991, four Centers were funded: the Southeast Center for Agricultural Health and Injury Prevention at the University of Kentucky, the Northeast Center for Agricultural and Occupational Health at the New York Center of Agricultural Medicine and Health, Great Plains Center for Agricultural Health at University of Iowa, and the Western Center for Agricultural Health and Safety at the University of California at Davis. By 1996, four more Centers were supported.

The AFF Program initiated another element to the Centers in 1997, the Center for the Prevention of Childhood Agricultural Injury. This change was motivated by a national action plan published in 1996 by the NCCAIP. The plan included 13 objectives and 43 recommended action steps, including a call for funding of research and safety programs. The plan specifically called for linkages among researchers, public sector agencies, and private sector foundations, corporations, associations, and community-based organizations.



In 1998, an additional Center in the southern region (Alabama, Florida, and Mississippi) was added, but some of its programs were subsequently merged with the North Carolina Center. A Center in Ohio was added during 2000.

Accomplishments of the Centers are integrated into the following chapters of this document because their efforts have contributed to the goals of the AFF Program. More detailed perspectives on the individual Centers are provided in Appendix 2-09 (Highlights) and Appendix 2-10 (Comprehensive). The primary areas of focus for the Centers are listed below:

Pacific Northwest Agricultural Safety and Health Center

- Pesticide exposure assessment methods
- Interventions to reduce pesticide exposures among agricultural workers and their families
- Traumatic injuries
- Musculoskeletal disorders
- Noise and vibration exposure

- Hired farm workers and their families

High Plains Intermountain Center for Agriculture Health and Safety

- Exposure assessment of pesticides (biomarkers)
- Occupational lung disease in agriculture
- Engineering controls (tractors, All-Terrain Vehicles [ATVs] and ROPS)
- Education and training
- Regionalization project with cooperative extension and other partners: PHS Region VIII

Northeast Center for Agricultural Safety and Health

- Tractor safety
- Child injury
- Safety training
- Personal protection
- Unwanted agrichemicals
- Migrant worker injury
- Musculoskeletal disorders and ergonomics

Great Plains Center for Agricultural Health

- Keokuk County Rural Health Study
- Child safety (especially including Farm Safety 4 Just Kids)
- Pesticide exposure
- Respiratory disease (especially including organic dust)
- Toxicology
- Certified safe farm intervention
- Training and education

Ohio Regional Center for Agricultural Disease and Injury

- Intervention
    - Adapting the Agricultural Safety and Health Best Management Practices for the insurance industry as a hazard audit tool
    - Audiovisual approach to train West Virginia farmers on prevention effectiveness of ROPS in reducing traumatic injury
    - Effectiveness of sun safety intervention approaches to change sun safety behavior of agricultural workers
- Diseases and injury (asthma)
- Risk management
    - Field test of the farm grain engulfment hazard assessment tool
- Professional development and outreach
    - Evaluating for impact a fellows program

    - Train-the-trainer program called Hazardous Occupations Safety Training in Agriculture

Southwest Center for Agricultural Safety and Health

- Tools and approaches
- Injury prevention
    - Cattle handling
    - Farmers with disabilities
    - Childhood agricultural injury prevention
- Special populations
    - Farm women and children
    - Understudied and under-represented population

Agricultural Health and Safety Center of UC Davis

- Research
    - Farmer, farm worker, and farm family health
    - Respiratory health and disease exposures
    - Biomarkers and pesticide surveillance
- Prevention
    - Ergonomics and injury prevention
- Education and outreach
    - Underserved populations
    - Social marketing

Southeast Center for Agricultural Health and Injury Prevention

- Special populations
    - Agricultural disability awareness and risk education: youth injury
    - Children's injuries on Kentucky's beef cattle farms
- Tractor roll-over protection systems

Southeastern Regional Center for Agromedicine

- Ergonomic interventions
- Farm vehicle public road safety
- Skin disorders in commercial fishermen
- Injuries and illness in migrant and minority agricultural workers
- Creating a safer environment for greenhouse vegetable workers

National Children's Center for Rural and Agricultural Health and Safety

- Intervention
    - North American Guidelines for Childhood Agricultural Tasks (NAGCAT)
    - Creating safe play areas on farms
- Outreach and education
    - Childhood Agricultural Safety Network
    - Childhood agricultural health and safety workshop for journalists
- Injury assessment
    - Youth, tractors, and policy

2.6b Individual Grant Projects

NIOSH has also supported individual research grants and cooperative agreements through program announcements and requests-for-applications over the time period of this report. In many cases, NIOSH intramural scientists have collaborated with the external investigators, and the results from those projects are integrated into the latter chapters of this document. Reports on representative grants are contained in Appendix 2-11, and a summary of the areas of focus covered by these grants is listed below.

Injuries

- Dairy farming
- Evaluation of the NAGCAT
- Evaluation of a health and safety curriculum for youth
- Adapting NAGCAT for ethnic communities
- Sleep deprivation among youth

Musculoskeletal disorders

- Vineyard harvesting ergonomics
- Vineyard trellis systems ergonomics
- Tree fruit harvesting ergonomics

Education and Outreach

- Computer-based training

2.7 External Factors

2.7a Consequences of Global Warming

The consequences of global warming on agriculture are largely as yet unknown; however they could include heat-related stress and deaths, the need for more and more potent pesticides, or the need to deal with extreme weather including hurricanes and flooding, increased air pollutants, and increases in infectious diseases among humans and animals. Coastal and arid farming populations could likely be displaced because of salt water intrusion, storm surges, and, conversely, droughts. Wildfire incidence can be expected not to abate and perhaps increase.

2.7b Old Tractors

Farmers continue to use older tractors that lack safety devices such as ROPS attachments. An increasing number of small farming operations (sometimes called "hobby farms") buy them because they are inexpensive. Moreover, as global markets grow, foreign tractors are imported that may lack safety features.

2.7c Zoonotic Disease

Climatic change, coupled with the increase of affordable worldwide travel, will continue to challenge the public health community to prepare for the potential of global infectious disease outbreaks. The current attention given to bird flu underscores that zoonotic diseases are a major part of this worldwide issue. For agricultural workers, zoonotic diseases also represent an occupational risk with the potential for significant health and economic impacts.

2.7d New Technology

Technology has contributed significantly to improving the safety and health of agricultural workers through reduced exposure to recognized risks and enhanced worker comfort. Agricultural production methods and processes will continue to change and adapt as new technology is introduced. This technology will not only enhance productivity and efficiency, but may also introduce new hazards that will need to be addressed.

Research topics that focus on both the attributes and harmful effects of the technology may include the following:

- Automatic steering, auto pilot, and computer operated processing equipment
- Biosensors
- Biotechnology: manipulating the growth processes of plants and animals
- DNA sensing chips and nano lasers
- Exposure to high-pressure hydraulic systems
- Exposure to genetically modified organisms (GMOs)
- High-speed equipment (vibration, jarring, reaction time)
- Intelligent default
- Irradiation of food
- Land application of sludge

- Managing safety in on-farm, value-added processing operations
- Operatorless/remote control tractors and machinery
- Power transmission lines and communication towers [exposure to electro-magnetic fields (EMF), radio frequencies (RF)]
- Sensors and automated process controls
- Using GMOs to develop safer production methods
- Using Global Positioning Systems (GPS) to monitor worker activities

2.7e Other Emerging Issues

- Biological manufacturing
- Changing farmer demographics
- Fatigue
- Site-specific Management
- Zoonotic disease outbreaks

2.8 References Cited

Aherin RA [2001]. The struggles of doing what is right and needed. J Ag Safety Health. 7(8):139-141.

Armbruster WJ [1994]. Letter re ad hoc working group on agricultural health and safety. Oak Brook, IL, July 29.

Bender TR [1994]. Introduction. In: Myers ML, Klatt ML, eds. Proceedings of the National Fishing Industry Safety and Health Workshop. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94–109, pp. 15–18.
Berry CM [1965]. Organized research in agricultural health and safety. Am J Public Health *55*(3):424–428.

BLS [2001]. Current population survey. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics. Available at: http://www.bls.gov/cps/ and http://www.bls.census.gov/cps/

BLS [2003]. Fatal occupational injuries to private sector wage and salary workers, government workers, and self employed workers by industry, all United States, 2003. Available at: http://www.bls.gov/iif/oshwc/cfoi/cftb0189.pdf

BLS [2004]. Census of Fatal Occupational Injuries. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics Available at: http://www.bls.gov/iif/oshwc/cfoi/cfch0003.pdf

BLS [2004]. Census of Fatal Occupational Injuries Summary. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics Available at: http:// stats.bls.gov/news.release/cfoi.nr0.htm

BLS [2004]. Fatal occupational injuries by industry and selected event or exposure. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics. Available at: http://www.bls.gov/news.release/cfoi.t02.htm

BLS [2006]. Occupational outlook handbook: agricultural workers. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics. Available at: http://www.bls.gov/oco/ocos285.htm

Brooks J [2003]. Agriculture: Why is it still so difficult to reform? OECD Observer. Available at: http://oecdobserver.org/news/fullstory.php/aid/1177/Agriculture:_Why_is_it_still_so_difficult_to_reform_.html

Buchan VV [2005]. Summary Proceedings, 2004 National Symposium on Agricultural Safety and Health, Keystone, CO, June 20–24. J Agromed *10*(1):53–56.

Castillo D, Hard D, Myers J, Pizatella T, Stout N [1998]. A national childhood agricultural injury prevention initiative. J Ag Safety Health. Special Issue 1:183–191.

CDC (Centers for Disease Control and Prevention) [2004]. Work-related pilot fatalities in agriculture—United States, 1992–2001. MMWR *53*(15):318–320.

Commercial Fishing Vessel Safety Act of 1988. Public Law 100–424. Available at: http://darwin.nap.edu/openbook.php?record_id=1622&page=261

Committee on Fishing Vessel Safety [1991]. Fishing vessel safety: blueprint for a national program. Washington DC: National Research Council.

Connally LB [1993]. Cancer control demonstration projects for farm populations.

Connon CL, Freund E, Ehlers JK [1993]. The Occupational health nurses in agricultural communities program. Identifying and preventing agriculturally related illnesses and injuries. AAOHN J *41*(9):422–428.

Daberkow SG, Fritsch CF [1979]. Agricultural workplace safety: a perspective on research needs. Am J Ag Econ *November*: 824–835.

DOL [1994]. Child labor requirements in agricultural operations under the Fair Labor Standards Act (Child Labor Bulletin 102) Washington, DC: U.S. Department of Labor, Employment Standards Administration, Wage and Hour Division. Available at: http://www.dol.gov/esa/regs/compliance/whd/childlabor102.pdf

Donham KJ, Storm JF [2002]. Agriculture at risk: report to the Nation—a historical review, critical analysis, and implications for future planning. J Ag Safety Health *8*(1):9–36.

Dosman JA, Cockcroft DW, eds. [1989]. Principles of health and safety in agriculture. Boca Raton, FL: CRC Press.

Dzugan JW [1994]. Marine safety instructor training. In Myers ML, Klatt ML, eds. Proceedings of the National Fishing Industry Safety and Health Workshop. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94–109.

Ehlers J, Palermo T [2005]. Community partners for healthy farming intervention research. J Agr Safety Health *11*(2):193–203.

EPA [2002]. Interim Reregistration Eligibility Decision for Chlorpyrifos (Case No. 0100) EPA 738-R-01-007. Washington, DC: U.S. Environmental Protection Agency, Office of Pesticide Programs, Health Effects Division.

EPA [2003]. Pesticides: health and safety. Part 170: worker protection standard. Washington, DC: U.S. Environmental Protection Agency. Available at: http://www.epa.gov/pesticides/safety/workers/PART170.htm

EPA [2006]. Organophosphate Cumulative Risk Assessment; Notice of Availability", Federal Register: August 2, 2006 (Volume 71, Number 148), [Notices] [Page 43740-43742] From the Federal Register Online via GPO Access [wais.access.gpo.gov]

Festenstein GN, Lacey J, Skinner FA, Jenkins PA, Pepys J [1965]. Self-heating of hay and grain in Dewar flasks and the development of farmer's lung antigens. J Gen Microbiol *41*:389–407.

Fine LJ [1995]. Lessons learned from the national occupational safety and health program in agriculture and possible future directions. Proceedings of the Sixth FIOH-NIOSH Joint Symposium on Occupational Health and Safety. Espoo, Finland, August 8–10. People and Work Research Reports 3. Helsinki: Finnish Institute of Occupational Health, pp. 66–70.

Frazier TM [1991]. The NIOSH farm family health and hazard surveillance program. National Conference on State-Based Occupational Health and Safety Activities, September 3–6, Cincinnati, Ohio. Cincinnati, OH: National Institute for Occupational Safety and Health.

Freund E, Seligman PJ, Rubin CH [1991]. Developing a nurse-based occupational health and safety infrastructure in agricultural communities. National Conference on State-Based Occupational Health and Safety Activities, Cincinnati, OH, September 3–6.

Hard DL, Myers JR, Stout NA, Pizatella TJ [1992]. A model agricultural health promotion systems program for building State-based agricultural safety and health infrastructures. Scand J Work Environ Health (Suppl) *2*:46–48.

Harris KG [1997]. EPA worker protection standard for agricultural pesticides. In: Langley RL, McLymore RL, Meggs WJ, Roberson GT, eds. Safety and Health in Agriculture, Forestry, and Fisheries. Rockville, MD: Government Institutes, pp. 483–494.

Heederik D [2006]. Personal communication, D. Heederik, May, 2006.

Helmers S, Top FH, Knapp LW [1971]. Ammonia injuries in agriculture. J Iowa Med Soc *61*(5):271–280.

Jewell JR [1931]. Farm and home accidents, their cause and prevention. Nebraska Cooperative Extension Work in Agriculture and Home Economics, University of Northern Agricultural College and US Department of Agricultural Cooperating, WH Brokaw (ed.). Extension Circular 5578.

Kass I, Zamel, N, Dobry CA, Holzer M [1972]. Bronchiectasis following ammonia burns of the respiratory tract : a review of two cases. Chest *62*(3):282–285.

Kelsey TW [1994]. The agrarian myth and policy responses to farm safety. Am J Public Health. *84*(7):1171–1177.

Langley RL [1997]. Wildland fires and firefighting. In: Langley RL, McLymore RL, Meggs WJ, Roberson GT, eds. Rockville, MD: Government Institutes, pp. 521–528.
Lee BC, Gunderson PD [1992]. Childhood agricultural injury prevention: issues and interventions from multiple perspectives. Proceedings from the Childhood Agricultural Injury Prevention Symposium, April 1–3. Marshfield, WI: National Farm Medicine.

Legge RT [1956]. Occupational hazards in the agricultural industries. Am J Public Health. *25*:457–462.

Luginbuhl RC [1997]. Occupational safety and health regulations in agriculture. In: Langley RL, McLymore RL, Meggs WJ, Roberson GT, eds. Safety and Health in Agriculture, Forestry, and Fisheries. Rockville, MD: Government Institutes, pp. 469–482.

Manwaring JC, Conway GA, Garrett LC [1998]. Epidemiology and prevention of helicopter external load accidents. J Safety Res *29*:107–121.

Marshfield Clinic. National Children's Center for Rural and Agricultural Health and Safety [1997]. Available at: http://www.marshfieldclinic.org/nfmc/pages/default.aspx?page=nccrahs_welcome

Mazza JJ [2006]. Promoting agricultural health and safety: A history of the National Farm Medicine Centers. Marshfield, WI: Marshfield Clinic.

Murphy DJ [1992]. Safety and health for production agriculture. St. Joseph, MI: American Society of Agricultural Engineers, p. 57. Available at: http://www.asabe.org

Murphy D [1995]. Just what the world needs—another new journal! J Ag Safety Health. *1*(1):5–6.

Murphy DJ [2003]. Looking beneath the surface of agricultural safety and health. St. Joseph, MI: ASAE. Available at: http://www.asabe.org

Myers JR [1989]. National traumatic occupational fatalities: a surveillance tool for agricultural work-related deaths. In: Proceedings of the National Institute for Farm Safety Summer Conference. Columbia, MO: National Institute for Farm Safety, Paper No. 89–9.

Myers JR, Hard DL [1995]. Work-related fatalities in the agricultural production and services sectors, 1980–1989. Am J Ind Med *27*(1):51–63.

Myers M [2000]. Tractor risk abatement and control. Central States Agricultural Health and Safety Conference: A Working Conference to Develop a Plan of Action, September 21–22. Available at: http://www.public-health.uiowa.edu/gpcah/tracsession.html

Myers ML [2002]. Tractor risk abatement and control as a coherent strategy. J Ag Safety Health *8*(2):185–188.

Myers ML et al., eds. [1991]. Papers and proceedings of the Surgeon General's Conference on Agricultural Safety and Health, Des Moines, Iowa, April 30–May 3, 1991.
National Coalition for Agricultural Safety and Health [1988]. Agriculture at risk: a report to the Nation, agricultural occupational and environmental health: policy strategies for the future. Iowa City, IA: The University of Iowa, Institute of Agricultural Medicine and Occupational Health.

National Committee for Childhood Agricultural Injury Prevention [1996]. Children and agriculture: opportunities for safety and health. Marshfield, WI: Marshfield Clinics.

NIOSH. 42 CFR Part 84, Approval of respiratory protective devices.

NIOSH [1992]. 1992 project facts: The National Program for Occupational Safety and Health in Agriculture.

NIOSH [1993]. FY 1992–1993 program briefing. A document for the annual CDC program review.

NIOSH [1993]. Program facts: the national program for occupational safety and health in agriculture. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health.

NIOSH [1994]. NIOSH Alert: request for assistance in preventing scalping and other severe injuries from farm machinery. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94–105.

NIOSH [1995]. NIOSH Alert: request for assistance in preventing injuries and deaths of loggers. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 95–101.

NIOSH [1997]. Injuries among farm workers in the United States, 1993. Cincinnati, OH: U.S. Department of Health and Human Services (DHHS), Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (NIOSH), DHHS (NIOSH) Publication No. 97–115.

NIOSH [2000]. The NIOSH National Program in Agricultural Safety and Health, prepared for a review of the intramural research program by the NIOSH Board of Scientific Counselors Subcommittee on Agriculture.

NIOSH. [2002]. National Institute for Occupational Safety and Health (NIOSH) Recommendations to the U.S. Department of Labor for Changes to Hazardous Orders--May

3, 2002. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health.

NIOSH [2004]. Worker Health Chartbook 2004. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2004–146. Available at: www2.cdc.gov/NIOSH-Chartbook/ch3/ch3-1.asp

NIOSH [2005-1]. Celebrating the first decade of NORA. Available at: http://www.cdc.gov/niosh/NORA/pastnora.html

NIOSH. [2005-2]. Fact sheet: mechanical timber harvesting reduces workers' compensation injury claims in West Virginia. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2005–129.

NIOSH [2006]. 2001 Childhood Agricultural Injury Survey. Database. Morgantown, WV: National Institute for Occupational Safety and Health.

NIOSH Agriculture Safety and Health Centers [2004]. National agricultural tractor safety initiative. Available at: http://depts.washington.edu/pnash/files/Tractor_Initiative.pdf

NIOSH Board of Scientific Counselors [2000]. National Occupational Safety and Health Program in Agriculture: NIOSH Intramural Research, Report by the Sub-Committee for Agricultural Review.

Noll BC [1994]. OSHA and the Alaskan fishing industry. In: Myers ML, Klatt ML, eds. Proceedings of the National Fishing Industry Safety and Health Workshop. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94–109, pp. 87–91.

NSC [1997]. Tractor companies unite to promote ROPS, seat belts on older machines. National Safety Council News 17M597, pp. 1–2.

Olenchock SA, May JJ, Pratt DS, Morey PR [1986]. Endotoxins in the agricultural environment. Am J Ind Med *10*:323–324.

OSHA [2006-1]. Agricultural operations standards. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration. Available at: http://www.osha.gov/SLTC/agriculturaloperations/standards.html

OSHA [2006-2]. The migrant season agricultural worker protection act. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration, Office of Compliance Assistance Policy. Available at: http://www.dol.gov/compliance/laws/comp-msawpa.htm

OSHA [1992]. Standards interpretations: farming appropriations rider. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration. Available at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=20764

Penn State, U.S. Department of Agriculture, Pennsylvania Counties [1997]. Another tractor manufacturer announces ROPS promotion program. Ag Safety Health News *9*(1):1.

Recommendations from the Report of an Extramural Committee to Review the Extramural Cooperative Agreement Programs. National Occupational Safety and Health Program in Agriculture [1995].

Senate Report [1990]. Excerpts from the Departments of Labor, Health and Human Services, and Education and Related Agencies Appropriation Bills.

Sicks GC [1994]. U.S. requirements for fishing vessels. In: Myers ML, Klatt ML, eds. Proceedings of the National Fishing Industry Safety and Health Workshop. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94–109.

USCG [2006]. Commercial fishing vessel safety. Washington, DC: U.S. Coast Guard. Available at: http://www.uscg.mil/news/fvsafety/fvsafety.htm

USDA. [2005]. What we know about the demographics of U.S. farm operators. Available at: http://www.nass.usda.gov/Census_of_Agriculture/2002/Other_Analysis/index.asp. Last accessed November 28, 2006.

USDA [2006]. Structure and finances of U.S. farms: 2005 family farm report. By Hoppe RA, Banker DE. Washington, DC: U.S. Department of Agriculture, Economic Research Service. Available at: http://www.ers.usda.gov/publications/EIB12/

Washington State Department of Labor and Industries. Safety Standards for Agriculture; Chapter 296-307 WAC, Part J-1, Cholinesterase Monitoring, 17 pages. Rule effective Feb. 2006. Available at: http://www.lni.wa.gov/WISHA/Rules/agriculture/HTML/part-j-1.htm. Last accessed November 20, 2006.

Williams JV [1963]. Inhalation and skin tests with extracts of hay and fungi in patients with farmer's lung. Thorax *18*:182–196.

Young HH, Ghormley RK [1946]. Accidents on the farm. JAMA *132*:768–771.

Chapter 3. Goal 1: Reduce Hazards, Illnesses, and Injuries in the AFF Workforce By Conducting Population-Based and Hazard Surveillance

One of the cornerstones of public health is the use of surveillance to track the health of populations over time. Surveillance serves many public health purposes, including defining the current health status of a population, identifying health risks within a population, and tracking changes in a population's health risk over time.

Occupational illness, injury, and hazard surveillance has evolved over the last 35 years and relies primarily on the BLS Survey of Occupational Injuries and Illnesses (SOII). However, for a variety of reasons, the SOII does not provide adequate surveillance for large portions of the agriculture industry. Since 1976, the SOII covers only those farming establishments with 11 or more full-time workers, which represent less than 5% of the farms in the United States. In addition, the SOII does not track injuries occurring on the 74% of farms with no hired workers. For similar reasons, the SOII does not cover small, family-oriented fishing operators in the United States.

This chapter presents three sections on surveillance research conducted by the AFF Program: illnesses and related hazards, injuries and related hazards, and injuries leading to fatalities and related hazards.

3.1 Illness Surveillance

3.1a Challenge or Issue

There are a number of challenges to illness surveillance in general and to surveillance in agriculture, fishing, and forestry. The relationship between illnesses and work exposures is generally less evident than the relationship between injuries and work activity. Diagnosis of health problems adds to the complexity of surveillance because of the potential for misdiagnoses and subsequent reporting bias. In agriculture, occupational health expertise is often not available. Agricultural workers are less likely to seek medical assistance for a variety of reasons, including time-sensitivity of completing agricultural tasks, inadequate medical insurance, lack of trust of health care professionals, and cultural norms. This leads to illness undercounts.

The NCASH report (Appendix 2-01) noted that epidemiologic studies have indicated that the NSC data underestimate farm injury rates by as much as 50%. In addition, a wide range of agriculturally related diseases have been documented in several epidemiological studies, but adequate population-based rates are not available. Accurate rates are needed for specific types of injury and disease (according to type and size of farm, demographic characteristics, and other risk factors) to better target prevention and intervention efforts. To obtain these rates, the NCASH report recommended that CDC/NIOSH conduct health and hazard surveys for agricultural workers.

The information previously available on excess mortality and morbidity experienced by farm workers lacks the detailed descriptors needed for the design of intervention programs. Apart from pesticides, little population-based data are available on the physical, chemical, and biologic hazards that exist on farms.

Over the past 20 years, there has been ample concern about environmental health issues, particularly the impacts of pesticide exposure. AFF workers are often exposed to an extensive mixture of pesticides. The health impacts of these mixtures are poorly understood, and human susceptibility to pesticide toxicity is likely to be highly variable.

More and better surveillance data are needed to determine appropriate prevention activities.

3.1b Activities

To address surveillance gaps within the agriculture industry and the mandate of Congress, the AFF Program pursued a mixture of population and case-based surveillance approaches. They are summarized in Table 3-1.

Table 3-1. Overview of Surveillance Projects

Project	Intramural staff	Extramural projects	Budget
Farm family health and hazard surveillance	5.0 FTE plus consultations	6	$1.5 to 2.0 million annually for 10 years
Occupational health nurses in agricultural communities	~5.0 FTE	1 for 4 years 1 for 5 years 8 for 6 years	$2 million / year for 6 years = $12 million
Community partners for healthy farming surveillance (Community Partners)	~1.5 FTE	1 for 3 years 8 for 4 years	$4 million
SENSOR− Pesticides	n/a	n/a	$1.5 million

n/a = not available. Budgets are estimates and are only available from 1996 to present. Therefore, budgets are likely an underestimation.

<u>Farm Family Health and Hazard Surveillance</u>

The Farm family health and hazard surveillance (FFHHS) surveys were started in 1994. The purpose of the FFHHS surveys was to provide data that would enable estimation and description of the prevalence and incidence of illnesses, injuries, and exposures to workplace hazards on family farms. Surveys were conducted through cooperative agreements with six States—California, Colorado, Iowa, Kentucky, Ohio, and New York. The FFHHS obtained population-based prevalence and incidence data for farmers and farm families on disease, injury, workplace exposures, and access to health care according to commodity, size of farm, demographic characteristics, nonfarm employment, and other risk factors. (Appendices 3.1-01, 3.1-02)
A mixture of intramural and extramural resources conducted the FFHHS effort. Partners for each participating group are listed in Table 3-2.

Table 3-2. FFHHS Collaborators and Resources, 1990 to present	
Sub-project lead agency	Major partners
Intramural NIOSH	Universities, health departments, cooperative extension services, agricultural centers, and agricultural organizations with other agricultural initiatives.
Occupational Health Branch Department of Health Services State of California	California State University Safe-Net Consultants Public Health Institute Westat, Inc. California Institute for Rural Studies Center for Agricultural Business
College of Veterinary Medicine and Biomedical Sciences Colorado State University	National Animal Health Monitoring System of USDA Colorado Department of Public Health
College of Medicine University of Iowa	Iowa Agricultural Statistics Service
College of Medicine University of Kentucky	Kentucky Agricultural Statistics Service Kentucky Farm Bureau Survey Research Center, University of Kentucky Cooperative Extension Service, University of Kentucky Mobiletek, Inc.
New York State Department of Health	Cornell University Extension Service New York Center for Agricultural Medicine and Health New York State Department of Agriculture and Markets
Department of Preventive Medicine The Ohio State University	Ohio Agricultural Statistics Service National Center for Environmental Health Ohio Department of Agriculture Ohio Fruit and Vegetable Grower's Society

The sample for each State-based survey was to be a probability sample based on certain geographic regions within the State. The samples represented a broad range of farming practices in terms of farm size, commodities, terrain, and farmer demographics. The survey consisted of health and hazard components. The health component was modeled after parts of the National Health Interview Survey (NHIS) and National Health and Nutrition Examination Survey (NHANES). The hazard component was modeled after the National Occupational Exposure Survey (NOES). The specific health events, hazardous exposures, and target populations varied among the six surveys because of the regional differences in agriculture work.

Investigators analyzed the data to identify farm subpopulations with excess rates of disease, injury, or workplace exposures. Excess rates were determined by comparing farm subpopulations within States and across States, and by comparing them with the reference surveys (NHIS, NHANES, NOES). The FFHHS series of surveys was completed in 2000.

Occupational Health Nurses in Agricultural Communities

Occupational health nurses in agricultural communities (OHNAC) was created in response to the Congressional mandate to fund nurses to conduct surveillance in rural communities. The OHNAC program funded 31 public health nurses in 10 States (California, Georgia, Iowa, Kentucky, Maine, Minnesota, New York, North Carolina, North Dakota, and Ohio) to conduct case-based and sometimes rate-based surveillance. Investigations identified previously unknown or under-recognized causes of illness and injuries. Selected OHNAC activities are outlined in Table 3-3. (Appendix 3.1-03)

Community Partners for Healthy Farming Surveillance (1996–2000) was an outgrowth of OHNAC and was funded in California, Iowa, Kentucky, Maine, Minnesota, New York, North Dakota, Ohio, Oregon, and Wisconsin (Appendix 3.1-04). This extension of OHNAC focused on more targeted hazards, included more hired farm workers, had wider geographic regions, and often collaborated with intervention research projects. The AFF Program nurses conducted surveillance primarily with emergency department logs for case identification. They conducted onsite investigations of selected cases. Emphasis was placed on timely identification, investigation, and dissemination of prevention information, especially in relationship to the seasonality of agriculture. From their surveillance findings, the nurses engaged communities to help. They leveraged support of stakeholders for education about illnesses, hazards, and injuries associated with farming. Farm safety day camps, newspaper columns, and interactive active displays at fairs are examples of these collaborative activities.

In 1993, a call to an Iowa OHNAC nurse by a community newspaper resulted in a finding that small engines can produce hazardous levels of carbon monoxide, even in apparently ventilated areas. The sentinel event/index case was reported to the Iowa OHNAC nurse by the editor of a local newspaper who called her about a death of a 33-year-old farmer while cleaning his 3420- cubic-foot-swine barn. This led to review of surveillance records for prior fatal or non-fatal carbon monoxide poisonings while using pressure washers. NIOSH staff subsequently assisted Iowa nurses in investigating that fatality and other non-fatal incidences of carbon monoxide poisoning reported to hospital emergency rooms across Iowa. OHNAC investigators and the Iowa nurses interviewed the four surviving persons and family members. It became apparent that some of their incidences could have been fatal had not family members or other co-workers found the person, recognized the problem, got them out of the hazardous environment, and obtained medical assistance. A follow-up survey in Missouri during the floods found that people were not aware that small engines could produce hazardous levels of carbon monoxide indoors in areas that were apparently ventilated [Grief et al. 1997].

AFF Program support included annual training meetings, a listserv, annual site visits, technical assistance for onsite investigations, and assistance in disseminating findings and interventions.

Table 3-3. Selected OHNAC Activities

State health department and number of local nurses	Examples of activities (especially those unique to extramural project)	Examples of unique partners and case investigations
California; 2 nurses and 1 outreach worker (2 counties)	Only project that focused on hired farm workers. Created NURSE Reports from selected investigations.	Migrant health clinics: Worker scalped in fruit packing plant Cotton harvester operator's arm mangled in cotton harvester spindles Bee stings
Iowa 4 nurses; State-wide	Nurses provide an active component to an existing rate-based, passive injury surveillance system	Grain suffocations Carbon monoxide (CO) poisoning from farmers using gasoline-powered pressure washers indoors
Kentucky 3 nurses; selected regions	-Ascertained (rate based surveillance) of hospital-treated injuries	Green Tobacco Sickness (GTS) Fatality related to dermal and respiratory exposure to a pesticide, endosulfan CO poisoning outdoors
Maine (2) Selected regions	-Initiated Noise-Induced Hearing Loss training with youths attending tractor safety training. -Contributed to annual surveillance of injuries during potato harvest	University of Maine Department of Audiology Northeast Agricultural Center Maine Agriculture in the Classroom State Board of Education Wrist tendonitis among blueberry rakers
Minnesota 4 nurses; selected regions	-Conducted farm surveys as their primary surveillance - Conducted an innovative intervention where grain elevator employees encouraged farmers to use appropriate respiratory personal protective equipment (PPE)	Grain elevator operators Milk testers Eye injuries from survey data Auger injuries
New York 3 nurses; selected regions	- Another AFF Program-funded project provided engineering expertise for selected case investigations. -Sheriff called nurse to respond to calls involving serious injuries or fatalities	Northeast Agricultural Center Cornell University Scalping incidents affecting women using hay baler/kickers Injuries associated with unloading Forage wagons Explosions related to drilling into sealed frames
North Dakota 5 nurses; entire State	In response to parents' request about safe tasks for children, created a table top educational display on age-appropriate farm tasks	Q fever in a sheep farmer Horse injuries
North Carolina 2 nurses and 1 outreach worker; Selected regions	Targeted education for four audiences at their request: farm women, migrant workers, children, and pork production workers	Farm Bureau Women's organizations State and local organizations related to Pork production
Ohio 3 nurses; regional	-Nurses in rural hospitals with occupational health capability -In response to a request of Ohio occupational nurses, assisted NIOSH in day-long agricultural health and safety program at a statewide conference.	Local college, farmers, and extension service assisted in training nurses from 10 States for onsite case investigations. A preventable tetanus fatality. The investigation found that the women had prior medical visits for chronic health problems and no record of tetanus inoculation. Respiratory conditions
Georgia 2 nurses for 4 years only selected regions	- Overnight camps with swimming lessons - Pond safety programs in response to drowning case - Skin cancer prevention	Red Cross for swimming Drowning in farm ponds

SENSOR - Pesticides

The mission of the SENSOR Program is to build and maintain occupational illness and injury surveillance capacity within State health departments. Under this program, NIOSH provides cooperative agreement funding and technical support to conduct surveillance on one or more occupational illnesses or injuries. Acute pesticide-related occupational illness and injury is one area that receives support. (Appendix 3.1-05)

Ten States currently participate in the SENSOR−Pesticides program. NIOSH funds health departments in five States (California, Michigan, New York, Texas, and Washington) to bolster pesticide-related surveillance. The remaining five are unfunded SENSOR−Pesticides Program partners (Arizona, Florida, Louisiana, New Mexico, and Oregon). In addition to tabulating the number of acute pesticide-related occupational cases, these surveillance programs conduct in-depth investigations for case confirmation and develop preventive interventions aimed at particular industries and hazards. The SENSOR−Pesticides Program is most useful for timely identification of outbreaks and emerging pesticide problems. However, a national aggregated database is also available. It consists of acute occupational cases submitted annually by each of the SENSOR−Pesticides States. This database includes cases identified between 1998 and 2004 and is useful to assess the magnitude and trend of acute pesticide-related occupational illness and injury.

Between 1987 and 1997, only three States participated in SENSOR−Pesticides. Since 1997, the number of participating States and activities has increased dramatically. One thing that made this possible was finalizing a standardized case definition and standardized variables in 1998. These were developed through a modified nominal group process. The group consisted of experts from Federal agencies (EPA, NIOSH, and NCEH), the Council of State and Territorial Epidemiologists (CSTE), and State health departments or other state designees.

Although all participating States require physician reporting of pesticide-related illness cases, SENSOR now obtains case reports from multiple sources. Between 1998 and 2004, the three leading sources were other government agencies (e.g. State department of agriculture, State departments of industrial relations, and county health departments), workers' compensation, and poison control centers. Health care professionals reported a much smaller proportion. Other sources of case reports vary by State. They include emergency medical services, medical laboratories, worker representatives (e.g., Migrant Legal Aid, selected community contacts, co-workers, friends, and relatives), employers, news reports, death certificates, and self reports.

The information collected by the State agencies in a standardized manner includes date of illness, information on the ill person (sex, race, age, signs, and symptoms), industry, occupation, whether the illness occurred as a result of workplace exposures, identification of the pesticide(s) that produced the illness, activity of the individual when exposed, type of exposure (e.g., drift, direct spray, indoor air exposure, or exposure to a spill or leaking container), biological monitoring information (i.e., cholinesterase testing and results, and whether other biological testing was performed), and PPE use.

The SENSOR−Pesticides Program captures illnesses resulting from both occupational and non-occupational exposures. However, collaborating States with limited resources are advised to focus their efforts on detecting occupational cases of pesticide poisoning. A case is classified as occupational if the pesticide exposure occurred at work. All other cases are classified as non-occupational.

The SENSOR−Pesticides Program has identified many emerging pesticide problems (listed under outputs). These reports led to targeted efforts to prevent their recurrence. For example, after illnesses were associated with the pesticides used to eradicate medfly infestations, additional resources were used to successfully prevent subsequent medfly infestations through mid-2005. The SENSOR−Pesticides Program also supported the need for public notification requirements for medfly eradication and mosquito abatement programs. Another emerging pesticide problem that was detected involved illnesses associated with automatic insecticide dispensers. Following publication of this report, the Association of American Pesticide Control Officials recommended that the EPA change the label on these devices to prevent their use in public spaces. Finally, another report documented the problem with off target drift of pesticides, specifically, off-target drift into a low-income Hispanic community where many residents lacked health insurance. After this report was published, a law was passed in California that makes growers liable for the uncompensated medical care provided to those who become sick from pesticides that drift from their farms (State of California Food and Agriculture Code, Sections 12996.5, 12997.5 and 12997.7).

Keokuk County Rural Health Study

Extramural AFF Program researchers in Iowa started the Keokuk County Rural Health Study in 1990. It is a prospective cohort study of agricultural budget and environmental exposures, risk behaviors, and health outcomes of a stable population in a highly agricultural county. Row crop farming and livestock production in this county are typical of Iowa and other parts staff for each of the rural Midwest. The primary foci of the study are respiratory diseases, occupational injuries, and occupational/environmental exposures. Other areas included are noise-induced hearing loss, mental health and stress, allergies, and farm safety. We found high rates of childhood asthma, noise-induced hearing loss, depression, adults who were overweight or obese. We also found young children performing dangerous farm chores, exposure to agricultural chemicals and low usage of personal protective equipment, and the presence of loaded and unlocked firearms in most homes. In addition to feeding the results of the study back to the county residents, program staff has conducted community services such as spirometry and blood pressure screenings.

The Keokuk study has sponsored and coordinated two Occupational and Industrial Coding classes with NIOSH staff. People from a variety of departments within The University of Iowa attended the classes. Further, the Iowa AFF Program staff participated annually in the training of University of Iowa College of Medicine students enrolled in medical research classes. Numerous Fogarty scholars and physicians from Eastern European countries (Czech Republic, Slovakia, Romania) have worked with theses researchers, both to receive training and to work on their own projects using our data. Several post-doctoral fellows, including a dermatologist from Finland, have spent a year working with our study data.

The Iowa researchers of the AFF Program have collaborated with others on related studies. Collaborating organizations include University of Nebraska Medical Center, Omaha; University of Arizona College of Medicine, Tucson; Creighton University; and Creighton University.

The Farmer Health Study

Extramural AFF Program researchers in California are conducting the Farmer Health Study, which began in 1990. The study is an investigation of prevalence and risk factors for acute and chronic diseases among California farmers (e.g., dry climate farming as a risk factor for respiratory disease). The results of a questionnaire indicate conditions limiting work, musculoskeletal problems, neuritis/nerve problems, and occupational injuries were the most commonly self-reported conditions, and those conditions were not associated with age. In comparison to the general population of the same age, chronic health conditions that were more prevalent in farmers included musculoskeletal conditions, lung problems, and injuries. However, the farmers appeared to be healthier than the rest of the population with respect to diabetes and heart disease. Farmers were still vulnerable to new respiratory symptoms even after many years in farming. The prevalence of asthma, chronic bronchitis, chronic cough and persistent wheeze had increased in 2004 from previous years, and incidence of new symptoms ran between 5% and 8%.

The project has a community advisory board, composed of local officials and 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. Program staff made presentations to the Merced and Fresno county health departments and will continue to inform them of study results.

3.1c Selected Outputs

Work-Related Lung Disease (WoRLD) Surveillance Report and System

The *WoRLD Surveillance Report* is an important result of the AFF Program surveillance efforts. This report presents a summary of occupational respiratory disease surveillance data at the national and State levels. In 1991, this information was published by NIOSH in the first of a series of six *WoRLD Surveillance Reports*, with subsequent publications in 1992, 1994, 1996, 1999, and 2002. Recently, these reports were placed in a Web based reporting system, the *Work-Related Lung Disease Surveillance System (eWoRLD)* located at http://www2a.cdc.gov/drds/WorldReportData/. (Appendix 3.1-06)

Although the summary focuses on respiratory disease related to several occupations, agriculture constituted approximately 60% of the tables and figures in the report present agricultural data. Included are statistics such as counts, crude and age-adjusted mortality rates, and years of potential life lost to age 65 and to life expectancy. Proportionate Mortality Ratios (PMRs) by industry and occupation are based on the most recent decade of data from a subset of States for which usual industry and occupation have been coded for decedents. The summary also presents U.S., State, and county maps showing the geographic distribution of age-adjusted mortality rates. For the pneumoconiosis, tables and figures summarize selected occupational exposure data for cotton dust and other hazards.

The *WoRLD Surveillance Report* includes analyses of data from the NCHS NHIS and the Social Security Administration disability award files. Other identified data sources include the following:

- The SOII
- Industrial hygiene sampling data from OSHA compliance inspections and consultation surveys
- NHDS reports
- Occupational and environmental diseases and chronic injuries database developed by the AOEC
- National population estimates from the Bureau of the Census
- SENSOR data on silicosis and work-related asthma

In August 2004, the highlights section of the *WoRLD Surveillance Report 2002* was incorporated into the NIOSH topic Web page on occupational respiratory disease surveillance and the electronic version of the *WoRLD Surveillance Report (eWoRLD)* was developed. Also, direct links to the hard copy versions of the *Report* series were created. The user is offered quick access to all summary tables, figures, and maps of the *Report* in three formats—html, gif, PDF, and data in CSV format.

More than 5,300 copies of *WoRLD Surveillance Report 1996* and 3,090 copies of *WoRLD Surveillance Report 2002* were distributed using NIOSH mailing lists and an American Lung Association mailing list. The lists include international and national researchers, physicians, employers, universities, and government agencies. In addition, the AFF Program responded to 202 e-mails received in the *WoRLD* e-mail box (WoRLD@cdc.gov) during 2000–2006.

As of March 2006, approximately 140 documents have cited the *WoRLD Surveillance Reports*. They include journal articles, trade articles, and newspapers. Several publications advertised the 2002 report, often in the form of a note to the reader. These are examples:

- MMWR: http://iier.isciii.es/mmwr/preview/mmwrhtml/mm4911a4.htm
- JAMA archive (reprinted from MMWR): http://jama.ama-assn.org/cgi/content/extract/283/15/1955
- *UTNE Reader*, Fall, 2000
- *American Family Physician*, August, 2000
- *Business and Legal Reports,* July, 2003

The *WoRLD Surveillance Report* or portions of the *Report* are also directly linked from several university, State, Federal and private Web sites, including Duke University and the American Lung Association.

Respiratory Disease in Agricultural Workers: Mortality and Morbidity Statistics

The AFF Program published this report in 2005. It presents surveillance data for agricultural respiratory disease to direct prevention activities. The report is intended to help prevent adverse respiratory health effects associated with AFF industries. Data were drawn from major existing database sources, including NCHS, BLS, and the *Current Population Survey*. PMRs are calculated for each worker group for selected respiratory conditions. Summary statistics and prevalence ratios are included. (Appendix 3.1-07)

Keokuk County Rural Health Study

This study has yielded publications, databases, newsletters (for participants), community presentations, a Website (http://www.kcrhs.org), and local press coverage.

The Farmer Health Study

One program staff member serves on the Rural Community Assistance Corporation board on health and housing, which is a forum for advancing the hired farm workers' health needs. That person has presented results from 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 goal of improving knowledge and reducing exposure to dust that was previously thought by many to be no more than a nuisance.

Other Outputs

Since 1991, the AFF Program disseminated surveillance findings and recommended interventions through the following:

- At least 185 peer-reviewed journal articles
- 24 MMWR articles
- Six NIOSH Updates that were used for targeted mailings to media, agricultural organizations, equipment manufacturers and health departments
- A multiagency Alert on CO poisoning related to small engines
- A how-to guide for pesticide surveillance
- Four other NIOSH publications
- At least 150 presentations at conferences and workshops
- Several unpublished reports
- Web sites

In 2005, AFF program staff in California gave a policy briefing at the California State Capitol on "Policies to Improve the Health and Well-Being of California's Hired Farm

Laborers" to an audience of legislative staff and advocacy groups. The presentation was based on their research findings 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.

Intramural and extramural AFF program staff wrote all the articles and editorials for a special edition of the AAOHN journal in 1993. In cooperation with AAOHN, the AFF Program reprinted all of the articles without other journal content into a publication that was distributed by OHNAC nurses and NIOSH (3,000 copies).

Peer-reviewed Publications

Among the most important publications from the program are the following two:

Ballard and colleagues published "Green tobacco sickness: Occupational nicotine poisoning in tobacco workers," in 1995 in the *Archives of Environmental Health*. This article drew attention to the problem for the first time in many years. It may have contributed to the development of multiple interventions targeting Hispanic farm workers, family farmer operations, and health care professionals.

Brandt and colleagues published, "Exposure to endosulfan in farmers: Two case studies," in the *American Journal of Industrial Medicine* in 2001.The EPA used the article in its scheduled review of the pesticide.

MMWR Articles

The 24 MMWR's published by the AFF Program were about a variety of agricultural exposures, including pesticides, growth regulators, dermal absorption of nicotine among tobacco harvesters, tetanus, carbon monoxide poisoning out-of-doors and in ventilated areas, eye injuries, tractors, and other machinery. Four examples:

Zwerling and colleagues published a MMWR on "Use of rollover protection structures (ROPS) - Iowa, Kentucky, New York, and Ohio, 1992-1997," in 1997. This article was an extensive summary of multistate data, useful in guiding ROPS work.

AFF Program researchers collaborated with OSHA, EPA, and the Colorado State Health Department in developing one of the MMWR articles and an Alert on the use of small engines indoors. People incorrectly assumed that using such equipment in a building with doors and windows open would be adequate ventilation. The Alert continues to be available on Web sites of multiple agencies, and JAMA reprinted the MMWR (http://www.cdc.gov/mmwr/preview/mmwrhtml/00022020.htm).

The AFF Program staff also contributed to the selection of carbon monoxide poisoning as one of the four occupational issues to be included in a CDC-wide telenovela outreach effort to the Hispanic community.

Program researchers collaborated with the Iowa Department of Health on carbon monoxide poisoning related to the use of pressure washers powered by small engines. A MMWR article and a NIOSH Update resulted.

Extramural AFF Program researchers in Ohio investigated a tetanus death in 1993. This person was regularly seen by her physician for chronic health problems, but her tetanus status was never updated. A MMWR article reported the case in 1993. As a result, the Ohio health department issued press releases and other outreach encouraging physicians to see that tetanus status is updated when seeing patients for other problems. This work led to an increase in tetanus inoculations in Ohio that were sustained for at least five years.

NIOSH Publications

AFF Program findings of increased risks for pesticide poisoning among working youths were published in peer-reviewed journals (*American Journal of Public Health* and *Environmental Health Perspectives*) in 2003. The findings formed the basis for the NIOSH recommendation to DOL to prohibit youths from handling and applying pesticides.

AFF Program staff produced the publication *Simple Solutions: Ergonomics for Farm workers*. The document includes one fact sheet based on an investigation of tendonitis among youths and adults harvesting blueberries in Maine. Seventy-seven thousand copies (in English and Spanish) have been disseminated. The AFF Program will print additional copies in 2007 because of continuing demand. Table 3-4 presents details on the dissemination of selected AFF Program publications

Over 77,000 copies have been requested. Contains fact sheets that can be printed individually and often include cost-effectiveness data.

Web sites

Many materials developed by the OHNAC staff are available on the National Agricultural Safety Database. Local organizations and university professors use these materials to teach agricultural safety and health.

Each participating FFHHS State provided year-end reports detailing methodologies and findings from their surveys. All final reports and data are available on the NIOSH–FFHHS

Table 3-4. Dissemination of selected AFF program publications via OHNAC and community Partners for health farming surveillance projects

Publication title	NIOSH Pub No.	Number of copies printed and date	Copies distributed and total printed	Web hits from 10/01/03 to 09/30/05
NIOSH reprint of *AAOHN J.* Issue dedicated to agricultural health and safety; 1993. 41(9)		1,200 1/7/94 1,200 5/2/94	2,400/2,400 (Last sent: before 2000)	NA
NIOSH Update: NIOSH Issues Warning to Tobacco Harvesters	93-115	20,000 7/9/93 3,500 11/14/96 8,500 9/12/97	31,457/ 32,000 (In stock: 543)	79
NIOSH Update: NIOSH Warns of Deadly Carbon Monoxide Hazard from Using Pressure Washers Indoors	93-117	3,000 4/23/93 5,500 5/7/93 20,000 6/9/93	28,500/ 28,500 None in stock: (Last sent: 9/05)	772
NIOSH Update: Farm Safety Danger of Hair Entanglement in Hay Baler Drive Shafts	93-126	15,000 5/12/94	15,000/15,000 (None in stock. Last sent: 9/05)	402
NIOSH Alert: Preventing Scalping and Other Severe Injuries from Farm Machinery	94-105	10,000 7/25/94 2,000 7/14/97 2,000 7/7/98	14,000/14,000 (None in stock Last sent: 7/06)	1811
NIOSH Update: NIOSH Warns Farmers of Forage Wagon Hazards	95-118	10,000 9/14/95 3,000 12/6/95 10,000 10/30/97	21,489 /23,000 (In stock: 1511)	186
NIOSH Alert: Preventing Carbon Monoxide Poisoning from Small Gasoline-Powered Engines and Tools	96-118	4,200 12/30/96 800 1/6/97 10,000 3/21/97 6,000 11/17/99	20,527 /21,000 (In stock: 473)	3,736
NIOSH Tear-Out-Sheet for Alert: Preventing Carbon Monoxide Poisoning from Small Gasoline-Powered Engines and Tools	96-118a	10,800 12/30/96 20,000 3/14/97 6,000 11/17/99	36,309 /36,800 (In stock: 491)	Not available
NIOSH Update: NIOSH Warns: Improper Hitching to Tractors Can Be Fatal	97-108	10,000 1/16/96 25,000 3/12/97	32,262 / 35,000 (In stock: 2738)	699

Web site, established in 1991 (http://www2a.cdc.gov/ffhhs/). A measure of the success of this site may be the number of hits per year: 6,391 in 2002; 18,035 in 2003; 12,487 in 2004; and 8,181 through September 2005. The number of these hits that were executed by extramural AFF Program staff is not known.

Sponsored Conferences and Workshops

AFF Program staff presented a seven-hour continuing education program on agricultural health and safety for the Ohio Occupational Health Nurses' conference in 1995. Registration (185) exceeded the two prior conferences by this organization by 50% and 100%. Nearly all participants were nurses in general industry that had employees that also farmed.

Theses and Dissertations

FFHHS analyses resulted in 15 masters theses, three Ph.D. dissertations, and two post-doctoral research studies.

Survey Instruments

The survey instruments used in individual State FFHHS surveys consisted of a series of modules: demographics, medical care access, injuries, musculoskeletal conditions, respiratory symptoms, hearing loss, dermatologic conditions, mental health, neurotoxic effects, cancer, and hazards. Examination protocols for spirometry and audiometry were also developed, as was a protocol for onsite walk-through surveys of potential exposure sources.

Training Curriculum

AFF Program staff created CAST, a series of approximately 500 slides illustrating agricultural hazards and proper working conditions. It also includes 28 lectures and instructor and student training manuals. Videotapes of the lectures were made available. CAST was used to train people to do observational surveys of potential exposures at farm sites. Approximately 50 sets of tapes were produced and sent to FFHHS participating states, other agricultural schools, and foreign countries. Several hundred copies of the hard copy manuals were produced.

Brochures, Checklists, Fact Sheets, White Papers

Investigators in several FFHHS projects developed brochures and fact sheets:

- Health checklists at the University of Kentucky (http://www.mc.uky.edu/scahip/).
- Three white papers for the National Institute for Farm Safety (NIFS) by investigators at Cornell University collaborating with the New York State Department of Public Health.
- Six Cornell Cooperative Extension Service fact sheets on AFF hazards
- Two sets of educational materials on occupational injuries and hazards distributed by California's Occupational Health Surveillance and Evaluation Program.

Exhibit Materials

Each OHNAC project nurse produced exhibit materials. The AFF Program nurses often engaged volunteers from 4-H and FFA to help develop these exhibits. Some 4-H and FFA groups produced additional exhibits they themselves used in their schools and communities.

Danger, a table top educational display on appropriate farm tasks for children (created by an OHNAC nurse) won "Best" in all three categories of exhibits at a national agricultural safety conference in 1995. The display continues to be distributed by request about four times a month in North Dakota by the Farm Bureau and nationally by Farm Safety 4-Just Kids, the latter for a moderate fee. The North Dakota Farm Bureau updated the display in 2003.

A complete list of outputs can be found in section 3.4 at the end of this chapter.

3.1d Intermediate Outcomes

A wide range of stakeholders are using the data produced by the AFF Program surveillance activities.

Farm Family Health and Hazard Surveillance

Spirometry and audiometry protocols developed for the FFHHS have been used in, for example, longitudinal studies in California (Farm Worker Family Health Cohort Study) and Iowa (Keokuk County Farm Health Study). In addition, the CAST training materials have been useful for environmental assessments in these studies. (Appendices 3.1-01, 3.1-02)

Occupational Health Nurses in Agricultural Communities

Data from OHNAC (Appendix 3.1-03) guided the Certified Safe Farm program in Iowa and the Kentucky ROPS project and other intervention research projects on tractors (see Research Goal 5). Those surveillance activities also informed a study of pesticide exposure (atrazine) in children in Ohio.

AFF Program staff learned of tetanus cases in OHNAC states. This resulted in inoculation programs in Ohio, Minnesota, and Iowa. In Minnesota, a creamery provided 71 tetanus immunizations to area farmers. The Ohio Health Department tracked an increase in inoculations following press releases related to a fatality of a woman who had received periodic care by a primary provider for chronic health conditions but whose tetanus immunizations had not been updated.

OHNAC nurses stimulated interest in occupational safety and health issues within the regions they served, which led to actions by others. Other media activity stimulated by the AFF Program surveillance activities includes the following:

- A writer for *Farm Journal* often attended OHNAC annual meetings. The writer provided input about dealing effectively with local media. She used surveillance data for stories she published in national trade publications.
- Local media initially cooperated with the nurses requests for promoting the program and subsequently offered free space for periodic columns such as *Ask the Farm Nurse*. OHNAC nurses were consulted for feature stories and reports of local fatalities.
- An article on OHNAC in *Successful Farming* generated 35 letters to NIOSH, primarily by nurses, praising the program and requesting further information about

becoming involved (e.g., in their practices or as a community volunteer). Each was provided with resources. They were encouraged to network and build support for outreach and research with such people as key community leaders, agricultural organizations, and hospital outreach and public health departments.

- When the AFF Program produced an MMWR article on green tobacco sickness, at least 14 newspaper and newsletter articles ensued summarizing the story.
- For example, a local newspaper published a local farmer's letter about his thoughts and feelings while trapped under his tractor and how to prevent such incidents.

EPA used AFF Program case reports in their scheduled review of endosulfan in 2003. One of the OHNAC investigators identified a fatal endosulfan poisoning case due to dermal or respiratory exposure. That led to the identification of a second case with permanent, disabling injuries requiring permanent institutional care [Brandt 2001].

North Carolina and Maine expanded their occupational injury State reporting laws, which resulted from an increased appreciation of the value of such data by exposure to OHNAC nurses.

Safety camps developed in response to identified hazards became one of two types of intervention products. In response to drowning of youths in farm ponds, the AFF Program nurses in Georgia initiated pond safety training and day camps that included teaching swimming to youths. *Progressive Farmer* (farm periodical) subsequently asked the project coordinator to assist them in establishing a national program of day camps modeled after camps in Georgia and other states. Nurses in most OHNAC States helped initiate such camps in their locales. Many of those locales have continued the annual camps. Evaluations of the day camp programs have found them to be effective in raising safety awareness and behavior change in children, disseminating hazard awareness to parents by participating children, and meeting other objectives (Table 3-5). In 1995, 19 day camps operated in 11 States and reached 2,020 campers. In 2006, 350 Progressive Agriculture Safety Days™ are planned in 34 States, 5 Canadian provinces, the U.S. Virgin Islands, and American Samoa. These safety days could reach 59,000 participants with the help of 19,000 adult and older teen volunteers in 2006. The not-for-profit Progressive Agriculture Foundation uses both public and nongovernmental partners nationally and in local communities. Individuals have communicated specific incidences where specific knowledge learned at the camps saved them from serious injury or death.

Table 3-5. Progressive farmer safety day camps: historical program statistics, 1995–2005

Item	Number
Safety days	
Participants	380,440
Volunteers	125,392
Total participants and volunteers	505,832
States	42
Canadian provinces	6
U.S. territories	2
Persons receiving in-depth training to conduct safety days	2631
Training sessions	99

An Anecdotal End Outcome

Lee Powell, age 15, of Omega, Georgia, credits a 1992 farm safety camp he attended with saving him when his tractor lurched forward into a ditch. A 15-year-old, from Shelton, Nebraska credits what he learned at a 1998 day camp with saving his life in 2004 when he was operating a tractor with a four-row ridger that struck a power pole, causing power lines to fall on the tractor; he called for help on his cell phone and stayed inside the tractor cab until the power company arrived and turned off the power to the lines (http://www.progressiveag.org/, http://progressiveag.org/content/blogcategory/19/25/).

California

For more than 12 years, insurance company risk managers have used the OHNAC-generated NURSE reports to train farm workers, crew leaders, and managers during training mandated by the DOL and others to prevent injuries and illnesses. University professors and safety trainers also use the reports.

OHNAC case investigations in California identified the need for first aid/CPR training, which resulted in Kellogg Foundation grants for several migrant health clinics to hire bilingual outreach workers who could provide such training.

North Carolina

OHNAC nurses initiated a *Farmwives Night Out* in collaboration with Farm Bureau Women, Farm Credit, and the North Carolina Cooperative Extension Service. The purpose was to raise the awareness of hazards and their preventability and to engage these women in supporting the reduction of hazards on their farms and in their communities. This program was continued after the project ended and was later repeated by cooperative extension educators.

Wisconsin

Analysis was performed on traffic accident reports involving tractors and farm trucks and postcard reports of other farm-related incidences. The findings are being used in ongoing educational intervention efforts through the Wisconsin Cooperative Extension Service. For example, data analysis and prevention recommendations were disseminated to the 200 high school agricultural teachers in Wisconsin. These teachers were involved in the ~240 tractor safety training programs that were conducted for ~3600 youth between 2000 and 2006. The reports were also used in numerous education programs related to production agriculture.

<u>SENSOR−Pesticides</u>

In 2005, AFF researchers published in JAMA the results of an investigation of pesticide exposure and related illnesses in schools [Alarcon 2005]. Subsequent media reports described school districts that had decided to adopt integrated pest management programs after learning of the JAMA report. After the article was published, U.S. Senator Frank Lautenberg (New Jersey) introduced a bill in the Senate that would require schools to adopt integrated pest management strategies. A similar bill was introduced in the House (neither passed). (Appendix 3.1-05)

AFF investigators published an MMWR article in August 2004 that described a large outbreak of pesticide poisoning caused by a chloropicrin drift exposure from a farm in California [Centers for Disease Control and Prevention 2003]. The article reinforced the need for a regulatory reevaluation of chloropicrin that was underway in California. The article also provided justification for legislation that was enacted just a month after the article appeared. It required growers to reimburse any medical expenses incurred by pesticide-drift victims.

A 2003 MMWR article describing the AFF Program findings on illnesses associated with mosquito control efforts provided public health authorities with information to better assess the benefits and risks associated with the use of adulticides to control mosquito populations [Centers for Disease Control and Prevention 2003]. Following publication of this article, EPA proposed revisions to adulticide labels to incorporate some of the recommendations made in this report [Environmental Protection Agency 2005].

Following release of an MMWR article in 2000 that described AFF Program findings on illnesses associated with automatic insecticide dispensers, information and recommendations contained in the article were used by EPA in cooperation with the American Association of Pesticide Control Officials in efforts to change the label on these devices to prevent their use in public spaces (e.g., restaurants). These label changes have not been finalized.

Following the release of an MMWR article in November 1999 describing AFF Program findings on illnesses associated with efforts to control medfly infestations, NIOSH recommendations for accomplishing medfly control without the use of pesticides (based on the MMWR) were adopted by the USDA. and the Florida Departments of Agriculture [Centers for Disease Control and Prevention 1998; US Department of Agriculture 2001]. No infestations of medfly have since been detected in the United States.

After we published a 1999 MMWR article that described 42 cases of pesticide-related illnesses attributed to occupational use of flea-control products (of which 17 were related to phosmet exposure), the manufacturers voluntarily cancelled the use of phosmet on all domestic pets in 2001 [Centers for Disease Control and Prevention 1999; Edwards 2006]. The article also led EPA and eight State health departments to notify grooming shops, veterinary offices, and professional veterinary associations about hazards associated with flea-control products and how to mitigate these hazards. Since 2001, the SENSOR−Pesticides Program has not identified any illnesses related to phosmet use for flea control.

AFF researchers published an MMWR article in February 1999 that described an incident in which a crew of 34 field workers became ill after entering a field sprayed 2 hours earlier with a pesticide solution containing carbofuran (this insecticide has a restricted entry interval of 48 hours) [Centers for Disease Control and Prevention 1999]. This article was praised by

EPA for reinforcing the importance of compliance with the EPA's Worker Protection Standard, and documenting the need for safer pesticide alternatives. The continuation of funding for SENSOR-Pesticides by EPA reflects the agency's high regard for SENSOR-Pesticides and its accomplishments.

Other Intermediate Outcome

AFF Program data were used to develop the National Agenda for Action, a national land grant research and extension agenda for agricultural safety and health prepared by the NCR–197 Committee on Agricultural Safety and Health Research and Extension of the North Central Regional Administrators of the Association of Agricultural Experiment Station Directors (http://www.tmvc.iastate.edu/).

3.1e End Outcomes

Evidence of reductions in occupational hazard exposures, illnesses and/or injuries as a result of the AFF Program research efforts is elusive at best. Many external factors affect the impact of research outputs in the workplace. Surveillance activities are no exception. Nevertheless, we feel that we have presented sufficient evidence above to establish our contribution to two end outcomes.

Between 1998 and 2004, the AFF SENSOR−Pesticides Program effort has observed a decrease in the rate of acute pesticide poisoning in the agricultural industry (Figure 3-1). Many factors contributed to this decline, including EPA's prohibition of some of the most toxic pesticides, worker training, new work practices, and adoption of integrated pest management strategies. We believe that surveillance data from this program are among those drivers. The Program has identified many emerging pesticide problems (described above) and provided recommendations to solve these problems (Appendix 3.1-05).

OHNAC and FFHHS surveillance data guided the development of an intervention project that has been shown to increase the use of ROPS by farmers. Case-based surveillance reports provided important details for development of realistic composite stories, interactive computer-based training, press releases, and other materials for promoting ROPS. In the intervention project, the use of retrofitted ROPS increased from 4 in 2 treatment counties the year before the intervention to 81 in the 3.5 years following the intervention (Appendices 3.1-01, 3.1-03).

3.1f External Factors

In addition to the social and economic conditions as well as regulatory environments relevant for any safety and health work in agriculture, these projects also had unique external influences that impacted their outcomes.

The seasonality of agricultural tasks and the unavailability of farmers during busy seasons sometimes delayed or complicated research efforts. The OHNAC nurses often made themselves available 24/7 to investigate incidents in a timely manner. For example, the investigation of green tobacco sickness in Kentucky was successful because of the availability of nurses to follow-up within hours of incidents. By contrast, in the same State, data on exposure to carbon monoxide while planting tobacco was not collected because all seedlings had been planted on area farms before a farm could be identified that would permit data collection (Appendix 3.1-03).

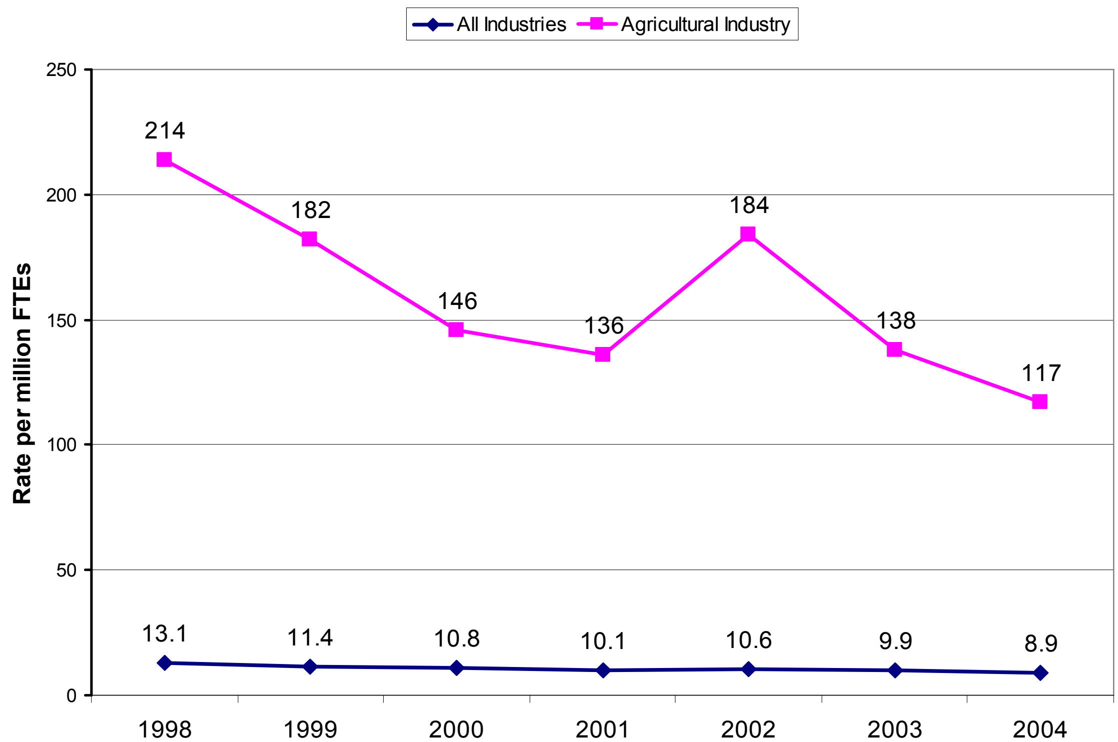


Figure 3-1: Incidence rate of acute occupational pesticide-related illness by year, 1998–2004.

3.1g Future Directions

SENSOR–Pesticides Program

Some regions of the country are not covered by the SENSOR–Pesticides Program (Appendix 3.1-05), including the prairie States and the States on the southeastern seaboard. We would like to add at least one State from each of these regions to the SENSOR–Pesticides program.

WoRLD Surveillance Report and System

A 2007 issue of the report will be released. *e-WoRLD* will be updated as soon as data relevant to respiratory disease outcomes and hazards are released. Also, in response to NIOSH researchers' requests, data will be presented by NORA sector, industry, and occupation. In addition, an Index will be developed. (Appendix 3.1-06)

RHAg Report

The *RHAg Report* is concerned only with health outcomes. In September 2005, we began a program of occupational respiratory disease hazard surveillance in agriculture to augment the report. The program will identify respiratory hazards and all relevant data available. The NIOSH Surveillance in Agriculture Web topic page is currently under development and will incorporate the *RHAg Report* and the agriculture hazard database. (Appendix 3.1-07)

3.1h List of NIOSH projects included in this section

- DSHEFS-VMO8549-Farm Family Health and Hazard Survey (Appendix 3.1-01)
- DSHEFS-9278549-Agriculture Research, Development and Planning Using State Farm family Health and Hazard Surveys (Appendix 3.1-02)
- DSHEFS-9278585-Occupational Health Nurses in Agricultural Communities (Appendix 3.1-03)
- DSHEFS-9278501-Community Partners for Healthy Farming (Appendix 3.1-04)
- DSHEFS-9278645-SENSOR Pesticides (Appendix 3.1-05)
- DRDS-927Z1NK-WoRLD Surveillance Report and System (Appendix 3.1-06)
- DRDS-9277416- Respiratory Health and Hazards in Agriculture Report (Appendix 3.1-07)

3.2 Injury Surveillance

3.2a Challenge or Issue

Health surveillance of the agriculture population presents unique challenges that have only begun to be significantly addressed in the last two decades. The agricultural worker population is made up of farmers, farm families, migrant and seasonal workers, and others. It is highly mobile as well as racially and ethnically diverse. The population includes large numbers of self-employed workers, most of who are not represented by organized groups or unions or covered by workers' compensation programs. Farmers are often an economically marginal group for whom preventive safety and health methods may seem unaffordable. Access to medical care is frequently distant or unavailable, and medical insurance may be marginal or nonexistent. Hence, medical usage patterns are frequently different from those of urban populations. Self-treatment is a common occurrence.

Farmers and their families represent one of the greatest age-spans of workers in any industry. From an early age to well past common U.S. retirement ages, they are exposed to hazards from machinery, animals, crops, chemicals, and the vagaries of the weather. They have preconceived notions about chores, production activities, and daily living that make traditional definitions of work-relatedness (particularly for children) difficult to apply to agricultural hazard assessments.

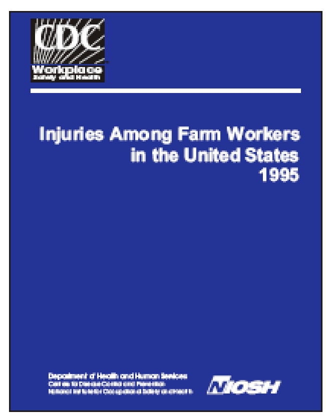
The AFF Program has pursued a mixture of population- and case-based surveillance approaches in the agriculture industry (Table 3-6). This approach has answered significant questions about farm hazards. However, continuity over time, filling missing gaps, and capturing information from the diverse farm population still remain as difficult challenges.

Table 3-6. NIOSH injury surveillance activities covering the agriculture industry 1990 to present

Activity	Years	Sector covered	Type of surveillance	Type of activity	Major partners
FFHHS	Varied	Farming	Population	External (Coop. Agreement)	States
OHNAC	1990–1996	Farming	Case-based	External (Coop. Agreement)	States
TISF	1993–1997	Farming	Population	Internal	NSC, USDA
CPHR–Surveillance	1996–2000	Farming	Case-based	External (Coop. Agreement)	States
NAWS	1999, 2002–2004	Crop Farming	Population	Internal	USDOL
NEISS-Work	1997–present	Farming	Population	Internal	CPSC
OISPA	2001-present	Farming	Population	Internal	USDA

3.2b Activities

Traumatic Injury Surveillance of Farmers



In 1986, the NSC−AD identified a need for farm injury data in the United States and established a sub-committee to evaluate different methods of obtaining these data. The AFF Program had identified a similar need and joined the NSC−AD data subcommittee. Between 1988 and 1992, nine States pilot tested a standard survey instrument and a contact approach developed by Murphy and Huizinga [1989]. Based on the results of the pilot test, the AFF Program established the TISF surveillance system in 1993. TISF was a population-based, cross-sectional survey conducted through an interagency agreement between NIOSH and the USDA National Agricultural Statistics Service (NASS). TISF results are available for the calendar years 1993–1995, and provide descriptive injury statistics and injury rates at the national and regional levels. Data are also available for States, with each State being reported at least once in the TISF over this three-year time period (Figure 3-2). (Appendix 3.2-01)

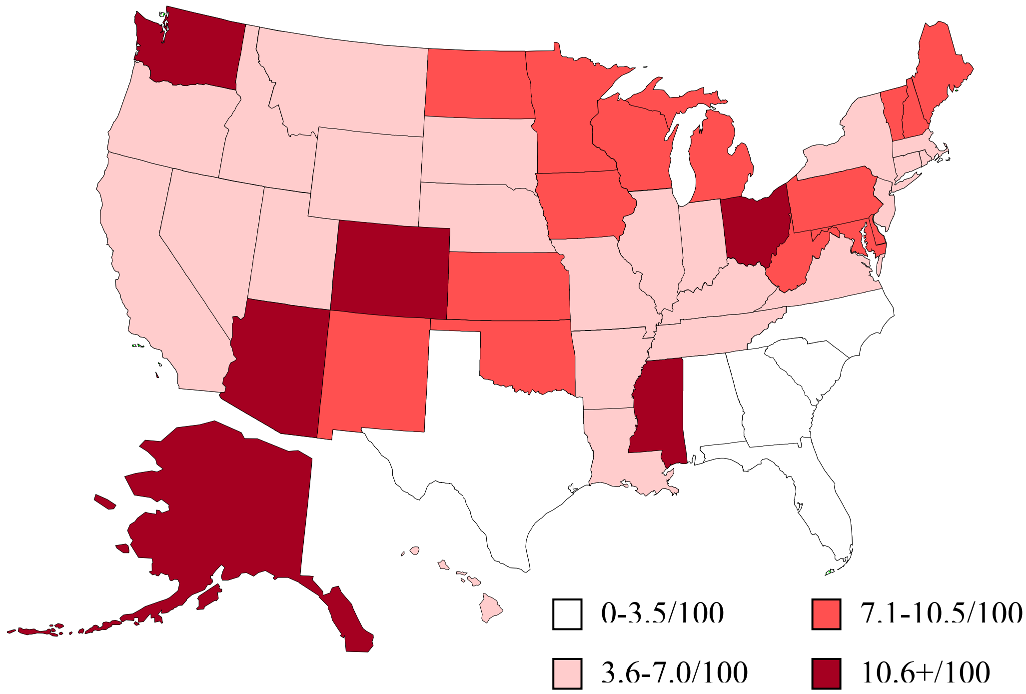


Figure 3-2.: Work-related nonfatal farming injury rates by State, 1993-1995.
Source: NIOSH Traumatic Injury Surveillance of Farmers.

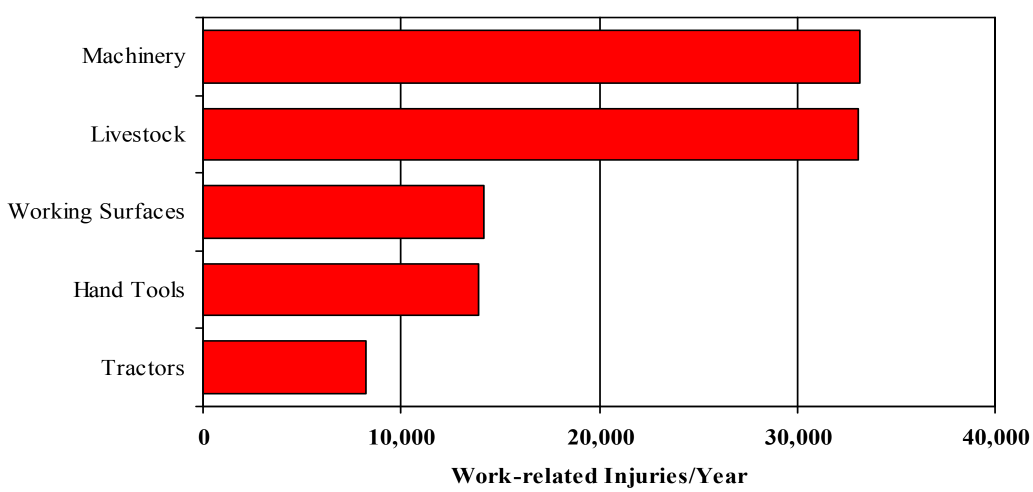


Figure 3-3: Leading Causes of Injury on Farms in the U.S., 1993-1995
Source: Traumatic Injury Surveillance of Farmers

Based on the TISF, an estimated 173,000 lost-time injuries occurred annually among farm operators and farm workers between 1993 and 1995, with 66% occurring to farmers or farm family members. The average annual injury rate for this 3-year period was 7.8 lost-time injuries per 100 workers. The leading causes of injury were machinery and livestock (Figure 3-3). In addition to occupational injury data, the TISF collected information on what tractors were in use on U.S. farms and whether they had a ROPS.

Farms averaged more than two tractors each. Average tractor age was more than 20 years. More than 60% of U.S. farm tractors were without a ROPS (Table 3-7).

Table 3-7. Summary of farm tractors used on farms in the US 1993

Item	Estimate
Tractors in use	4,800,000
Average tractor age	22.8 years
Tractors per farm	2.3
Tractors with ROPS	1,824,000
ROPS Roll bar	528,000
ROPS Cab	1,296,000
Tractors without ROPS	2,980,000
ROPS tractors per farm	0.90
Source: TISF	

In addition to providing baseline tractor information, the TISF tractor data also provided estimates of the most common tractors without ROPS used on farms (Table 3-8). AFF Program researchers used these data to identify common older tractor models to target engineering research designing new ROPS and assessing the structural integrity of older tractors to support ROPS structures during overturns.

Table 3-8. The five most common farm tractors without ROPS in use on U.S. farms, 1993

Manufacturer and model	Non-ROPS units in use
John Deere 4020	100,000
Ford 8N/9N	84,000
International Farmall M	77,000
International Farmall H	66,000
John Deere 3020	56,000

Note: TISF tractor prevalence data were used by Colorado State University to identify common tractors by manufacturer and model for ROPS retrofit evaluations (e.g., Ford 8–N). TISF was discontinued in 1997.

<u>Occupational Injury Surveillance of Production Agriculture</u>

In 2001, the AFF Program re-established a farm-operator-based surveillance system that built on TISF. The new surveillance system, the OISPA , also expanded on an existing partnership between NIOSH and USDA-NASS under which youth farm injury data were being collected (Appendix 3.2-02).

OISPA is a telephone-based survey of a random sample of farm operators across the United States The target population for the survey is adults working on the farm that are aged 20 or older. Occupational farm injuries for youths under age 20 are addressed by the AFF Program's CAIS. The OISPA sample design allows regional (but not State) injury estimates. Like TISF, OISPA collects information on farm demographics, occupational injuries, and hired workers. To date, three OISPA surveys have been conducted by NASS for us. Surveys in 2001 and 2004 provided estimates for all farm operators in the United States and the 2003 survey specifically collected information from racial minority and Hispanic farm operators, an AFF Program priority population.

Table 3-9. Estimated occupational injuries and injury rates per 100 workers in production agriculture, 2001 and 2004

Year	Lost-time injuries for workers aged 20 or older	Lost-time injuries for workers under age20	Lost-time injuries per 100 workers
2001	87,500	9,500	5.2
2004	80,300	8,300	4.9

Source: OISPA and CAIS

By combining injury estimates from 2001 and 2004, OISPA and CAIS farm injury numbers and rates comparable with 1993–1995 TISF reports were obtained (Table 3-9).

Occupational farm injuries during the earlier part of this decade averaged approximately 93,000 lost-time injuries annually, with a lost-time injury rate of about 5 per 100 workers. Working surfaces were identified as the most frequent source of injury in 2001, followed by livestock and parts and materials (Figure 3-4).

Table 3-10. Summary of farm tractors used on farms in the United States in 2001

Item	Estimate
Tractors in use	4,700,000
Average tractor age	25.7 years
Tractors per farm	2.5
Tractors with ROPS	2,326,000
ROPS Roll bar	926,000
ROPS Cab	1,400,000
Tractors without ROPS	2,374,000
ROPS tractors per farm	1.2

Source: OISPA

As with the TISF, OISPA collected similar information on farm tractors. These data indicated that the use of ROPS increased in the United States, with nearly 50% of all tractors in use on farms having either a ROPS roll bar or ROPS cab (Table 3-10). From 1993 to 2001, the use of roll bar ROPS dramatically increased (75%). Historically, tractors have had a long useful lifetime, and the average age increased somewhat over the 8 years between surveys. The distribution of tractors without ROPS changed little between the surveys, with the oldest tractors (the Farmalls) being slowly taken out of service.

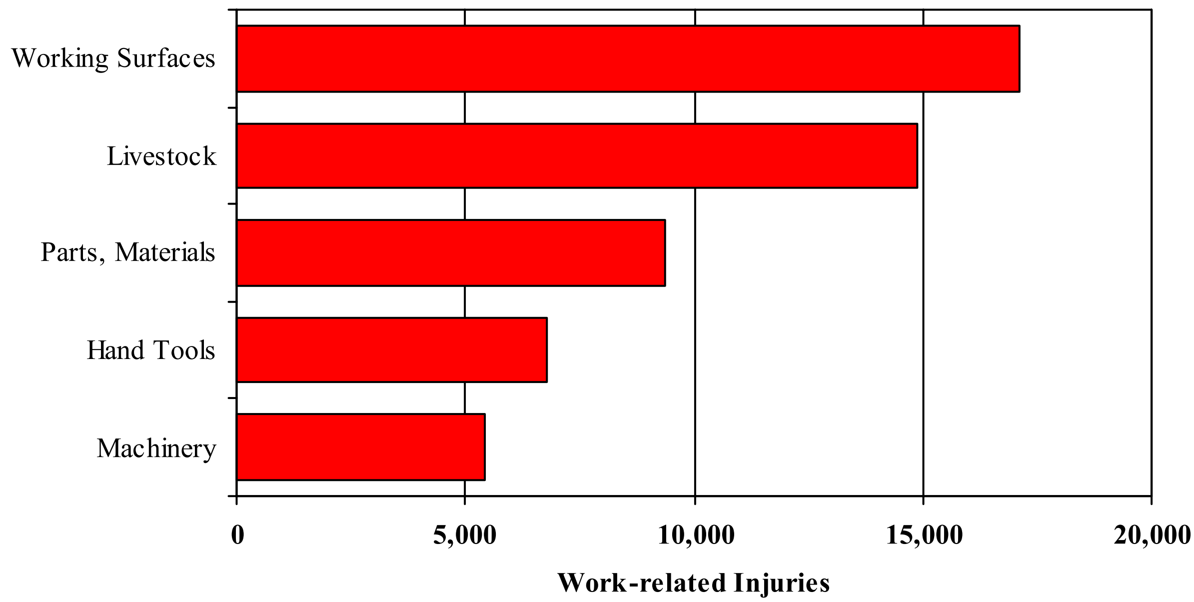


Figure 3-4: Leading Causes of Injury on Farms in the U.S. for Adults 20 Years of Age or Olders, 2001
Source: Occupational Injury Surveillance of Production Agriculture.

Extramural AFF Program researchers at the National Farm Medicine Center, Marshfield, Wisconsin, used the more recent tractor prevalence data from the OISPA for an ergonomic evaluation of common tractors with and without ROPS for use by youths on farms. The Agricultural Safety and Health Center located at the University of California–Davis is collaborating.

Another extramural AFF Program researcher at the University of Kentucky is using OISPA tractor prevalence data for an economic analysis project of ROPS use on farms. The project includes analysis of tractor and ROPS use by hours worked, farming operation, and the need and feasibility of retrofitting ROPS to existing tractors.

National Agricultural Workers' Survey

NAWS (Appendices 3.2-02, 3.2-03) is a special data collection activity maintained by DOL since 1988 [DOL 2006]. The primary purpose of NAWS is to collect economic and demographic information on the estimated 1.8 million farm workers in the United States. However, NAWS has not traditionally looked at occupational safety and health issues. In 1998, as part of a broader surveillance activity, the AFF Program identified NAWS as a potentially useful means of collecting occupational health and injury data on this special population. The AFF Program provided funds to DOL in 1999 to collect special modules on a variety of topics, including farm work-related injuries. Results from this initial survey yielded an estimate of 64,000 farm worker injuries occurring in 1999, and an average farm work injury rate of 7.8 per 100 full-time workers (Figure 3-5). These data suggested that migrant and seasonal farm workers aged 45–54 were at highest risk for these farm work injuries.

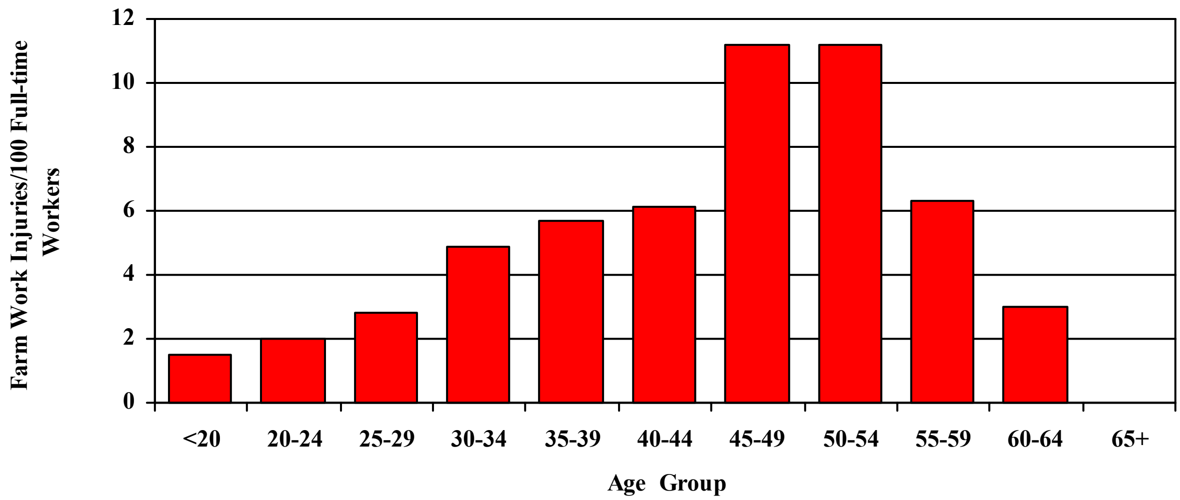


Figure 3-5: Farm work injury rates by age group

In 2002 and 2004, the AFF Program supported additional NAWS agricultural injury data collection to enhance surveillance of migrant and seasonal farm workers. Results of these data collection efforts have not been released.

<u>National Electronic Injury Surveillance System</u>

NEISS (Appendix 3.2-04), which is maintained by the U.S. Consumer Product Safety Commission (CPSC), collects injury and illness data from a national probability sample of U.S. hospital emergency departments to identify hazards related to consumer products under their jurisdiction. NEISS has been an invaluable data source for meeting this need. It has also been used to study farm-related injuries based on an injury locale variable.

These studies have frequently focused on injuries to children, particularly those resulting from horses and all-terrain vehicles. Historically, NEISS excluded work-related cases as a general rule. This makes interpreting these older studies somewhat difficult when work and recreational uses of consumer products, horses, and ATVs are commonly blurred on farms, which is still a problem today. In the 1980s and again in the 1990s, the AFF Program partnered with CPSC for special studies to collect work-related injuries and illnesses regardless of consumer product involvement. Since 1998, uniform data collection has been maintained for all work-related cases captured at a sub sample of the NEISS hospitals.
One of the strengths of using NEISS-Work data for agricultural injury prevention activities is the capture of all work-related cases without limitation by self-employment, number of hired workers, age, family relationship, or working for direct payment. NEISS-Work includes all production-related injuries. The NEISS program also allows the opportunity to do in-depth

follow back interviews with injured workers—a process that was used to study injuries to youths on farms. One of the weaknesses is the lack of coded, standardized industry classifications.

As has been done in the past for agricultural injury studies, an injury locale of farm/ranch can be used as a surrogate for industry classification. In recent years, the NEISS product-related injury estimates for emergency department-treated injuries that occurred at a farm/ranch locale have remained about 20,000 cases per year, whereas work-related injuries at farm locales have ranged from about 50,000 to 70,000 cases (Figure 3-6). Identifying cases by farm locale alone does not capture all agriculture-related injuries, and not all injuries are treated in emergency departments. Plans exist for more complete and robust identification of agriculture cases by reviewing text fields.

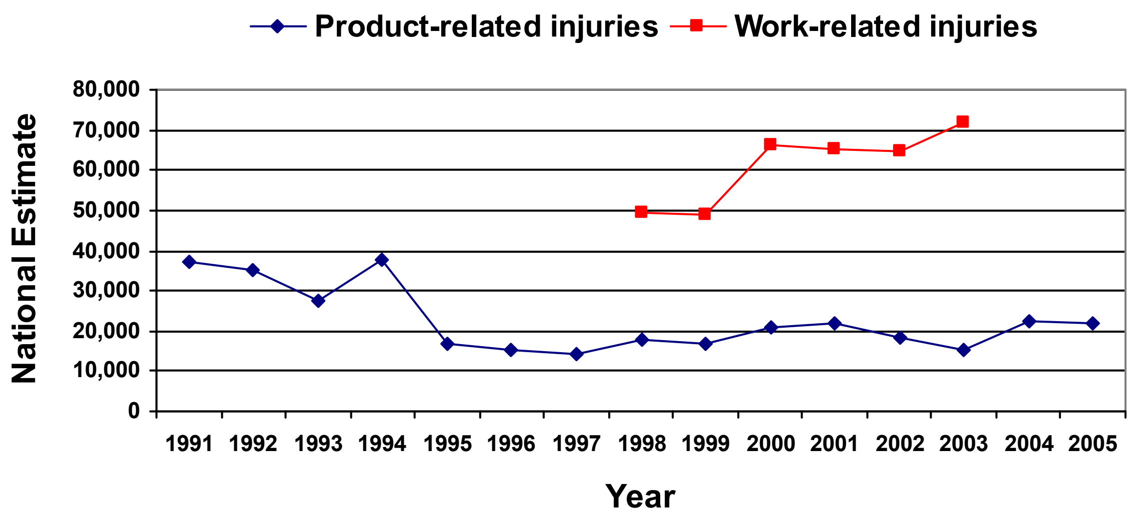


Figure 3-6. National estimates of injuries and illnesses incurred at a farm location and treated in a U.S. hospital emergency department. Sources: NEISS, CPSC, and NIOSH

3.2c Selected Outputs

The major output from the TISF was the manuscript, "Roll-over protective structure use and the cost of retrofitting tractors in the United States, 1993 [Myers 1993]." The paper provides information on the makes and models of tractors that were in use on farms without ROPS in the United States and an estimate of the cost to retrofit these tractors with ROPS. This manuscript has been referenced in at least 29 peer-reviewed journal articles to date.

Other major output from the TISF have been the three volume statistical abstract of results from the 1993-1995 surveys [Myers 1993, 1998, 2001]. These reports have been referenced in a minimum of 39 peer-reviewed journal articles to date.

A complete list of outputs can be found in section 3.4 at the end of this chapter.

3.2d Intermediate Outcomes

Tractor data collected through the TISF survey were used by engineering researchers within the AFF Program as part of their CROPS project. TISF tractor data were used to identify commonly used farm tractors without a ROPS, and to provide low-cost ROPS designs for them to encourage farmers to retrofit to these tractors. Having tractor estimates by manufacturer and model was important in this process because these factors influenced each individual CROPS design. Six CROPS designs have been developed by the AFF Program and have been shared with a ROPS manufacturer (FEMCO). Having an estimate of the potential market for each AFF Program ROPS design was helpful in getting FEMCO to pursue CROPS on a commercial basis.

In 2002, data from the TISF were used by NIOSH to support recommendations to DOL on changes to their existing child labor regulations. The recommendations were requested by DOL.

3.2e End Outcomes

Since end outcomes usually result from intervention activities that surveillance activities stimulate, they are reported under other AFF Program goals.

3.2f Future Directions

The AFF Program is moving toward more online dissemination of surveillance data. However, because agricultural families and migrant workers may have less online access than other groups of workers, we will continue to partner with farm safety advocates and organizations to distribute important farm safety information by other means.

3.2g List of NIOSH Projects included in this section

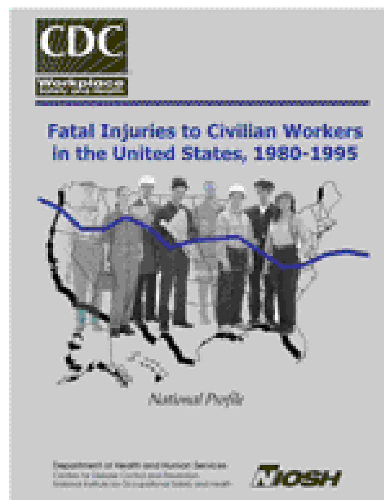
- DSR-VLB827-Occupational Traumatic Injury Surveillance of Farmers (Appendix 3.2-01)
- DSR-9277135-Occupational Injury Surveillance of Production Agriculture (Appendix 3.2-02)
- DSHEFS-9278639-National Agricultural Workers Survey (Appendix 3.2-03)
- DSR-9278875-National Surveillance of Nonfatal Occupational Injury Using the NEISS (Appendix 3.2-04)

3.3 Traumatic Fatality Surveillance

3.3a Challenge or Issue

Until the mid-1980s, little research was focused on farm safety, and no clear picture of the number and characteristics of farm fatalities existed. BLS and the NSC independently produced widely disparate survey estimates of agricultural worker fatalities, ranging from a low of 100 to a high of 1,600 deaths for 1985 [NSC 1986; BLS 1997]. These estimates were consequently suspect, and the studies did not provide the detailed information needed to develop safety interventions [Stout-Wiegand 1988]. However, these surveys noticeably demonstrated that agriculture apparently had one of the highest fatality rates of all U.S. industries.

In the early 1980s, no systematic national data collection of fatal agricultural injury information existed. What data did exist resided in death certificate files of State vital statistics registrar offices with minimal information identifying the injury event or the deceased's occupation. In the absence of a mandate for collecting this information, an agency specifically tasked with compiling the state data, or a broad community or scientific partnership to push for focusing on agricultural fatalities, surveillance for fatal injuries and intervention research began slowly.



The 1989 report *Agriculture at Risk: A Report to the Nation* highlighted many agricultural safety issues by taking advantage of new fatality surveillance data. The report also forms a coalition of partners to address these issues. But implicit in the policy recommendations was the need for better data—more information about injury characteristics and a more complete injury census.

3.3b Activities

To provide a better understanding of occupational fatalities, NIOSH began two separate fatality research programs in the early 1980's: a fatality investigation program (FACE); and a fatality surveillance system (NTOF). Although general in nature and not specifically targeted to agriculture, these programs proved valuable in identifying and addressing agricultural safety needs.

<u>FACE Investigations</u>

Beginning in 1982, the FACE program used onsite investigations to obtain detailed information about selected events such as related to machinery, electrocution, and confined spaces fatalities; such targets are particularly apropos to agriculture. The FACE model of obtaining a thorough understanding of the chain of events leading to a fatal incident and the contributing factors has identified new hazards and supported evidence-based safety recommendations. Because this model was so successful in getting safety and health information out in a timely fashion, NIOSH began funding selected States to conduct their own FACE investigations in 1987. Thus far, 19 States have participated and investigated more than 360 agriculture-related fatalities (http://www.cdc.gov/niosh/injury/traumaagface.html). (Appendices 3.3-01, 3.3-02)

From 1986 until the present, the AFF Program conducted 16 agriculture-related FACE investigations. These investigations explored the worksite where the fatality occurred, examined equipment or machinery involved in the incident and how it was used, determined whether safety features on equipment and machinery functioned properly, listed personal-protective equipment used, and identified the deceased's experience level and training along with many other factors. Because the FACE investigations are conducted as scientific, nonregulatory studies, they provide the opportunity to explore facets of fatal incidents that might otherwise be difficult to obtain. For example, FACE investigations of young worker fatalities have identified that youths are often assigned prohibited tasks, lack appropriate training, and have physical and cognitive limitations. For Hispanic workers, language and cultural barriers as well as lack of appropriate training or skills have contributed to the fatal events.

National Traumatic Occupational Fatalities

In 1983, NIOSH developed NTOF by collecting death certificates from State vital registrars in all 50 states, New York City, and the District of Columbia. Demographic information, industry, occupation, and circumstances of death data were abstracted from the certificates. This system was maintained for fatalities occurring in 1980 through 2001. For the first time, NTOF provided a uniform surveillance system of work-related fatal injuries for all industries, including agriculture. The brief information collected on death certificates (often provided by relatives or witnesses to coroners and funeral directors) was not specifically designed for detailed occupational injury research. It was often difficult to identify a fatality as work-related or to determine the deceased's occupation, industry, and activity at the time of death. This has been particularly problematic for agriculture-related fatalities (e.g., fatalities involving part-time farmers, highway incidents, or other incidents that may obscure work-relatedness). Despite the limitations, NTOF filled a critical data need. The AFF Program confirmed that agriculture was a hazardous industry having the fourth highest fatality count and third highest fatality rate per 100,000 workers in 1984 (Figure 3-7) [Stout-Wiegand 1988]. From 1980 to 1985, agriculture had higher fatality rates per 100,000 workers than did the general U.S. workforce [Bell et al 1990]. Agriculture machines were the leading cause of all machine-related deaths for this same period [Etherton 1991]. These initial studies and numerous subsequent reports clarified the magnitude and nature of agricultural fatalities and identified the most prominent hazardous exposures (Figure 3-8). Since its inception, NTOF has been used for setting research and prevention priorities. Selection of FACE program investigation priorities have relied on NTOF data. (Appendices 3.3-03, 3.3-04)

*Transport/PU=Transportation and Public Utilities;
Ag/For/Fishing= Agriculture, Forestry and Fishing
Figure 3-7: Percentage and Rate of Occupational Fatalities by Selected Industry Divisions,* 1984.
Source: NIOSH NTOF

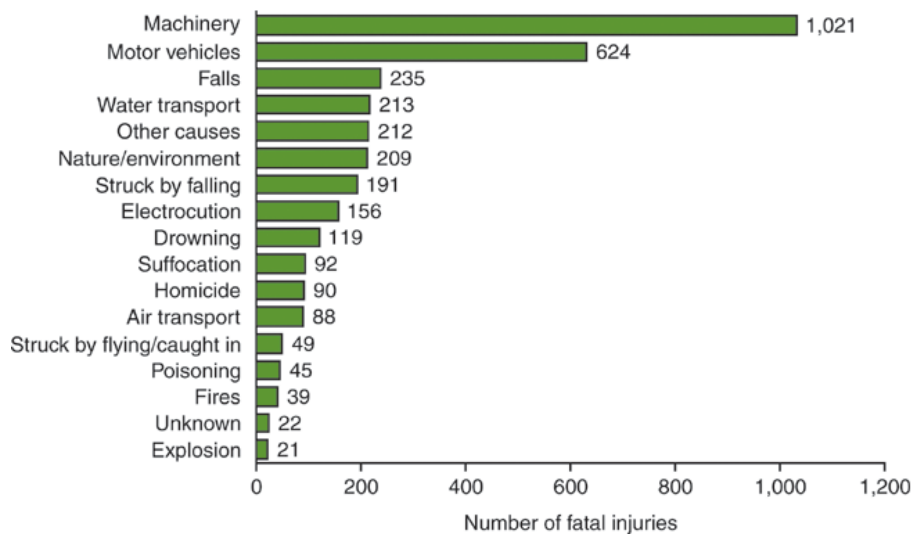


Figure 3-8: Number of Occupational Fatalities in the Agriculture/Forestry/Fishing Industry by Cause of Death, 1992-1997. *Source: NIOSH NTOF*

NTOF data also supported AFF Program focus on machinery-related fatalities in agriculture, particularly from tractor rollovers. The impact of tractor rollovers was reinforced by the BLS Census of Fatal Occupational Injuries (CFOI) data as well (Figure 3-9).

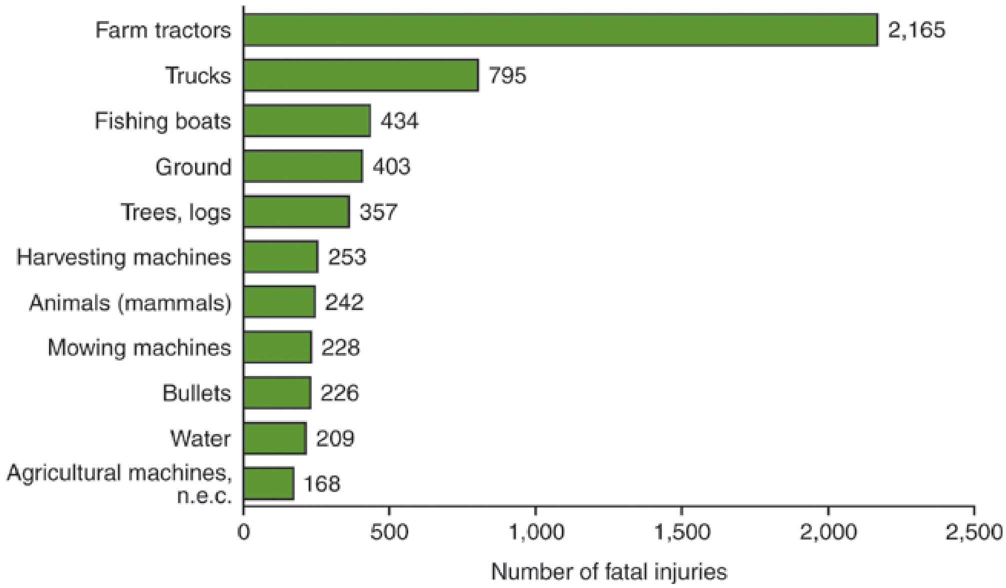
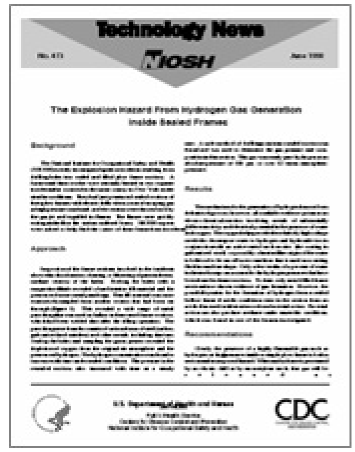


Figure 3-9: Number of Occupational Fatalities in the Agriculture/Forestry/Fishing Industry by Sources of Death, 1992-2001.* *Source: BLS CFOI*
*Fatality data exclude New York City.

Youth farm worker dies after falling into operating feed grinder/mixer – Ohio NIOSH In-house FACE Report 2002-10

NTOF successfully filled a critical data need to drive agricultural safety research. However, well- known limitations are inherent in conducting surveillance based solely on death certificates. This is based on recommendations of the National Academy of Science Panel on Occupational Safety and Health Statistics [Pollack and Keimig 1987]. BLS began collecting occupational fatality information from multiple sources. In 1992, the BLS CFOI was fully operational and continues through today. The use of multiple fatality data sources with improved case capture (~20% increase in fatalities versus NTOF) and dual confirmation of work-relatedness has provided a better surveillance system (Figure 3-10). After a decade of overlap, the AFF Program discontinued the NTOF data collection at the end of 2001. We now use CFOI data. We maintain these data as a resource for examination of trends.

3.3c Selected Outputs


Technology News
NIOSH
The Explosion Hazard From Hydrogen Gas Generation Inside Sealed Frames
Background
Approach
Results
Recommendations
CDC

All 16 agriculture-related FACE fatality reports can be accessed on the NIOSH FaceWeb at http://www.cdc.gov/niosh/face/default.html.

The AFF Program has published NIOSH Alerts, Hazard IDs, and monographs that focused on agricultural safety issues. NIOSH Alerts have addressed electrocutions from grain augers contacting overhead power lines, suffocation in grain silos and manure pits, scalping from entanglement in tractor power-take-off units and other machinery, and crushing incidents involving skid-steer loaders. A NIOSH Hazard ID alerted implement manufacturers to potential explosion hazards from gases in sealed metal frames. NIOSH combined surveillance data and information from case investigations to publish hazard monographs on confined spaces and electrocutions.

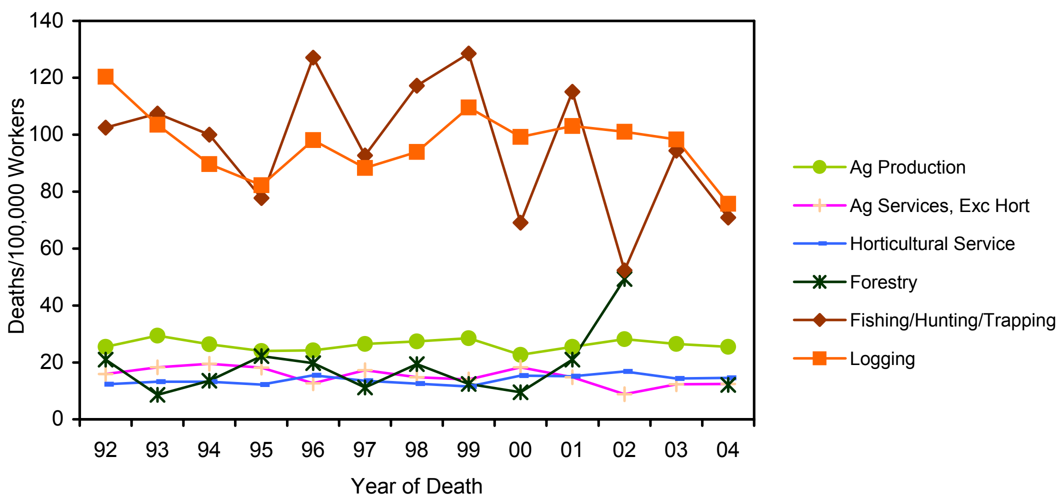


Figure 3-10: Rate of Occupational Fatalities by Detailed Industry Sector, 1992-2004*
Source: BLS CFOI
*2003 forestry sector rate did not meet BLS reporting requirements and all 2004 CFOI fatality counts are provisional.

In 1998, the AFF Program caused manufacturing changes to eliminate a farm equipment hazard after investigating two separate reports of farm workers seriously burned while attempting to drill holes into sealed plow frames. NIOSH published a Hazard ID entitled *Ignition Hazard from Drilling into Sealed Frames of Agricultural Equipment* (http://www.cdc.gov/niosh/hid4.html). The document not only led to manufacturing changes but caused the publisher of *Successful Farming* to disseminate the safety information to all FFA chapters after the magazine (with no awareness of the hazard) used a cover photograph of two FFA members drilling into a plow frame to install a slow-moving vehicle sign. Penn State University also printed a capsulated version of the Hazard ID in its College of Agricultural Sciences *Agricultural Safety and Health News.* Other NIOSH researchers published a related document entitled *The Explosion Hazard from Hydrogen Gas Generation inside Steel Frames.* After the release of this document and the Hazard ID, NIOSH received notification that similar problems had been identified in pods of dragline mining equipment in Australia and in crane sections in the United States.

Following the investigations of two multiple fatality incidents involving grain augers contacting overhead power lines, the AFF Program developed a NIOSH Alert entitled, *Preventing Grain Auger Electrocutions* in 1986. The Alert and a warning decal were disseminated to farm owners through county extension agents at fairs and community meetings and to implement manufacturers' and dealers' distribution at the point of sale. The popularity of the document resulted in the reprinting of the decal.

In the early 1990s, the AFF Program investigated multiple asphyxiations of workers and would-be rescuers in manure pits, resulting in an Alert that was widely disseminated through county extension agents and from which the recommendations have been incorporated into other organization's safety fact sheets (such as the Iowa State University Extension's Safe Farm fact sheet *How to Respond to Farm Accidents)*.

A complete list of outputs can be found in section 3.4 at the end of this chapter.

3.3d Intermediate Outcomes

The AFF Program partnered with the Agricultural Health Nurse Program of New York State to investigate four incidents involving female victims' hair entanglement around the rotating secondary driveline of hay balling equipment. These FACE investigations resulted in the development of the NIOSH Alert entitled *Preventing Injuries and Other Severe Injuries from Farm Machinery* (1994). The machines involved in these incidents were made by the same manufacturer and contained the same driveline. Although a retro fitted machine guard had been available for nearly two decades from the manufacturer, it was not employed in any of the scalping incidents investigated. After dissemination of the Alert through county extension service agents, equipment dealers, and manufacturers, the manufacturer reported that the entire stock of the retrofit guards had been exhausted and production of the guard had resumed. The Alert had noted that the retrofit guard was available from the manufacturer.

A State FACE investigation in Nebraska revealed that an antibiotic routinely used to treat shipping fever in cattle (micotil) caused the death of a farmer who accidentally injected himself. This finding was communicated widely to the agricultural community, who were unaware of this hazard. In conjunction with State FACE colleagues, the AFF Program prepared a *Workplace Solutions* document on micotil hazards which will be published in Fiscal Year 2007. In addition, dialogue between the State, NIOSH, the drug manufacturer (Elanco), and FDA have resulted in additional warnings provided by Elanco to all micotil purchasers. These warnings include a "paper shroud" on all micotil bottles. The shroud contains new instructions and warnings affixed to the top of the bottle that must be removed prior to actual use.

3.3e End Outcomes

In conjunction with State FACE colleagues in Minnesota, the AFF Program developed a NIOSH Hazard ID on the fatality risks associated with using tractors to move large hay bales in 2001.The Hazard ID was widely distributed within the state of Minnesota. Since the release of this document, the fatalities assoicated with round bales in this state have decreased from an average of 1.57 deaths per year between 1993 and 1999 to 0.66 deaths annually between 2002 and 2005.

3.3f List of NIOSH projects included in this section

- DSR-9278807-Fatality Assessment and Control Evaluation (FACE) Project (Appendix 3.3-01)
- DSR-9278870-State-Based Fatality Surveillance Using Face Model (Appendix 3.3-02)
- DSR-9278805-National Traumatic Occupational Fatality (NTOF) Surveillance System (Appendix 3.3-03)
- DSR-9278951-Analysis of Surveillance Data for Agricultural Injuries (Appendix 3.3-04)

3.4 Outputs

3.4a Farm Family Health and Hazard Surveillance

Publications

Abend EA, Hallman EM [1997]. Strategies for Effective On-Farm Hazard Surveillance Visits. *J Agromed.* 4(1): 47-53.

Abend E, Stark A, Hwang S, May J [1997]. Tractor and machinery hazard surveillance within the New York FFHHS project. *National Institute for Farm Safety Paper* # NIFS 97-9. Columbia, Missouri.

Bartels S, Niederman B, Waters TR [2000]. Job hazards for musculoskeletal disorders for youth working on farms. *J Ag Safety and Health Aug* 6(3):191-201. (ISI Web of Science: Cited 4 times as of 11/14/06)

Beckett WS, Chamberlain D, Hallman E, May J, Hwang SA, Gomez M, Eberly S, Cox C, Stark A [2000]. Hearing conservation for farmers: source apportionment of occupation and environmental factors contributing to hearing loss. *J Occ & Enviro Med*. Aug 42(8):806-13. (ISI Web of Science: Cited 9 times as of 11/14/06)

Beckett WS, Hallman E, May J, Hwang SA, Gomez M, Eberly S, Cox C [2004]. Follow-up to Farm Family Health and Hazard Survey. J Occ & Enviro Med 46:314-5.

Beseler C, Stallones L [2003]. Safety practices, neurological symptoms and pesticide poisoning. *J Occ & Enviro Med* 45(10):1079-1086. (ISI Web of Science: Cited 1 time as of 11/14/06)

Browning SR, Truszzczynska H, Reed D, McKnight RH [1998]. Agricultural injuries among older Kentucky farmers: the farm family health and hazard surveillance study. *Am J Ind Med* 33(4):341-353. (ISI Web of Science: Cited 29 times as of 11/14/06)

Browning SR, Westneat SC, Donnelly C, Reed DB [2003]. Agricultural tasks and injuries among Kentucky farm children: Results from the *Farm Family Health and Hazard Surveillance Project. Southern Medical Journal* 96(12):1203-1212. (ISI Web of Science: Cited 1 time as of 11/14/06)

Browning SR, Westneat SC, Szeluga R [2001]. Tractor driving among Kentucky farm youth: Results from the Farm Family Health and Hazard Surveillance Project. *J Ag Safety and Health* 7(3):155-167. (ISI Web of Science: Cited 3 times as of 11/14/06)

Browning SR, Westneat SC, Truszczynska H, Reed D, McKnight R [1999]. Farm tractor safety in Kentucky, 1995. *Public health Reports* 114(1): 53-59. (ISI Web of Science: Cited 1 time as of 11/14/06)

Champney M, Stallones L, Blehm K, Tucker A, Merchant D [1996]. A survey of respiratory symptoms in a farming population in Northeastern Colorado. *J Agromed* 3(3):47-57. (ISI Web of Science: Cited 5 times as of 11/14/06)

Choi SW, Peek-Asa C, Sprince NL, Rautiainen RH, Donham KJ, Flamme GA, Whitten PS, Zwerling C [2005]. Hearing loss as a risk factor for agricultural injuries. *Am J Ind Med*. 48(4):293-301.

Choi SW, Peek-Asa C, Zwerling C, Sprince NL, Rautiainen RH, Whitten PS, Flamme GA [2005]. A comparison of self-reported hearing and pure tone threshold average in the Iowa Farm Family Health and Hazard Survey. *J Agromed*. 10(3):31-9.

Crawford JM, Wilkins III JR, Mitchell GL, Moeschberger ML, Bean TL, Jones LA [1998]. A cross-sectional case control study of work-related injuries among Ohio farmers. *Am J Ind Med* 34(6):558-599. (ISI Web of Science: Cited 2 times as of 11/14/06)

Darragh A, Stallones L, Sample P, Sweitzer K [1998]. Perceptions of farm hazards and personal safety behavior among adolescent farm workers *J Ag Safety and Hlth Special Issue* (1):159-161. (ISI Web of Science: Cited 4 times as of 11/14/06)

DeArmond SE, Stallones L, Chen PY, Sintek EE [2006]. Depression and somatic symptoms within the farming community. *J Ag Safety and Hlth* 12(1):5-15.

Elliot M, Heaney CA, Wilkins JR, III, Mitchell GL, Bean T [1995]. Depression and Perceived stress among cash grain farmers in Ohio. Aug; 1(3):177-184. (ISI Web of Science: Cited 1 time as of 11/14/06)

Gomez MI, Hwang SA, Sobotova L, Stark AD, May JJ [2001]. A comparison of self-reported hearing loss and audiometry in a cohort of New York farmers. ournal of Speech, Language, and Hearing Research 44:1201-1208. (ISI Web of Science: Cited 11 times as of 11/14/06)

Gomez MI, Hwang S, Stark AD, May JJ, Hallman EM, Pantea CI. An Analysis of Self-Reported Joint Pain among New York Farmers. Journal of Agricultural Safety and Health. 2003;9(2): 143-157.

Gomez MI, Hwang S, Lin S, Stark AD, May JJ, Hallman EM [2004]. Prevalence and predictors of respiratory symptoms among New York farmers and farm residents. American Journal of Industrial Medicine 46:42-54. (ISI Web of Science: Cited 1 time as of 11/14/06)

Hallman EM [1993]. Structuring a Farm Safety Survey: Research vs. Education. [1993] *National Institute for Farm Safety Paper* # 93-11. Columbia, Missouri.

Hallman EM, Chamberlain DC, May J, Hwang SA [1998]. On-Farm Hazard Data Collection: Strategies and Results from 580 New York State Farms. *National Institute for Farm Safety Paper* # NIFS 98. Columbia, Missouri. (ISI Web of Science: Cited 1 time as of 11/14/06)

Hallman E, Pollock J, Chamberlain D, Heath RL, Browning SR, Reed DB [1998]. Prevalence and risk factors for hypertension among older Kentucky farmers. *J Ag Safety and Hlth..*

Hwang S, Gomez MI, Sobotova L, et al [2001]. Predictors of hearing loss in New York farmers. American Journal of Industrial Medicine 40:23-31. (ISI Web of Science: Cited 10 times as of 11/14/06)

Hwang S, Gomez MI, Stark AD, et al [2001]. Severe farm injuries among New York farmers. American Journal of Industrial Medicine 40:32-41. (ISI Web of Science: Cited 9 times as of 11/14/06)

Hwang SA, Gomez MI, Stark AD, St John TL [2000]. Pantea CI. Hallman EM. May JJ. Scofield SM. Safety awareness among New York farmers. *American Journal of Industrial Medicine* 38(1):71-81, Jul. (ISI Web of Science: Cited 5 times as of 11/14/06)

Jones ML, Reynolds SJ, Burmeister LF, Lewis MQ, Whitten PS, Scarth RD, Zwerling C [1999]. Application of a subjective health and safety rating system to Iowa farm operations. *Appl occup &Enviro Hygiene* Dec 14 (12):852-67.

Kakefuda I, Stallones L [2006]. Comparisons of Colorado women's cancer screening practices by residence: Metropolitan, nonmetropolitan and farm. Journal of Agriculture Safety and Health 12(1):59-69.

Kettles MA, Browning SR, Prince TS, Horstman SW [1997]. Triazine herbicide exposure and breast cancer incidence: An ecologic study of Kentucky counties. *Environmental Health Perspectives* November 105(11)1222-1227. (ISI Web of Science: Cited 39 times as of 11/16/06)

Kidd PS, Scharf T, Veazie M [1996]. Linking stress and injury in the farming environment.. *Health Education Quarterly* 23: 224-237.

Lewis MQ, Sprince NL, Burmeister LF, Whitten PS, Torner JC, Zwerling C [1998]. Work-related injuries among Iowa farm operators: an analysis of the Iowa FFHHS project. *Am J Industr med* May 33(5):510-7. (ISI Web of Science: Cited 26 times as of 11/16/06)

Merchant DL, Stallones L, Keefer S, Rickard R [1996]. An ecologic analysis of congenital anomalies and agricultural chemicals in Colorado, 1989-1991. *Journal of Agricultural Safety and Health* 2(4):197-206.

Osorio AM, Beckman J, Geiser CR, Husting EL, Inai A, Summerill KF [1998]. California farm survey of occupational injuries and hazards. *J ag safety and health* Special issue (1):99-108. (ISI Web of Science: Cited 3 times as of 11/16/06)

Osorio AM, Geiser CR, Husting EL [1998]. Farm Injury Surveillance in 2 California Counties – General Findings. *J Ag Safety and Health* Special Issue (1):99-108. (ISI Web of Science: Cited 3 times as of 11/16/06)

Park H, Reynolds SJ, Kelly KM, Stromquist AM, Burmeister LF, Zwerling C, Merchant JA [2003]. Characterization of agricultural tasks performed by youth in the Keokuk County Rural Health Study. *Appl Occup Environ Hyg* 18(6): 418-29, Jun. (ISI Web of Science: Cited 1 time as of 11/17/06)

Park H, Sprince NL, Jensen C, Whitten PS, Zwerling C [2002]. Health risk factors among Iowa farmers. *J Rural Health*. 18(2):286-93, Spring. (ISI Web of Science: Cited 1 time as of 11/17/06)

Park H, Sprince NL, Lewis MQ, Burmeister LF, Whitten PS, Zwerling C [2001]. Risk factors for work-related injury among male farmers in Iowa: A prospective cohort study. *J Occup Environ Med*. 43(6):542-47, Jun. (ISI Web of Science: Cited 7 times as of 11/16/06)

Park H, Sprince NL, Whitten PS, Burmeister LF, Zwerling C [2001]. Farm-related dermatoses in Iowa male farmers and wives of farmers: A cross-sectional analysis of the Iowa Farm Family Health and Hazard Surveillance Project. *J Occup Environ Med* 43:364-369. (ISI Web of Science: Cited 2 times as of 11/16/06)

Park H, Sprince NL, Whitten PS, Burmeister LF, Zwerling C. [2001] Risk factors for back pain among male farmers. Analysis of Iowa Farm Family Health and Hazard Surveillance Study. *Am J Industrial Medicine* 40 (6):646-654. (ISI Web of Science: Cited 1 time as of 11/17/06)

Pedersen DH, Wilkins III JR, Bean TL, Mitchell GL, Crawford JM, Jones LA. Agricultural hazard data from a population-based survey of cash grain farms: Ohio observations. *App Occ & Enviro Hygiene.* 1999 May 14(5):299-305.

Reynolds SJ, Merchant JA, Stromquist AM, Burmeister LF, Taylor C, Lewis MQ, Kelly KM [1998]. *J Agric Saf Health Special Issue 1* (May 1998): 79-88.

Scarth RD, Rohrer JE, Burmeister LF, Zwerling C [1998]. Perceptions of access to medical care among Iowa farmers. *Journal of Agromedicine* 5(4): 5-20.

Scarth RD, Stallones L, Zwerling C, Burmeister LF [2000]. The prevalence of depressive symptoms and risk factors among Iowa and Colorado farmers. *Am J Industr Med* 37(4):382-389.(ISI Web of Science: Cited 12 times as of 11/16/06)

Scarth RD, Zwerling C, Lewis MQ, Burmeister LF [1997]. Depression and Risk factors among Iowa farmers. *J Agromed* 4 (3/4):207-216.

Sprince NL, Lewis MQ, Whitten PS, Reynolds SJ, Zwerling C [2000]. Respiratory symptoms: associations with pesticides, silos, and animal confinement in the Iowa Farm Family Health and Hazard Surveillance Project. *Am J Industr Med* 38(4):455-462. (ISI Web of Science: Cited 12 times as of 11/16/06)

Sprince N, Lewis M, Whitten P, Zwerling C. Lung function outcomes from IFFHHS project (in preparation)

Stallones L (editorial) [1996]. Stress among farmers. *Journal of Agricultural Safety and Health* 2(2).

Stallones L, Beseler C [2003]. Farm work practices and farm injuries in Colorado. *Injury Prevention* 9:241-244. (ISI Web of Science: Cited 2 times as of 11/16/06)

Stallones L, Beseler C [2002]. Pesticides and depressive symptoms among farm residents. *Annals of Epidemiology* 12(6):389-394. (ISI Web of Science: Cited 13 times as of 11/16/06)

Stallones L, Beseler, C. Pesticide illness, farm practices, and neurological symptoms. Environmental Research, Section A, 90:89-97. 2002. (ISI Web of Science: Cited 9 times as of 11/16/06)

Stallones L, Beseler C [204]. Safety practices and depression among farm residents. *Annals of Epidemiology* 14:571-578.

Stallones L, Gunderson P [1994]. Epidemiologic perspectives on childhood agricultural injuries within the United States. *Journal of Agromedicine* 1(4):3-18. (ISI Web of Science: Cited 8 times as of 11/16/06)

Stallones L, Keefe T, Xiang H [1997]. Characteristics associated with increased farm-work related injuries among male farm operators in Colorado, 1993. *Journal of Agricultural Safety and Health* 3(3):195-201. (ISI Web of Science: Cited 8 times as of 11/16/06)

Stallones L, Leff M, Garrett C, Criswell L, Gillan T [1995]. Depressive Symptoms among Colorado farmers. *J Ag Safety and Health* 1:37-43. (ISI Web of Science: Cited 11 times as of 11/16/06)

Stallones, L, Xiang H [2003]. Alcohol consumption patterns and work-related injuries among Colorado farm residents. *American Journal of Preventive Medicine* 25 (1): 25-30. (ISI Web of Science: Cited 5 times as of 11/16/06)

Taylor CD, Reynolds SJ, Stromquist A, Merchant J, Zwerling C, Kelly K [1999]. Environmental conditions in the homes of a rural Iowa county. *J Agric Saf Health*. 5(4):407-16.

Thu K, Lasley P, Whitten P, Lewis M, Donham K, Zwerling C, Scarth R. Stress as a Risk factor for agricultural injuries: comparative data from the Iowa Farm Family Health and Hazard Survey (1994) and the Iowa Farm and Rural Lifee Poll (1989). Journal of Agromedicine 4 (3/4):181-191. Published simultaneously in: Donham KJ, Rautiainen R, Schuman SH, and Lay JA. *Agricultural Health and Safety: Recent Advances*. Haworth Medical Press.

Wilkins JR III, Bean TL, Mitchell GL, Crawford JM, Eicher LC [1997]. Development and application of a pen-based computer program for direct entry of agricultural hazard data. *Appl Occup Environ Hyg* 12(2):105-110. (ISI Web of Science: Cited 2 times as of 11/16/06)

Wilkins JR III, Bean TL, Moeschberger ML, Mitchell GL, Crawford JM, Jones LA [1997]. Mixed-Mode Survey of Cash Grain farmers yields mixed response. *J Ag Safety Hlth* Feb 3(1):27-39. (ISI Web of Science: Cited 4 times as of 11/16/06)

Wilkins III JR, Engelhardt HL, Crawford JM, Mitchell GL, Eicher LC, Bean TL, Jones LA [1998]. Self-reported Noise Exposures among Ohio Cash Grain Farmers. *J Ag Saf Health* Special Issue (1):79-88. (ISI Web of Science: Cited 1 time as of 11/16/06)

Xiang H, Stallones L, Chiu Y [1999]. Nonfatal Agricultural Injuries Among Colorado Older Male farmers. *J Aging and Health* 11(1):65-78. (ISI Web of Science: Cited 7 times as of 11/16/06)

Xiang H, Stallones L, Chiu Y, Epperson A [1998]. Nonfatal Agricultural Injuries Among Colorado Female farmers. *J Agromed* 5(4):21-33.

Xiang H, Stallones L, Hariri S, Darragh A, Chiu Y, Gibbs-Long J [1999]. Back pain among persons working on small or family farms – eight Colorado counties, 1993-1996. *MMWR* Apr 23 48(15):301-4. (ISI Web of Science: Cited 1 time as of 11/16/06)

Xiang H, Stallones L, Keefe TJ [1999]. Back pain and agricultural work among farmers: an analysis of the Colorado farm family health and hazard surveillance survey. *Am J Industr Med* 35(3):310-316. (ISI Web of Science: Cited 11 times as of 11/16/06)

Zwerling C, Burmeister L, Reynolds S, Jones M, Lewis M, Popendorf W, Scarth R, Whitten P [1998]. The Iowa FFHHS Project. *J Ag Safety and Health* May 4 (Special Issue 1):13-20. (ISI Web of Science: Cited 1 time as of 11/16/06)

Zwerling C, Burmeister L, Reynolds S, McKnight R, Browning S, Reed D, Wilkins J, Bean T, Mitchell L, Hallman E, May J, Stark A, Hwang S, Division of Surveillance, Hazard Evaluations, and Field Studies, Division of Safety Research, National Institute of Occupational Safety and Health, Division of Unintentional Injury Prevention, National Center for Injury Prevention and Control, CDC [1997]. Use of rollover protection structures (ROPS) - Iowa, Kentucky, New York, and Ohio, 1992-1997. MMWR. 46(36):842-45. (ISI Web of Science: Cited 1 time as of 11/16/06)

3.4b OHNAC and Community Partners for Healthy Farming: Surveillance

Publications

Ballard T, Freund E, Ehlers J, Brandt B, Boyland B, Halperin J [1995]. Green tobacco sickness: Occupational nicotine poisoning in tobacco workers. *Arch Environ Health*; 50(5):384-389. NN: 00229929 (ISI Web of Science: Cited 23 times as of 11/16/06)

Baron S, Estill C, Steege A [2001]. Simple Solutions: Ergonomics for Farmworkers; English and Spanish (Pub. 2001-111). [http://www.cdc.gov/niosh/01-111pd.html]

Boyd J, Hill M, Pollock J, Casey G, Gelberg K, Roering S, Grant A [1997]. Epidemiological characteristics of reported hand injuries - New York State 1991 -1995. *J of Agricultural Safety and Health*.; 3(2):101-7.

Brandt, V, Moon, S, Ehlers, J, Methner, N, Struttman, T [2001]. Exposure to endosulfan in farmers: Two case studies. *Am J Ind Med*; 39(6):643-9. NN: 20023301 (ISI Web of Science: Cited 4 times as of 11/16/06)

Brandt, VA, Struttmann, TW, Morgan, SE, Piercy, LR [2001]. Delivering health and safety education messages for part-time farmers through local businesses and employers. *J. Agromedicine* 7(3), 23-30.

Casey G, A Grant [1997]. Farm worker injuries associated with bulls. *AAOHN J*; 45(8):393-396. NN: 00238204 (ISI Web of Science: Cited 2 times as of 11/16/06)

Casey G, A Grant, et al [1997]. Farm worker injuries associated with cows. *AAOHN Journal;* 45(9):446-50. (ISI Web of Science: Cited 2 times as of 11/16/06)

Centers for Disease Control and Prevention [1992]. Scalping incidents involving hay balers. New York. MMWR July; 41(27):489-91. NN: 00232215 [http://www.cdc.gov/mmwr/preview/mmwrhtml/00017187.htm]

Centers for Disease Control and Prevention [1993]. Tetanus fatality, Ohio, 1991. MMWR; 42(8):148-9. [http://www.cdc.gov/mmwr/preview/mmwrhtml/00019820.htm]

Centers for Disease Control and Prevention. Green tobacco sickness in tobacco harvesters. Kentucky, 1992. MMWR 1993; 42(13):237-39. NN 00235887 [http://www.cdc.gov/mmwr/preview/mmwrhtml/00020119.htm]

Centers for Disease Control and Prevention [1993]. Carbon monoxide poisoning of farmers using gasoline-powered pressure washers in animal buildings – Iowa, January 1992-January 1993. MMWR; 42(40):777-85. [http://www.cdc.gov/mmwr/preview/mmwrhtml/00022020.htm]

Centers for Disease Control and Prevention [1995]. Eye injuries to agricultural workers. Minnesota, 1992-1993. MMWR; 44(18):364-66. [http://www.cdc.gov/mmwr/preview/mmwrhtml/00037037.htm]

Centers for Disease Control and Prevention [1995]. Injuries Associated with Self-Unloading Forage Wagons, New York, 1991-1994. MMWR; 44(32):595-97,603. [http://wonder.cdc.gov/wonder/prevguid/m0038481/m0038481.asp#head001000000000000]

Centers for Disease Control and Prevention [1995]. Agricultural Auger-Related Injuries and Fatalities - MN, 1992-1994. MMWR; 44(36):660-663. [http://www.cdc.gov/mmwr/preview/mmwrhtml/00038801.htm]

Centers for Disease Control and Prevention. Fatalities associated with improper hitching to farm tractors, New York, 1991-1995. MMWR 1996; 45(15):307-11. NN: 00232461 [http://www.cdc.gov/mmwr/preview/mmwrhtml/00040898.htm]

Centers for Disease Control and Prevention [1997]. Outdoor carbon monoxide poisoning attributed to tractor exhaust – Kentucky. MMWR; 46(51):1224-27. NN: 00240362 http://www.cdc.gov/nasd/docs/d001201-d001300/d001212/d001212.html]

Centers for Disease Control and Prevention [1999]. Farm worker illness following exposure to Carbofuran and other pesticides. Fresno County, California 1998. MMWR; 48(6):113-6. NN: 20027440 [http://www.cdc.gov/mmwr/preview/mmwrhtml/00056485.htm]

Donham KJ, Ehlers J, Sheridan C, Willard P, and Chapman R [1997]. Agricultural occupational health nurse training and certification program: fulfilling the needs for occupational health. *J Agromedicine*; 4(3):105-116. (ISI Web of Science: Cited 1 time as of 11/17/06)

Ehlers JK, Connon C, Themann C, Myers J, Ballard T [1993]. Health and safety hazards associated with agriculture. *AAOHN Journal.* Issue dedicated to agricultural health and safety; 41(9):422-428. (ISI Web of Science: Cited 3 times as of 11/17/06)

Estill CF, Tanaka S [1998]. Ergonomic considerations of manually harvesting Maine wild blueberries. *J of Agricultural Safety and Health;* 4(1):43-57. [http://asae.frymulti.com/toc_journals.asp?volume=4&issue=1&conf=j&orgconf=j1998] NN: 20025139 (ISI Web of Science: Cited 1 time as of 11/17/06)

Estill C, Tanaka S, Wild D [1996]. Ergonomic Considerations of Manually Harvesting Maine Wild Blueberries. *Am Ind Hyg Assoc J*; 57(10):946-948. NN: 00233944

Estill CF, Tanaka S, Wild DK [1996]. Ergonomic considerations of manually harvesting Maine wild blueberries (AIHCE extended abstract) *Am Ind Hyg Assoc J* 1996 Oct; 57(10):946-948. NN: 00233944

Gelberg KH, Church L, Casey G, London M, Roering, DS, Boyd, J, Hill M [1999]. Nitrate Levels in Drinking Water in Rural New York State. *Environmental Research*; 80:34-40. (ISI Web of Science: Cited 8 times as of 11/17/06)

Grief AL, Goldenhar, LM, Freund E, Stock, A, Halperin W [1997]. Carbon monoxide poisoning from gasoline-powered engines: risk perception among Midwest food victims [letter to the editor]. *Am J Publ Health;* 87(3):466-467. NN00240940   (ISI Web of Science: Cited 1 time as of 11/17/06)

Guo H, Gilmore R, Waag D, Shireley L, Freund E [1998]. Prevalence of Coxiella Burnetii infections among North Dakota sheep producer. *J Occup Environ Med;* 40(11):999-1006. [http://www.joem.org/wass]. (ISI Web of Science: Cited 3 times as of 11/17/06)

Hartley JW, Colson PH, Fussel NW [1994]. Surveillance and the Georgia healthy farmers project: agricultural occupational health nurses. *J of Agromedicine*;(1)4:81-84.

Hawkes AP, Roy J, Stacey-Scott N, Joy JEA, Bogdan G [1997]. Health and safety issues relating to Maine's fishing industry. *J Agromedicine*; 4(3/4):223-229. NN: 00239234

Hughes J, Hartley J [2000]. Georgia Healthy Farmers Farm Safety Camp: Description and Evaluation of a Model Program. *J of Agromedicine*; 6(3):43-59.

Husting EL, Geiser CR, Summerill KF, Cervantes Y, Moltrum R, Ruiz C, Osorio AM [1997]. Occupational agricultural injury surveillance in California: Preliminary results from the nurses using rural sentinel events (NURSE) project. *J of Agromedicine*; 4(3/4):269-283. NN: 239238 (ISI Web of Science: Cited 2 times as of 11/17/06)

Jones B, Randolph SA [1997]. Reporting occupational illnesses and injuries in North Carolina. *North Carolina Medical J*; 58(5):2-5.

Jones ML, Reynolds SJ, Burmeister LF, Lewis MQ, Whitten PS, Scarth RD, Zwerling C [1999]. Application of a subjective health and safety rating system to Iowa farm operations. *Appl occup &Enviro Hygiene.* Dec. 14 (12):852-67. (ISI Web of Science: Cited 1 time as of 11/17/06)

Jones SK [1993]. Agricultural injury and surveillance: occupational health and nurses role. *AAOHN J*; 41(9), 434-7.

Lexau C, Kingsbury L, Lenz B, Nelson C, Voehl S [1993]. Building coalitions: a community-wide approach for promoting farming health and safety. *AAOHN J;* 41(9):440-9. (ISI Web of Science: Cited 5 times as of 11/17/06)

McIntee K, Garetson [1995]. The status of tetanus in the United States: Implications for occupational health nurses. *AAOHN J*; 43 (12):627-632.

McKnight, R., Levine, E., Rodgers, G [1994]. Detection of green tobacco sickness by a regional poison center. Vet Human Toxicol. 36(6):505-510. (ISI Web of Science: Cited 13 times as of 11/17/06)

Migliozzi AA, Randolph SA [1993]. Editorial: Agricultural Health and Safety. *AAOHN Jl*; 41(9):413. Issue dedicated to agricultural occupational health and safety.

Millard P, Shannon S, Carvette B, Tanaka S, Halperin W [1996]. Maine students' musculoskeletal injuries attributed to harvesting blueberries. *Am J Publ Health*; 86(12):1821-1822. NN: 00235081 (ISI Web of Science: Cited 1 time as of 11/17/06)

NIOSH reprints of five articles plus the guest editorial in dedicated Journal. *AAOHN Journal.* Issue dedicated to agricultural health and safety; 41(9). 2800 distributed.

NIOSH [1992] NIOSH Update: Farm Safety - Danger of Hair Entanglement in Hay Baler Drive Shafts. Pub 93-126: July 1992. http://www.cdc.gov/nasd/docs/d001001-d001100/d001023/d001023.html]. NIOSH Web Link: [http://www.cdc.gov/niosh/93-126.html]

NIOSH [1993]. NIOSH Update: NIOSH Warns Farmers of Deadly Risk of Grain Suffocation. Pub 93-16

NIOSH [1993]. NIOSH Update: NIOSH Issues Warning to Tobacco Harvesters. July 8, 1993. [http://www.cdc.gov/nasd/docs/d001001-d001100/d001025/d001025.html]

NIOSH [1993]. NIOSH Update: NIOSH Warns of deadly carbon monoxide hazard from using pressure washers indoors. April 23, 1993. NN: 00235012 [http://www.cdc.gov/niosh/93-117.html].

NIOSH [1993]. NIOSH Update: NIOSH Warns Farmers of Deadly Risk of Grain Suffocation. [http://www.cdc.gov/niosh/flood.html]

NIOSH [1994]. NIOSH Update: NIOSH Warns of Hazards of Flood Cleanup Work NIOSH Pub 93-128. Revised (1994) 94-123. Disseminated for adding in flood clean-up in the Upper Midwest.

NIOSH [1994]. NIOSH Alert: Preventing Scalping and Other Severe Injuries from Farm Machinery. Publication number 94-105: June 1994. (Related link) NN: 00221250 [http://www.cdc.gov/nasd/docs/d000701-d000800/d000756/d000756.html]
NIOSH Web Link: [http://www.cdc.gov/niosh/pto.html]

NIOSH [1995]. NIOSH Update: NIOSH Warns Farmers of Forage Wagon Hazards. Pub 95-118: September 14, 1995. [http://www.cdc.gov/niosh/95-118.html]

NIOSH [1996]. NIOSH, Colorado Department of Public Health and Environment, U.S. Consumer Product Safety Commission, Occupational Safety and Health Administration, U.S. Environmental Protection Agency. (November 1996)

NIOSH Alert: Preventing carbon monoxide poisoning from small gasoline-powered engines and tools.[http://www.cdc.gov/niosh/carbon2.html]

NIOSH [1997]. NIOSH Update: NIOSH Warns: Improper Hitching to Tractors Can Be Fatal. January 14, 1997. NN: 00235897 [http://www.cdc.gov/niosh/tractor1.html]

NIOSH Hazard ID #4: Ignition Hazard from Drilling into Sealed Frames of Agricultural Equipment DHHS (NIOSH) Pub 98-146 (July 1998). [http://www.cdc.gov/niosh/hid4.html]

Osoria AM, Greiser CR, Husting EL, Summerill KF [1998]. Farm injury surveillance in two California counties. general findings, *J of Agricultural Safety and Health*, Special Issue. (1):89-98.

Pavelchak N, Church L, Roerig S, London M, Welles W, Casey G [1999]. Silo gas exposure in New York State following the dry growing season of 1995. *App Env and Occ Hygiene;* 14(1):34 (ISI Web of Science: Cited 2 times as of 11/17/06)

[http://elib2.cdc.gov:2350/media/43wrcgvurh3xr223recn/contributions/d/8/7r/d87rn5q777tkgchf.pdf]

Purschwitz MA [1994]. Equipment engineering issues associated with childhood agricultural injuries. *J of Agromedicine*; 1(4):19-29. (ISI Web of Science: Cited 1 time as of 11/17/06)

Randolph SA, Migliozzi AA [1993]. The role of the agricultural health nurse: Bringing together community and occupational health. *AAOHN Journal*; 41(9): 429-33. (ISI Web of Science: Cited 2 times as of 11/17/06)

Roerig S [1993]. Scalping accidents with shielded PTO units: four case reports. *AAOHN Journal*; 4l(9):437-9. (ISI Web of Science: Cited 1 time as of 11/17/06)

Struttmann TW, Scheerer A, Prince S. and Goldstein L [1998]. Unintentional carbon monoxide poisoning from an unlikely source. *J of the American Board of Family Practice;11:481-484.*

Struttmann TW, Scheerer A, Moon E [1998]. Potentially productive years of life lost in Kentucky due to occupational fatalities. *J of the Kentucky Med Assoc*; 96: 369-73.
Tanaka S, Fairfield-Estill C. (1994). Blueberry Raker's Tendonitis. *The New England J of Medicine*; 331(8):552. NN 00221941

Taylor CD, Reynolds SJ, Stromquist A, Merchant J, Zwerling C, Kelly K [1999]. Environmental conditions in the homes of a rural Iowa county. J Agric Saf Health. 5(4):407-16.

Tanaka S, Fairfield-Estill C [1994]. Blueberry Raker's Tendonitis. *The New England J of Medicine*; 331(8):552. NN 00221941

Zlochower I, Ehlers J [1999]. The danger of drilling into sealed and filled plow frames. *Am J Ind Med*; 36(S1):110-112. NN: 20000844
[http://www3.interscience.wiley.com/cgi-bin/abstract/66002092/ABSTRACT]

Zwerling C, Burmeister L, Reynolds S, Jones M, Lewis M, Popendorf W, Scarth R, Whitten P [1998]. The Iowa FFHHS PROJECT. *J Ag Safety and Health.* May 4 (Special Issue 1):13-20. (ISI Web of Science: Cited 1 time as of 11/17/06)

Zwerling C, Burmeister L, Reynolds S, McKnight R, Browning S, Reed D, Wilkins J, Bean T, Mitchell L, Hallman E, May J, Stark A, Hwang S [1997]. Division of Surveillance Hazard Evaluations, and Field Studies, Division of Safety Research, National Institute of Occupational Safety and Health, Division of Unintentional Injury Prevention, National Center for Injury Prevention and Control, CDC. Use of rollover protection structures (ROPS) - Iowa, Kentucky, New York, and Ohio, 1992-1997. MMWR. 46(36):842-45, 1997. (ISI Web of Science: Cited 1 time as of 11/17/06)

Reports (unpublished)

Auslander M, Struttmann TW, Brandt V, Muehlbauer J, Boylan BS. (1997). Agricultural injury in Kentucky, Kentucky OHNAC Project Review. Monograph based on final report for National Institute for Occupational Safety and Health Cooperative Agreement No. U06/CCU406069-05-1.

Johnson, B and Scott N (November 1993). Report of injuries in the 1993 potato harvest: Aroostook County, Maine. Internal report. University of Maine Cooperative Extension Service, Presque Isle, Maine 04769.

Johnson, B and Scott N (January 1993). Report of injuries in the 1992 potato harvest: Aroostook County, Maine. Internal report. University of Maine Cooperative Extension Service, Presque Isle, Maine 04769.

Maine Department of Labor [MDOL]. (1997). Fatal occupational injuries in Maine 1996. BLS 696. December.

34+ California NURSE Reports in English and Spanish that were case reports of investigations covering a wide range of hazards with recommendations for prevention:

NURSE Report #1: Fatal Electrocution in Poultry Processing Plant
May 1992, CASE 191-006-01 A self-employed electrician was hired by a turkey plant to install an icemaker. The plant program:
[ttp://www.cdc.gov/nasd/docs/d000001-d000100/d000031/d000031.pdf]

NURSE Report #2: Arm Amputated by Tractor Power-Take-Off
May 1992, CASE 191-012-01 A farm laborer was feeding the cows on a dairy farm. BACKGROUND In December, 1991 a California Occupational Safety....
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000032/d00032.pdf]

NURSE Report #3: Tractor Driver Crushed by Scraper-Roller
May 1992: Tractor Driver Crushed by Scraper-Roller: CASE 191-010-01 A tractor driver was towing a scraper and a roller through a walnut orchard.
http://www.cdc.gov/nasd/docs/d000001-d000100/d000033/d000033.pdf]

NURSE Report #4: Lightning Strikes Kill Two Field Workers
May 1992, Cases 291-003-01, 291-003-02, 291-009-01, 291-009-02, 291-009-03. Lightning strikes killed two farm workers who were picking.
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000034/d000034.pdf]

NURSE Report #5: Grape Picker Run Over by Bin Trailer, Breaks Leg
May 1992, CASE 191-011-01 Grape pickers were riding from the vineyard to the road on bin trailers.[http://www.cdc.gov/nasd/docs/d000001-d000100/d000035/d000035.pdf]

NURSE Report #6: Maintenance Worker's Arm Broken by Fruit-Tray Transporter
May 1992, CASE 192-012-01 A maintenance worker in a fruit drying plant was cleaning and oiling a tray transporter:

[http://www.cdc.gov/nasd/docs/d000001-d000100/d000036/d000036.pdf]

NURSE Report #7: Cantaloupe Picker Dies of Heat Stroke
May 1992, CASE 191-002-01 A cantaloupe picker collapsed and died of heat stroke after four hours of work:
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000037/d000037.pdf]

NURSE Report #8: Heavy Equipment Operator Crushed in Roll Over
May 1992, CASE 291-002-01 A vineyard hired a heavy equipment operator to dig irrigation ditches and mix fertilizer:
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000038/d000038.pdf]

NURSE Report #9: Poisonous Spider Bites Vineyard Worker
June 1992, CASE 192-028-001 A farm laborer was working in a vineyard, cleaning weeds away from the base of the grape vines with a shovel:
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000039/d000039.pdf]

NURSE Report #10: Tractor Runs Over Asparagus Sledder
May 1992, CASE 292-008-01 An asparagus sledder was loading bunches of asparagus into large bins. As the tractor moves slowly through the field:
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000040/d000040.pdf]

NURSE Report #11: Foot Amputated by Auger
July 1992, CASE 292-009-01 At a vegetable processing plant, a machine operator's foot was amputated while walking down a trimming:
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000055/d000055.pdf]

NURSE Report #12: Tree Trimmer Electrocuted in Orchard
August 1992, CASE 192-036-01 A tree trimmer was pruning walnut trees in an orchard. At the edge of the orchard, high voltage power lines:
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000056/d000056.pdf]

NURSE Report #13: Tractor Driver Crushed Between Two Tractors
August 1992, CASE 192-129-01 At an onion harvest, a worker was driving a tractor which pulled trailers loaded with onions out of:
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000057/d000057.pdf]

NURSE Report #14: Irrigator Worker in ATV Crash on Dairy Farm
August 1992, CASE 192-110-01 The irrigators on a dairy farm use three-wheel ATVs (All Terrain Vehicle) to move around the farm:
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000058/d000058.pdf]

NURSE Report #15: Tractor Driver Killed by Flying Metal Object
August 1992, CASE 192-040-01 A tractor driver was pulling a mulcher (which cuts wood into smaller pieces) over cut branches in an :
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000059/d000059.pdf]

NURSE Report #16: Lettuce Packer Collapses Due to Heat
September 1992, CASE 292-127-01 Manual lettuce harvesting is often a two-person job. Lettuce Packer Collapses Due to Heat Page 2 The lettuce:
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000060/d000060.pdf]

NURSE Report #17: Irrigator Struck in Face by Pipe Valve
October 1992. CASE 192-114-01 Farm irrigators set up and take apart pipes that carry water to fields. Water pressure from the main water:
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000061/d000061.pdf]

NURSE REPORT #18: Plum Picker Breaks Ankle in Ladder Fall
October 1992. CASE 192-163-01 A farm labor contractor was hired to pick a plum orchard as quickly as possible. The NURSE Senior Safety.
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000062/d000062.pdf]

NURSE Report #19: Dairy Worker Crushed by Field Cultivator
October 1992, CASE 192-164-01 A worker on a dairy farm was waiting behind a field cultivator to attach it to the back of a tractor:
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000063/d000063.pdf]

NURSE Report: # 20: Teenage Irrigator's Finger Mangled by Pipe
October 1992, CASE 192-344-01 A fifteen year-old irrigator was taking apart sprinkler lines in a garlic field with another worker:
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000064/d000064.pdf]

NURSE REPORT #21: Foot Amputated by Fan in Fig Orchard
December 1992. CASE 192-207-01 A farm worker was driving a mechanical harvester in a fig orchard. A metal cover guarded the fan blades,….
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000067/d000067.pdf]

NURSE REPORT #22: Leg Partly Severed by Forklift Prong
December 1992, CASE 292-260-01 In a lettuce cooling plant boxes of lettuce are stacked on forklift pallets. [http://www.cdc.gov/nasd/docs/d000001-d000100/d000068/d000068.pdf]

NURSE REPORT #23: Raisin Picker Breaks Leg While Riding on Bin Trailer
January 1993. CASE 192-382-01. Raisin pickers were riding bin trailers from the vineyard to the road. These bin trailers carry....
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000069/d000069.pdf]

NURSE REPORT #24: Farm Worker's Skull Fractured by Exploding Brake
January 1993, CASE 192-383-01 Workers were harvesting almonds. The injury occurred while the farm worker was attempting to.…
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000070/d000070.pdf]

NURSE REPORT #25: Tractor Driver's Head Crushed by Moving Tractor

March 1993, CASE 192-459-01 During the raisin harvest a farm owner noticed that one of his tractor drivers seemed sick. Tractor...
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000071/d000071.pdf]

NURSE Report #26: Tractor Driver Knocked Off Tractor by Tree Branch
March 1993, CASE 192-548-01 A tractor driver was pulling a disc through an apricot orchard. A tractor driver was knocked off...
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000072/d000072.pdf]

NURSE Report #27: Arm Caught in Mechanical Cotton Picker
March 1993, CASE 192-549-01 A mechanical cotton picker was stopped in a field. A 39 year-old Hispanic male cotton picker driver injured h...
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000073/d000073.pdf]

NURSE Report #28: Machine Operator Electrically Shocked in Transplant Nursery
March 1993, CASE 292-327-01 Some greenhouses grow vegetables from seeds. When approaching the cutting machine, the c...
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000074/d000074.pdf[

NURSE Report #29: Farm Worker Burned in Explosion
October 1993, CASE 193-208-01 A farm worker told the following story. The farm employs 8 full-time workers, 10 casual workers (working 1-12 week...
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000075/d000075.pdf]

NURSE Report #30: Hot Radiator Fluid Scorches Forklift Operator
November 1993, CASE 193-378-01 A forklift driver was moving boxes at a raisin packaging plant....
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000076/d000076.pdf]

NURSE REPORT #31: Worker Scalped in Fruit Packing Plant
January 1994, CASE 193-209-01 Early one morning a worker was setting up her work station in a packing plant. ….
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000077/d000077.pdf]

NURSE REPORT #32: Nectarine Picker Injures Neck in Ladder Fall
February 1994, CASE 193-368-01 A nectarine picker was busy picking in the orchard. When meeting with the farm labor contractor,....
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000078/d000078.pdf]

NURSE REPORT #33: Cotton Harvester Operator Fatally Electrocuted
February 1994, CASE 193-488-01. Four brothers and a father were helping a relative harvest cotton. The cotton is emptied into a ma...
[http://www.cdc.gov/nasd/docs/d000101-d000200/d000127/d000127.pdf]

NURSE REPORT #34: Cotton Harvester Operator's Arm Mangled in Cotton Harvester Spindles May 1994, CASE 193-489-01 A cotton harvester operator was warming up his

cotton harvester before going out ….
[http://www.cdc.gov/nasd/docs/d000001-d000100/d000080/d000080.pdf]
Struttmann TW and Auslander M. (1996). Farm injury surveillance in Kentucky: What have we learned? Kentucky Epidemiological Notes and Reports;31(10):1-4.
Maine Department of Labor [MDOL]. (1997). Report of fatal occupational injuries in Maine 1995. BLS 690. April.

3.4c SENSOR Pesticide

Publications

Alarcon WA, Calvert GM, Blondell JM, Mehler LN, Sievert J, Propeck M, Tibbetts DS, Becker A, Lackovic M, Soileau SB, Das R, Beckman J, Male DP, Thomsen CL, Stanbury M [2005]. Acute illnesses associated with pesticide exposures at schools. JAMA 2005; 294: 455-465. (ISI Web of Science: Cited 10 times as of 11/17/06)

Ballard TJ, Calvert GM [2001]. Surveillance of acute occupational pesticide-related illness and injury: the US experience. Ann Ist Super Sanita (Roma);37:175-179.

Brevard TA, Calvert GM, Blondell JM, Mehler LN [2003]. Acute occupational disinfectant-related illness among youth, 1993-1998. Environ Health Perspect; 111:1654-1659. (ISI Web of Science: Cited 6 times as of 11/17/06)

Calvert GM. Health effects from pesticide exposure (editorial). Am Fam Physician 2004; 69: 1613-1614, 1616.

Calvert GM, Barnett M, Mehler LN, Becker A, Das R, Beckman J, Male D, Sievert J, Thomsen C, Morrissey B. Acute pesticide-related illness among emergency responders, 1993-2002. Am J Ind Med 2006; 49:383-393.

Calvert GM, Mehler LN, Rosales R, Baum L, Thomsen C, Male D, Shafey O, Das R, Lackovic M, Arvizu E [2003]. Acute pesticide-related illnesses among working youths, 1988-1999. Am J Public Health 2003; 93:605-610. (ISI Web of Science: Cited 6 times as of 11/17/06)

Calvert GM, Petersen AM, Sievert J, Ball C, Mehler LN, Das R, Harter L, Romoli C, Becker A, Male D, Schwartz A [in press]. Acute pesticide poisoning in the US retail industry, 1998-2002. Public Health Rep 2006.

Calvert GM, Plate DK, Das R, Rosales R, Shafey O, Thomsen C, Male D, Beckman J, Arvizu E, Lackovic M [2004]. Acute occupational pesticide-related illness in the US, 1998-1999: surveillance findings from the SENSOR−Pesticides Program. Am J Ind Med 2004;45:14-23. (ISI Web of Science: Cited 10 times as of 11/17/06)

Calvert GM, Sanderson WT, Barnett M, Blondell JM, Mehler LN [2001]. Surveillance of pesticide-related illness and injury in humans. In : Krieger R, editor. Handbook of pesticide

toxicology. 2nd ed. San Diego: Academic Press; 2001. p. 603-641. (ISI Web of Science: Cited 6 times as of 11/17/06)
Centers for Disease Control and Prevention [1999]. Farm worker illness following exposure to carbofuran and other pesticides-Fresno County, California, 1998. MMWR 1999; 48:113-116. Reprinted in JAMA 281:981-982.

Centers for Disease Control and Prevention [1999]. Illnesses associated with occupational use of flea-control products-California, Texas, and Washington, 1989-1997. MMWR 1999; 48:443-447. Reprinted in JAMA 282:125-126.

Centers for Disease Control and Prevention [1999]. Surveillance for acute pesticide-related illness during the Medfly Eradication Program - Florida, 1998. MMWR 1999; 48:1015-1018, 1027. Reprinted in JAMA 1999; 282:2204-2206.

Centers for Disease Control and Prevention [2000]. Illnesses associated with use of automatic insecticide dispenser unitsBselected states and United States, 1986-1999. MMWR 2000; 49:492-495. Reprinted in JAMA 284:432-434.

Centers for Disease Control and Prevention [2001]. Nosocomial poisoning associated with emergency department treatment of organophosphate toxicity - Georgia, 2000. MMWR 2001; 49:1156-1158. Reprinted in JAMA 2001; 285:527-528.

Centers for Disease Control and Prevention [2001]. Pesticide-related illnesses associated with the use of a plant growth regulator - Italy, 2001. MMWR 2001; 50:845-847. Reprinted in JAMA 2001; 286:2804-2805.

Centers for Disease Control and Prevention [2003]. Surveillance for acute insecticide-related illness associated with mosquito-control efforts - Nine states, 1999 - 2002. MMWR. 2003; 52:629-634.

Centers for Disease Control and Prevention [2004]. Illness associated with drift of chloropicrin soil fumigant into a residential area – Kern County, California, 2003. MMWR. 2004; 53:740-742.

Centers for Disease Control and Prevention [2005]. Update: Hydrogen cyanamide-related illnesses–Italy, 2002-2004. MMWR. 2005; 54:405-408.

Centers for Disease Control and Prevention [2005]. Unintentional topical lindane ingestions – United States, 1998-2003. MMWR. 2005; 54: 533-35.

Centers for Disease Control and Prevention [2006]. Pesticide-related illness and injury surveillance: a how-to guide for state based programs. Cincinnati, OH: US Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health; 2005 October. DHHS (NIOSH) Publication No.2006-102.

Centers for Disease Control and Prevention [2006]. (CDC authors: Calvert GM, Alarcon WA). A report of three farm workers who gave birth to infants with severe birth defects closely grouped in time and place ─ Florida and North Carolina, 2004-2005. MMWR. 2006; submitted for publication.

NIOSH [1991]. Work-related lung disease surveillance report. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Washington, DC: DHHS (NIOSH) Publication No. 91-113. Song J, Calvert GM. Surveillance of acute occupational pesticide-related illness and injury: the US experience. Korean J Rural Med 2002; 27:1-8.

NIOSH [1992]. Work-related lung disease surveillance report, supplement 1992. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Washington, DC: DHHS (NIOSH) Publication No. 91-113S.

NIOSH [1994]. Work-related lung disease surveillance report 1994. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Washington, DC: DHHS (NIOSH) Publication No. 94-120.

NIOSH [1996]. Work-related lung disease surveillance report 1996. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Washington, DC: DHHS (NIOSH) Publication No. 96-134.

NIOSH [2000]. Work-related lung disease surveillance report 1999. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Washington, DC: DHHS (NIOSH) Publication No. 2000-105.

NIOSH [2003]. Work-related lung disease surveillance report 2002. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Washington, DC: DHHS (NIOSH) Publication No. 2003-111.

3.4d Traumatic Injury Surveillance

Presentations (Published)

Bobick TG, Myers JR, Hard DL, Parker JE [1991]. Musculoskeletal injuries in the major agricultural industries. In: 35th Annual Meeting, Human Factors Society. San Francisco, CA, September, 1991. (ISI Web of Science: Cited 1 time as of 11/17/06)

Bobick TG, Myers JR [1992]. Back injuries in agriculture: occupations affected. In: Third International Symposium: Issues in Health, Safety and Agriculture, University of Saskatchewan. May 10-15, 1992, Saskatoon, Saskatchewan, Canada.

Bobick TG, Myers JR [1992]. Back Injuries in Agriculture: occupations affected. In: National Institute for Farm Safety 1992 Summer Conference, June 14-18, 1992, Myrtle Beach, SC. Paper No. 92-01.

Etherton JR, Myers JR [1990]. The use of rollover protection on farm tractors in West Virginia. B.Das ed., Advances in Industrial Ergonomics and Safety II, Taylor and Francis, Philadelphia, PA. pp. 819-825.

Jensen R, Etherton J, Russell J, Myers J [1994]. Most common compensation claims for farm and ranch employees in the United States: Back injuries from manual materials handling. In: Proceedings of the 12th Triennal Congress of the International Ergonomics Association, August 15-19, 1994, Toronto, Canada, pp.246-248.

Myers JR [2003]. Tractor occupational safety and health update. In: Record of Tractor-Related Injury and Death Meeting. Pittsburgh, PA, February 13-14, 2003, pp. 5-23. Morgantown, WV: NIOSH.

Presentations (unpublished

Myers JR. [1993]. Traumatic injury surveillance of farmers. American Society of Agricultural Engineers 1993 Winter Conference, June 20-24, 1993, Spokane, WA.

Myers JR. [1994]. Occupational injury surveillance in agriculture. Agricultural Safety and Health: A National Conference on Detection, Prevention, and Interaction, August 24-26, 1994, Columbus, OH.

Myers JR. [1995]. The Traumatic Injury Surveillance of Farmers survey. National Institute for Farm Safety 1995 Summer Conference, June 18-22, 1995, Saratoga Springs, NY.

Myers JR. [1996]. Results from the Traumatic Injury Surveillance of Farmers survey. Eleventh Annual Agricultural Machinery Conference, May 6-8, 1996, Cedar Rapids, IA.

Myers JR. [1999]. Work-related injuries among hired, non-family farm workers. The Dynamics of Hired Farm Labor: Constraints and Community Response, October 25-26, 1999, Concordville, PA.

Myers JR. [2000]. Work-related injuries among hired, non-family farm workers. Agricultural Safety and Health in a New Century, April 28-30, 2000, Cooperstown, New York.

Myers JR. [2000]. Comparison of farm worker injury and fatality experiences to all U.S. workers. Presented at the 13th Annual East Coast Migrant Stream Forum, Double Tree Hotel, Philadelphia, PA, November 3-5, 2000.

Results from both NTOF and FACE have been disseminated through NIOSH publications, scientific journals, and at scientific conferences and professional meetings.

Publications

Bobick TG, Myers JR [1994]. Agriculture-related sprain and strain injuries, 1985-1987. International Journal of Industrial. Ergonomics 14:223-232. (ISI Web of Science: Cited 1 time as of 11/17/06)

Ehlers JK, Connon C, Myers JR, Ballard T [1993]. Health and safety hazards associated with farming. American Association of Occupational Health Nurses Journal 41(9):414-421. (ISI Web of Science: Cited 13 times as of 11/17/06)

Greife A, Halperin W, Groce D, O'Brien D, Pedersen D, Myers J, Jenkins L [1995]. Hazard surveillance: its role in primary prevention of occupational disease and injury. Applied Occupational and Environmental Hygiene 10(9):737-742. (ISI Web of Science: Cited 4 times as of 11/17/06)

Myers JR. [1998]. Injuries among farm workers in the United States, 1994. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 98-153.

Myers JR. [2001]. Injuries among farm workers in the United States, 1995. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 2001-153.

Myers JR [2004]. It's time for change, one way or another. Journal of Agricultural Safety and Health 10(1):3-5.

Myers JR, Snyder KA [1995]. Roll-over protective structure use and the cost of retrofitting tractors in the United States, 1993. Journal of Agricultural Safety and Health 1(3):185-197. (ISI Web of Science: Cited 8 times as of 11/17/06) Myers JR. 1997. Injuries among farm workers in the United States, 1993. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 97-115.

Myers JR, Hard DL, Snyder KA, Casini VC, Cianfrocco R, Fields J, Morton L [1998]. Statistics and epidemiology of tractor fatalities–a historical perspective. Journal of Agricultural Safety and Health 4(2):95-108. (ISI Web of Science: Cited 5 times as of 11/17/06)

NIOSH. [2004]. Worker Health Chartbook, 2004. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 2004-146. *(Pages 195-211 of this publication contain agricultural data developed in part from the TISF project).*

Zwerling C, Burmeister L, Reynolds S, McKnight R, Browning S, Reed D, Wilkins J, Bean T, Mitchell L, Hallman E, May J, Stark A, Hwang S, Ehlers J, Lalich N, Myers J, Foster K. Use of Rollover Protective Structures – Iowa, Kentucky, New York, and Ohio, 1992-1997. MMWR 46(36):842-845. (ISI Web of Science: Cited 1 time as of 11/17/06)

3.4e National Traumatic Occupational Fatalities Surveillance

Publications

Adekoya N, Myers JR [1999]. Fatal Harmful Substances or Environmental Exposures in Agriculture, 1992 to 1996. J Occup Environ Med 41(8): 699-705. (ISI Web of Science: Cited 4 times as of 11/17/06)

Bobick TG, Jenkins EL [1992]. Agricultural-related Fatalities: 1986-1988. Advances in Industries Ergonomics and Safety IV. Book chapter edited by S. Kumar, Taylor & Francis: 121-128. (ISI Web of Science: Cited 2 times as of 11/17/06)

Braddee RW & Myers JR [1997]. Logging-type Fatalities in the U.S. Production Agriculture Industry, 1980-1992. J of Agromedicine 4(3/4): 373-375.

Castillo DN, Malit BD [1997]. Occupational Injury Deaths of 16 and 17 Year Olds in the U.S.: Trends and Comparisons with Older Workers. Inj Prev 3(4): 277-281. (ISI Web of Science: Cited 7 times as of 11/17/06)

Etherton JR, Myers JR, Jensen RC, Russell JC, Braddee RW [1991]. Agricultural Machine-related Deaths. Am J Public Health 81(6): 766-768. (ISI Web of Science: Cited 27 times as of 11/17/06)

Hard DL, Myers JR, Gerberich, SG [2002]. Traumatic Injuries in Agriculture. J Ag Safety Health 8(1): 51-65.

Hard D, Myers J, Snyder K, Casini V, Morton L, Cianfrocco R, Fields J [1999]. Young Workers at Risk When Working in Agricultural Production. Am J Ind Med Suppl 1: 31-33. (ISI Web of Science: Cited 8 times as of 11/17/06)

Hard DL, Myers JR, Snyder KA, Casini VJ, Morton LL, Cianfrocco R, Fields J [1999]. Identifying Work-related Fatalities in the Agricultural Production Sector Using Two National Occupational Fatality Surveillance Systems, 1990-1995. J Ag Safety and Health 5(2): 155-169. (ISI Web of Science: Cited 1 time as of 11/17/06)

Jenkins EL, Hard DL [1992]. Implications for the Use of E codes of the International Classification of Diseases and Narrative Data in Identifying Tractor-related deaths in Agriculture, United States, 1980-1986. Scand J Work Environ Health 18 Suppl 2: 49-50. (ISI Web of Science: Cited 7 times as of 11/17/06)

Myers JR [1990]. National Surveillance of Occupational Fatalities in Agriculture. Am J Ind Med 18(2): 163-168. (ISI Web of Science: Cited 23 times as of 11/17/06)

Myers JR, Hard DL [1995]. Work-related Fatalities in the Agricultural Production and Services Sectors, 1980-1989. Am J Ind Med 27(1): 51-63. (ISI Web of Science: Cited 33 times as of 11/17/06)
Myers JR, Adekoya N [2001]. Fatal On-farm Injuries Among Youth 16 to 19 Years of Age: 1982-1994. J Ag Safety and Health 7(2): 101-112.

Myers JR, Snyder KA, Hard DL, Casini VJ, Cianfrocco R, Fields J, Morton L [1998]. Statistics and Epidemiology of Tractor Fatalities – A Historical Perspective. J Ag Safety and Health 4(2): 95-108. (ISI Web of Science: Cited 5 times as of 11/17/06)

Myers JR, Hard DL, Snyder KA, Casini VJ, Cianfrocco R, Fields J, Morton L [1999]. Risks of Fatal Injuries to Farm Workers 55-Years of Age and Older. Am J Ind Med Suppl 1: 29-30. (ISI Web of Science: Cited 3 times as of 11/17/06)

NIOSH [2004]. Worker Health Chartbook, 2004. DHHS (NIOSH) Pub. No. 2004-146.

Pratt SG, Kisner SM, Helmkamp JC [1996]. Machinery-related Occupational Fatalities in the United States, 1980-1989. J Occup Environ Med 38(1): 70-76. (ISI Web of Science: Cited 16 times as of 11/17/06)

Suruda AJ, Pettit TA, Noonan GP, Ronk RM [1994]. Deadly Rescue: The Confined Space Hazard. J Hazardous Materials 36:45-53. (ISI Web of Science: Cited 1 times as of 11/17/06)

3.4f Fatality Assessment and Control Evaluation Program

NIOSH Numbered Publications

FACE Reports

NIOSH [1986]. 21-Year-Old Electrocuted While Moving Grain Auger in Indiana. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 86-22.

NIOSH [1986]. Three Electrocuted on Farm in Georgia. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 86-06.

NIOSH [1986]. Two Electrocuted on Farm in Georgia. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 86-07.

NIOSH [1987]. Farm Worker Asphyxiated in Grain Silo in Indiana. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 87-39.

NIOSH [1987]. Farmer Dies in Indiana. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 87-49.

NIOSH [1989]. Five Family Members Die After Entering Manure Waste Pit on Dairy Farm. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 89-46.

NIOSH [1989]. Two Farm Laborers Die in Oxygen Deficient Manure Pit. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 89-44.

NIOSH [1992]. Farm Owner and Son Asphyxiated in Manure Waste Pit – MN. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 92-29.

NIOSH. [1992]. Hog Farm Co-Owner and Employee Die of Hydrogen Sulfide Poisoning in Manure Pit – Minnesota. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 92-28.

NIOSH [1993]. Part-Time Farmer Dies in Tractor Rollover – West Virginia. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 93-20.

NIOSH [1998]. 9-Year-Old Child Helping with Blueberry Harvest Dies After Being Run Over by Cargo Truck on Field Road. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 98-15.

NIOSH [2000]. A 15-Year-Old Farm Laborer Dies After the Tractor He Was Operating Overturned into a Manure Pit – Pennsylvania. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 2000-18.

NIOSH [2000]. Sixteen-Year-Old Farmworker Dies in a Cotton Packing Machine After Being Covered with a Load of Cotton – Georgia. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 2000-06.

NIOSH [2000]. Worker Dies From Crushing Injuries After Falling into a Baling Machine – North Carolina. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 2000-01.

NIOSH [2002]. Youth Farm Worker Dies After Falling into Operating Feed Grinder/Mixer – Ohio. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 2002-10.

NIOSH [2003]. Female Hispanic Farm Laborer Dies After Falling from the Elevated Forks of a Forklift – North Carolina. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 2003-04.

NIOSH Alerts

NIOSH [1986]. Preventing Grain Auger Electrocutions. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 86-119.

NIOSH [1988]. Preventing Entrapment and Suffocation Caused by the Unstable Surfaces of Stored Grain and Other Materials. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 88-102.

NIOSH [1990]. Preventing Deaths of Farm Workers in Manure Pits. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 90-103.

NIOSH [1994]. Preventing Scalping and Other Severe Injuries from Farm Machinery. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94-105.

NIOSH [1998]. Preventing Injuries and Deaths from Skid-Steer Loaders. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 98-117.

NIOSH Hazard IDs

NIOSH [1998]. Ignition Hazard from Drilling into Sealed Frames of Agricultural Equipment – Hazard ID 4. Cincinnati, OH: U.S. Department of Health and Human Services, Public

Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 98-146.

NIOSH [2001]. Hazards associated with using farm tractors to move large bales. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Pub. No. 2001-146.

NIOSH Monographs

NIOSH [1994]. Worker Deaths in Confined Spaces – A Summary of Surveillance Findings and Investigative FACE Reports. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94-103.

NIOSH [1998]. Worker Deaths by Electrocution- A Summary of Surveillance Findings and Investigative FACE Reports. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 98-131.

NIOSH [2000]. Worker Deaths by Falls – A Summary of Surveillance Findings and Investigative FACE Reports. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2000-116.

3.5 References Cited

Alarcon WA, Calvert GM, Blondell JM, Mehler LN, Sievert J, Propeck M, Tibbetts DS, Becker A, Lackovic M, Soileau SB, Das R, Beckman J, Male DP, Thomsen CL, Stanbury M [2005]. Acute illnesses associated with pesticide exposures at schools. JAMA 294: 455-465.

Brandt V, Moon S, Ehlers J, Methner N, Struttman T [2001]. Exposure to endosulfan in farmers: Two case studies. Am J Ind Med; 39(6):643-9.

Bell CA, Stout NA, Bender TR, Conroy CS, Crouse WE, Myers, JR. 1990. Fatal Occupational Injuries in the United States, 1980 through 1985. JAMA 263(22):3047-3050.

Centers for Disease Control and Prevention [1998]. Farm worker illness following exposure to carbofuran and other pesticides-Fresno County, California. MMWR 1999; 48:113-116. Reprinted in JAMA 1999;281:981-982.

Centers for Disease Control and Prevention [1998]. Surveillance for acute pesticide-related illness during the Medfly Eradication Program - Florida. MMWR 1999; 48:1015-1018, 1027. Reprinted in JAMA 1999;282:2204-2206.

Centers for Disease Control and Prevention [1999]. Illnesses associated with occupational use of flea-control products-California, Texas, and Washington, 1989-1997. MMWR 48:443-447. Reprinted in JAMA 1999;282:125-126.

Centers for Disease Control and Prevention [2003]. Surveillance for acute insecticide-related illness associated with mosquito-control efforts - Nine states, 1999 - 2002. MMWR 52:629-634.

Centers for Disease Control and Prevention [2004]. Illness associated with drift of chloropicrin soil fumigant into a residential area – Kern County, California. MMWR.53:740-742

Department of Agriculture [2001]. Fruit Fly Cooperative Control Program Final Environmental Impact Statement 2001. [http://www.aphis.usda.gov/ppq/enviro_docs/pdf_files/fffeis.pdf]

Edwards Debra [2006]. Memorandum of July 31, 2006, from Debra Edwards, Director, Special Review and Reregistration Division, Office of Pesticide Programs, Environmental Protection Agency, to Jim Jones, Director, Office of Pesticide. [http://www.epa.gov/REDs/phosmet_ired.pdf].

Environmental Protection Agency [2005]. Pesticide Registration (PR) Notice 2005-1. Notice to Manufacturers, Producers, Formulators, and Registrants, of Pesticide Products. [http://www.epa.gov/opppmsd1/PR_Notices/pr2005-1.pdf]

Etherton JR, Myers JR, Jensen RC, Russell JC, Braddee RW [1991]. Agricultural Machine-related Deaths. Am J Public Health 81(6): 766-768.

Myers JR, Snyder KA [1995]. Roll-over protective structure use and the cost of retrofitting tractors in the United States, 1993. Journal of Agricultural Safety and Health 1(3):185-197.

Myers JR [1997]. Injuries among farm workers in the United States, 1993. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 97-115.

Myers JR [1998]. Injuries among farm workers in the United States, 1994. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 98-153.

Myers JR [2001]. Injuries among farm workers in the United States, 1995. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 2001-153.

Stout-Wiegand N [1988]. Fatal occupational injuries in US Industries, 1984: Comparison of Two National Surveillance Systems. AJPH 78(9): 1215-1217.

Chapter 4. Goal 2: Priority Populations at Risk

Research Goal 2: Reduce injuries, illnesses, and fatalities among subgroups of the working population determined to be at high risk or underserved by traditional occupational health approaches.

4.1 Child Labor

4.1 Goal: Protection of children living and working on farms, Understanding the Exposures: Reduce injuries, illnesses, and fatalities among children working on farms.

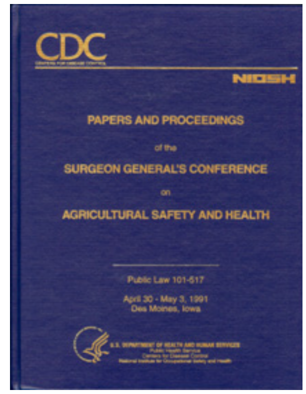
4.1a Challenge or Issue

The problem of children being injured while living, working, or visiting agricultural work environments (primarily farms) has been recognized for several decades. Youth deaths on farms during the 1980s averaged more than 100 per year (Figure 4-1), while nonfatal injuries during this same time period were estimated to occur to as many as 100,000 farm youths per year [NCCAIP 1996, Adekoya and Pratt 2001]. During the early 1990s, national surveillance data maintained by the BLS identified an average of 70 workplace fatalities per year among workers under age 18 [Derstine 1994] (Figure 4-1). The BLS data showed that the majority of the deaths of youths under age 16 and one-fourth of the deaths of youths aged 16 and 17 were in the agriculture industry. In addition, youths working on farms were suspected of having increased risks for cumulative trauma MSDs. Surveillance data on occupational injuries and illnesses among young workers has been sparse for many years. In 1998, nearly two million youths under age 20 lived or worked on a farm in the United States [Myers and Hendricks 2001].

Another challenge is that regulatory activity to improve safety and health for youths employed in agriculture has been uneven and neglected. Goal 2: Priority Populations at Risk Fair Labor Standards Act (FLSA) defines work activities prohibited for young workers through Hazardous Orders (HOs), 11 of which apply to agricultural occupations. No changes of any kind have been made to the agricultural HOs since 1970, despite far-reaching shifts in the agricultural production industry in terms of levels of mechanization, use of pesticides and herbicides, livestock handling practices, production demands, marketing practices, and labor arrangements. In addition, none of the HOs addresses MSDs or their associated risks. HOs for agricultural occupations applied only to youths under age 16, leaving older teens unprotected. Finally, youths working on their own family farms were exempted from child labor laws, apparently excluding a large proportion of working youths from safety and health protections.

4.1b Activities

Beginnings of the Childhood Agricultural Injury Prevention Initiative



In 1991, the Surgeon General's Conference on Agricultural Safety and Health included a session that highlighted the risks faced by persons, young and adult, involved with production agriculture [Myers, et al. 1992]. In the following year a Childhood Agricultural Injury Prevention symposium sponsored by the National Farm Medicine Center sought to develop consensus on research, education, policy, and other interventions to reduce agricultural injuries among children [Lee and Gunderson 1992].

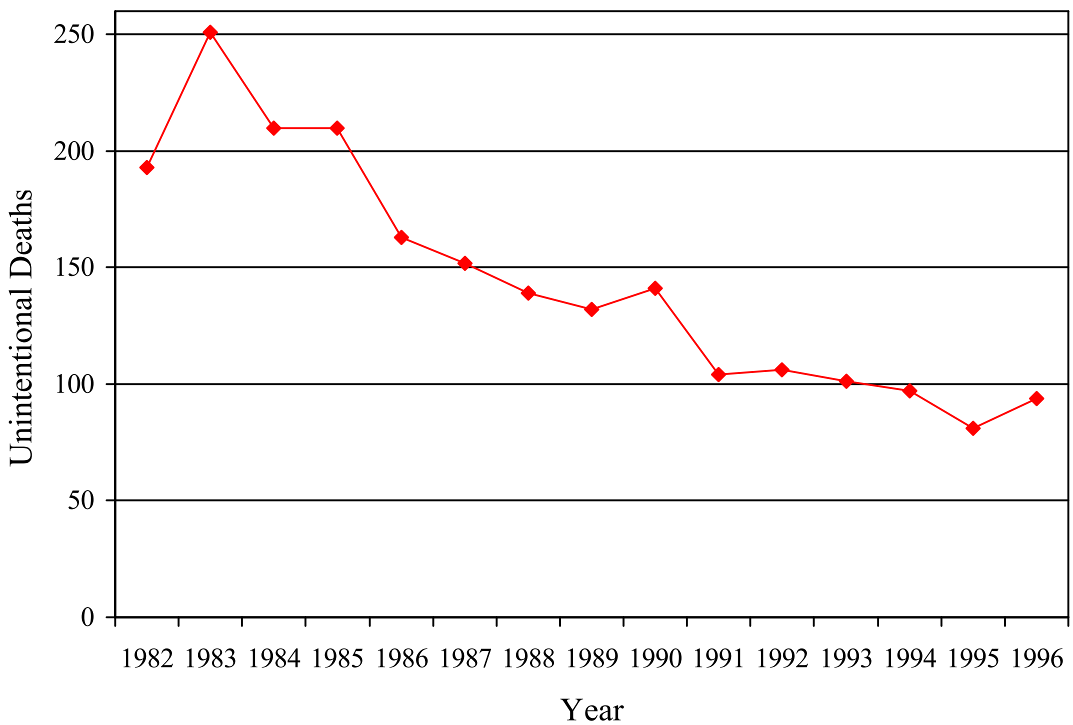
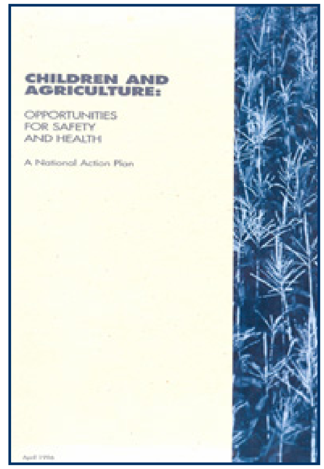


Figure 4-1: Unintentional farm deaths to youths under age 20, 1982–1996.
Source: National Center for Health Statistics, National Vital Statistics System.

In 1995, the National Farm Medicine Center sponsored another conference, this one on Child and Adolescent Rural Injury Control. An outgrowth was the establishment of the NCCAIP, representing a core group of 42 persons from national organizations, as well as authorities in childhood agricultural injury or disease prevention and two scientists from the AFF Program. Chaired by Dr. Barbara Lee of the National Farm

Medicine Center, this committee finalized a national action plan to address childhood injuries on farms.



The final NCCAIP document, released in 1996 [NCCAIP 1996], specifically recommended that NIOSH serve as the lead Federal agency in preventing childhood agricultural injury. On the basis of this report, Congress appropriated the AFF Program $5 million in Fiscal Year 1997 to implement the NCCAIP plan, thus giving rise to the Childhood Agricultural Injury Prevention Initiative.

As part of the planning process, a public meeting was held in 1997 to allow stakeholders to comment on the AFF Program plan for implementing the Initiative. Twenty-three persons attended, representing farm families, a farm worker organization, an insurance agency, an equipment manufacturer, safety advocates and educators, researchers, and key Federal agencies. Participants stressed that surveillance should cover as many youth populations as possible; including young migrant and seasonal farm workers and youths visiting farms in the United States.

To implement the initiative, the AFF Program has allocated 75% of the appropriated funds to the extramural grant process and 25% for intramural NIOSH activities. Extramural funds have been directed primarily towards addressing research and outreach, while intramural funds have been used predominantly to support surveillance activities.

<u>Childhood Agricultural Injury Surveillance</u>

In response to comments from the 1997 public meeting, the AFF Program held a separate peer review meeting that year to gather more input into its surveillance options. Comments came from extramural researchers and representatives of potential partners in surveillance efforts, including USDA, NASS, and CPSC.

The peer review panel concluded that additional surveillance efforts by the AFF Program for occupational fatal injury of youths on farming operations was not required, since adequate work-related fatality surveillance was provided by BLS CFOI. For general youth fatality information for farms, the AFF Program proposed using the NCHS National Vital Statistics System (NVSS) data files, and collecting death certificates from vital statistics reporting agencies meeting specific criteria. These data would then be used to define the general fatality and nonoccupational fatality issues faced by youths on farms. The panel agreed this was a reasonable approach.

National Vital Statistics System

For nonfatal injuries, the panel concluded that the populations of interest for surveillance fell into the following three main groups: 1) children of farm operators, 2) young farm workers and the children of farm workers, and 3) children visiting farming operations. For farm family youths, the panel recommended that the AFF Program take special care to ensure that minority youths were adequately covered in any final surveillance plan.

The panel examined a range of surveillance options but found none of them ideal. They concluded that no single surveillance approach would adequately cover all the populations of interest. As a result, the AFF Program decided to pursue a variety of methods of obtaining population-specific childhood agricultural injury data, to assess how each system worked, and to examine the possibility of using a combination of surveillance methods to find representative data sources of nonfatal injuries for each group.

Nonfatal Injury Surveillance

To date, the AFF Program has assessed three existing surveillance or survey systems (the CPSC NEISS, the NCHS NHIS, and the DOL NAWS) for their potential to track childhood agricultural injuries and two new methods to fill gaps in existing systems [using Health Resources Service Administration (HRSA) lay health advisors to collect injury information for migrant and seasonal farm youths and farm operator telephone surveys through the USDA, NASS]. Because of low capture rates and technical problems, the AFF Program ruled out using the NCHS NHIS survey and the HRSA lay health advisor model. This decision left three surveillance methods for nonfatal childhood agricultural injuries: NAWS, CAIS and NEISS. (Appendices 4.1-01, 4.1-02, 4.1-03)

NAWS – NAWS [DOL 2006] is a personal interview survey of 3,400 predominantly migrant and seasonal farm workers across the United States each year. In 1999, the AFF Program pilot tested the use of a farm injury module within NAWS. The module was asked of all farm workers in the NAWS sample, including workers under age 20. Workers were asked about work or nonwork injuries that occurred to them on a farm in the last 12 months. Details about the injuries were collected for all positive responses. The initial results of this pilot study found that youths under age 20 accounted for 14% of the migrant and seasonal farm worker workforce, and 6% of the total farm-related injuries in this special population (Figure 4-2). The initial results from NAWS led the

Table 4-1. Injuries to youths under age 20 that occurred on U.S. farms during 1998, 2001, and 2004, by sex and work status.

Injuries	1998	2001	2004
Total injuries*	37,774	29,207	27,590
Male	29,564	16,526	14,390
Female	8,210	12,641	13,201
Work	16,695	9,481	8,130
Nonwork	18,169	19,611	19,439

*Total injuries may not add because of rounding or missing data. *Source: NIOSH CAIS*

AFF Program to provide the DOL additional funds to collect the injury module in the 2002–2004 NAWS (Appendix 3.2-03). These data are currently being analyzed.

CAIS - The second surveillance approach pursued by the AFF Program is CAIS, a series of farm operator surveys conducted for the Program by the USDA, NASS. CAIS covers youths who live on, work on, or visit farms in the United States. Each round of CAIS is based on a telephone survey of 50,000 farm operations selected at random across the United States. Farm operators are asked about the total number of nonfatal injuries that occurred to youths under age 20 on their farms in the preceding calendar year. Details about all injuries are collected for positive responses. Demographic data on farm household youths and youths directly hired to work on the farm are also collected.

To date, CAIS data have been collected for calendar years 1998, 2001, and 2004. These results have allowed the AFF Program to track the number of youth farm injuries over time (Table 4-1).

Significant findings to date from CAIS include a decrease in the number of childhood agricultural injuries reported by farm operators between 1998 and 2004, with the largest decrease occurring among young males. Injury rates for farm household youths decreased the most in the Northeast and the South, with the Midwestern States showing the smallest decrease in injury rates (Figure 4-3). Nonwork-related injuries account for the largest proportion of these farm injuries to youths and they have not been decreasing with time (Table 4-1). Finally, the number of females injured on farms has been increasing over time.

Figure 4-2. Percentage distributions of the injuries and workforce by age for migrant and seasonal farm workers in the United States, 1999. *Source: DOL NAWS*

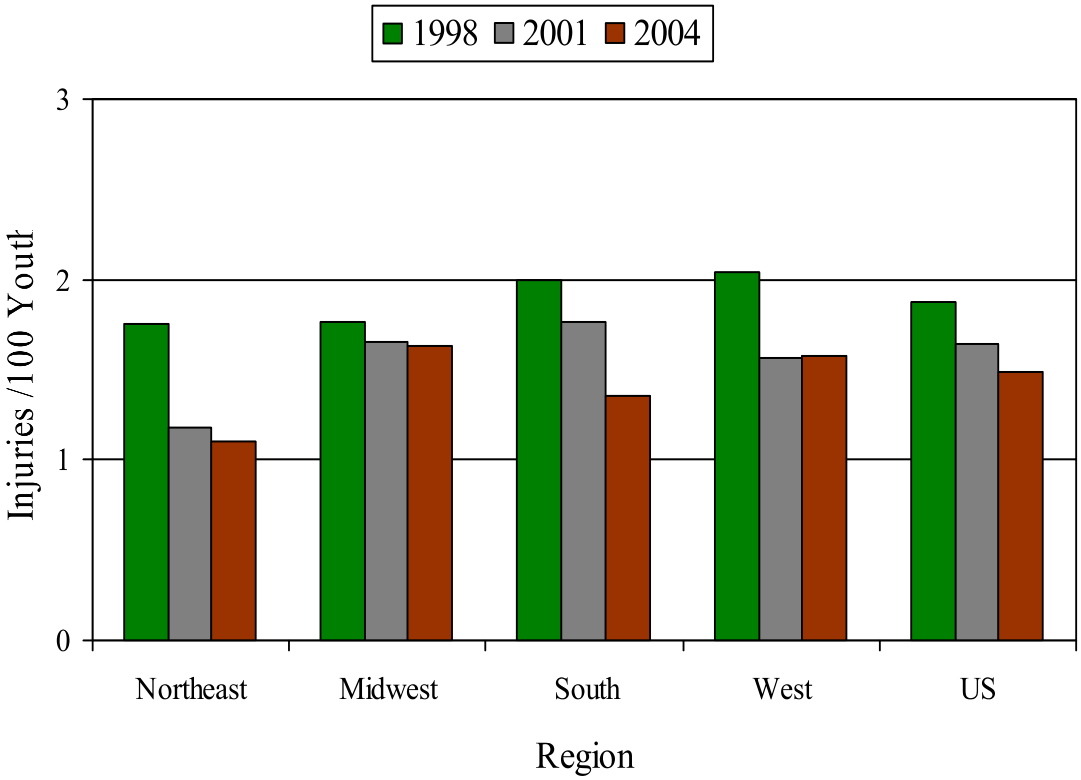


Figure 4-3: Farm Injuries per 100 household youths by region, 1998, 2001, and 2004. *Source: NIOSH CAIS*

Results of the initial 1998 CAIS verified the concerns of the 1997 surveillance review panel that minority youths living on farms would not be adequately covered by a random sample of all farms in the United States. To address this gap, the AFF Program approached NASS to conduct a more focal CAIS survey for minority farm operations made possible through its list of minority farm operations from the 1997 Census of Agriculture. In 2001, NASS completed the first M-CAIS for the AFF Program, covering injuries to youths on racial minority and Hispanic-operated farms during calendar year 2000. A second round of M-CAIS has been conducted for the calendar year 2003 (NASS requires the AFF Program to report racial minority and Hispanic estimates separately).

The youths farm injury estimates for racial minority farms from M-CAIS show patterns similar to those seen in CAIS. The total youths injuries on racial minority farms and injuries to males decreased slightly between 2000 and 2003, with injuries to females increasing (Table 4-2). Injury rates for household youths on racial minority farming operations did not change significantly over this time period (12.2 injuries per 1,000 household youths in 2000 to 12.6 injuries per 1,000 household youths in 2003).

A significant finding from the M-CAIS has been that household youths on Native American farming operations have the highest farm-related injury rate of all farm household youths (Figure 4-4).

For Hispanic farm operations, the total number of injuries increased slightly, as did the number of injuries due to work (Table 4-3). However, during this time period M-CAIS estimated that the number of youths on Hispanic farms increased by 59%. The upshot is that injury rates decreased 32% for household youths on Hispanic farms in the United States (14.2 injuries per 1,000 household youths in 2000 down to 9.7 injuries per 1,000 household youths in 2003).

Table 4-2. Injuries to youths under age 20 that occurred on racial-minority-operated farms in the United States during 2000 and 2003, by sex and work status.

Injuries	2000	2003
Total injuries*	653	627
Male	470	384
Female	181	227
Work	245	228
Nonwork	402	378

* Total injuries may not add up due to rounding. *Source: NIOSH M-CAIS*

NEISS - The AFF Program continues to use the CPSC NEISS as part of the Childhood Agricultural Injury Prevention Initiative [CPSC 2006]. NEISS is an Emergency Department (ED)-based system used to monitor occupational injuries in the United States. Specifics on the NEISS are provided in Chapter 3.

In 1998, NIOSH published an analysis of NEISS cases (October 1995 through September 1997) involving agricultural work-related injuries to youths under age 20 [Adekoya et al. 1998]. The report estimated an average of 5,400 work-related agricultural injuries to youths each year. The relatively low number of cases and the limited information available within NEISS precluded in-depth analyses.

To collect more information, the AFF Program conducted telephone follow-back interviews of youths injured on farms. Cases were selected for follow-back if the injury occurred on a farm, involved sources of injury thought to be associated with farm activities (e.g., tractors, barb wire, agricultural machines, hay bales), or had been identified as a probable farm injury based on the ED narrative of the injury. A total of 423 surveillance cases were identified between June 1, 1998 and September 30, 1999. Follow-back interviews were completed for 245 cases (58%). Of the 245 completed interviews, 129 respondents indicated that their injury occurred on a farm.

Table 4-3. Injuries to youths under age 20 that occurred on Hispanic operated farms in the United States during 2000 and 2003, by sex and work status.

Injuries	2000	2003
Total Injuries *	366	434
Male	262	314
Female	104	120
Work	140	167
Nonwork	226	267

Source: NIOSH M-CAIS

Fatal Injury Surveillance

Occupational fatality surveillance is provided through the BLS CFOI [BLS 2006] and through the NIOSH FACE program [NIOSH 2006]. Details on CFOI and FACE are provided in Chapter 3. (Appendices 3.3-01, 3.3-02)

As a result of NIOSH FACE emphasizing youths and agriculture as priority areas, AFF researchers have investigated five youth fatalities on farms since 1989 and State FACE programs have investigated 29 youth fatalities on farms since 1992. These case-based investigations allow for a more in-depth understanding of the causes of these deaths and the development of cause-specific prevention recommendations than may be possible from other large scale surveillance studies.

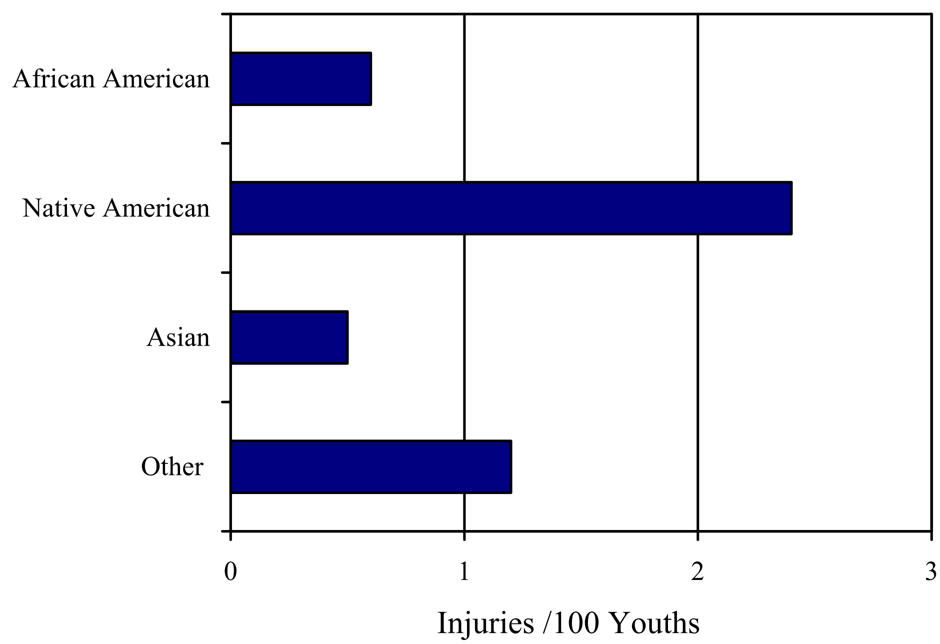


Figure 4-4: Farm injuries per 100 household youths by race, 2000. *Source: NIOSH M-CAIS*

The AFF Program has conducted two separate analyses of the CFOI during the initiative [Castillo, et al. 1999, Hard and Myers 2006]. The main finding from these analyses is that youths working on farms have occupational fatality rates 3 to 4 times higher than the national average occupational fatality rate for all working youths (14.6 deaths per 100,000 working youths on farms verses 3.6 deaths per 100,000 working youths during the time 1997–2002). These studies show that the annual number of deaths to youths working on farms decreased between 1992 and 2002, but that fatality rates have not decreased, and have even increased over the same time period for youths aged 15–19 (Table 4-4). The leading source of these fatalities was farm tractors, accounting for 27% of the deaths.

CFOI and FACE only provide information about occupational fatalities. To assess all deaths occurring on farms, the AFF Program reviewed mortality data from the NCHS for the years 1982 through 1996 [Adekoya 2001]. Farm deaths were identified by the location of injury code provided in the NCHS file. The analysis found that the number of fatalities to youths on farms decreased during the study period, with the biggest decrease occurring from deaths associated with machinery (Figure 4-5). The report also found that after machinery, the leading causes of death for youths on farms were drowning and firearms. Since the release of these data, six additional years of NCHS fatality data have become available. The AFF Program will update this document with the new years of data.

Table 4-4. Rates per 100,000 FTE of fatal work-related injuries for workers aged 15–19 for all industries and the agricultural production industry in the United States, 1992–1996 and 1997–2002.

Age (Years)	All Industries 1992–1996 Rate	All Industries 1997–2002 Rate	All Industries % Change	Ag Production 1992–1996 Rate	Ag Production 1997–2002 Rate	Ag Production % Change
15	5.2	5.1	-1.9	13.3	24.1	81.2
16	3.6	2.8	-22.2	10.5	15.2	44.8
17	3.5	2.9	-17.1	16.8	12.9	-23.2
18	4.1	3.4	-17.1	12.0	10.3	-14.2
19	4.4	4.0	-9.1	11.8	14.6	23.7
Total	4.1	3.6	-12.2	12.8	14.6	14.1

*Numbers and rates were calculated by NIOSH and may differ from previously published BLS CFOI numbers and rates. *Source: BLS CFOI*

One problem identified with NCHS mortality data is that, due to International Classification of Diseases (ICD) coding rules, the location variable is only provided for nontransportation, unintentional injuries. As a result, farm fatalities involving off-roadway traffic events and intentional causes of death are not identifiable from the NCHS mortality files. To address this issue, the AFF Program began collecting death certificates for all on-farm fatalities for youths under age 20 from all States. To date, death certificates have been collected through calendar year 2004. A preliminary analysis of this death certificate data for the years 1995–2000 [Goldcamp et al. 2004] has revealed that nearly 31 % of the deaths to youths on farms were due to either transportation or intentional causes of death (Figure 4-6). In addition, the study found suicide was the leading cause of death for youths aged 16–19 on farms.

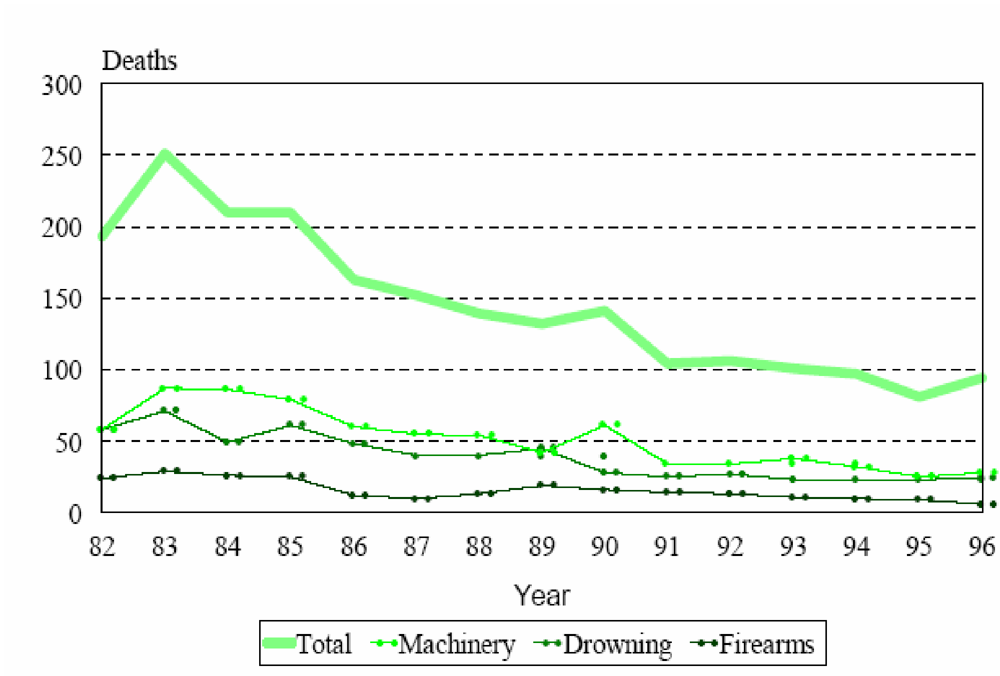


Figure 4-5: Trend of the leading causes of fatal farm injuries to persons under age 20 in the United States, 1982–1996. *Source: NCHS NVSS.*

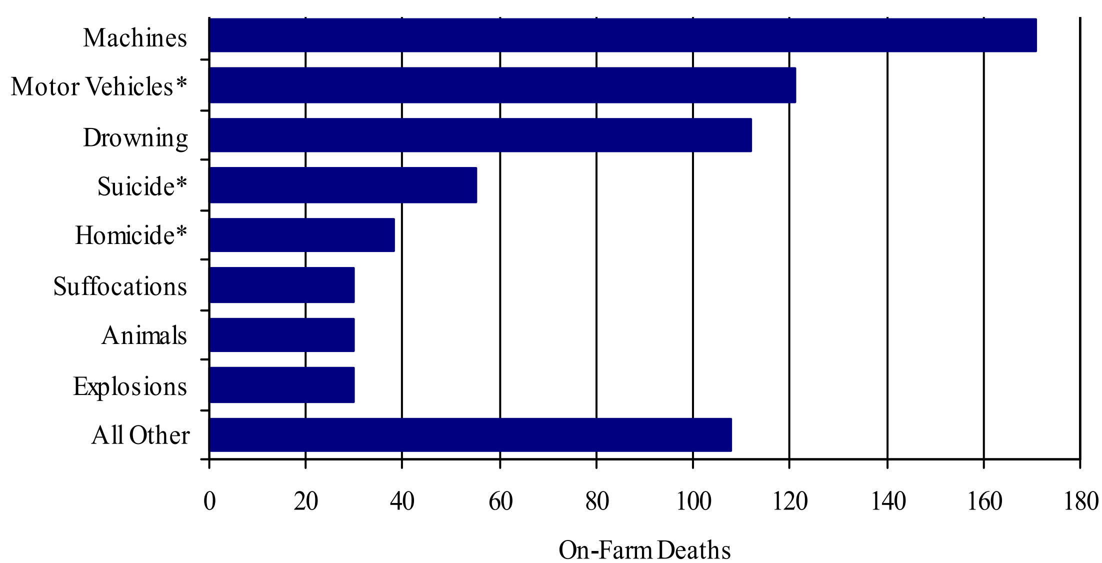


Figure 4-6: Cause of death for youths under age 20 on U.S. farms, 1995–2000. * On-farm deaths not reported by NCHS NVSS. *Source: NIOSH, Childhood Agricultural Mortality System*

Childhood Agricultural Musculoskeletal Disorder Research

Before 1998, little research had been conducted on the risk of MSDs for youths and adolescents working in agriculture. The few studies that had evaluated the risk of chonic MSDs among youths workers showed that many jobs performed by youths and adolescents on farms would be considered high risk for low back disorders for adults [Allread et al. 2004]. The risk of MSDs was thought to be even greater for youths and adolescents who perform these jobs compared to adult workers. To begin assessing the actual MSD risks of youths working on farms, the AFF Program initiated a childhood agricultural MSD research program in 1998. (Appendices 4.1-04, 4.1-05)

This progam of research encompassed several individual projects and activities including the following:

- In 1999, a literature review examined what was known about the potential risk of MSDs for youths working in agriculture.
- In 1999, a project conducted focus groups with farm parents, farm youths, and farm employers to obtain information about perceptions of risk of MSDs for youths working on farms and high risk tasks.
- In 2000, a project was initiated to develop and evaluate a clinic-based surveillance system for documenting ag-related MSD cases for youths.
- In 2001, a project began that focused on developing a biomechanical model to assess the physical stress for youths performing manual material handling jobs on farms.
- In 2001, a project was intiated to assess the risk of low back pain associated with various manual material handling tasks performed by youths on farms.
- In 2002, a conference was organized to seek input from experts on research gaps for prevention of MSDs for youths working in agriculture.
- In 2002, a study was conducted to obtain information about hours of work from youths working on farms.
- In 2002, a project was initiated to compare bone mineral content and bone stiffness in farm youths versus nonfarm youths to determine whether there may be early indicators for potential long-term effects for farm youths due to stiffer bones resulting from heavy physical labor on farms.
- In 2003, a series of studies was inititated to develop and evaluate ergonomic interventions designed to reduce the physical demands of specific high risk tasks.

Findings from these activities confirmed that MSDs are a problem for youths working on farms. Task assessments have concluded that a high percentage of jobs performed by youths on farms place them at high risk for low back pain. This work also identified a number of research gaps in preventing MSDs for youths working in agriculture. The AFF Program and its partners will continue to look at interventions to reduce the risk of MSDs for youths working on farms, and to develop or modify exposure assessment methods to assess the MSD risks among youths and adolescents.

Child Labor Hazardous Orders for Youths Working in Agriculture

On October 25, 1994, the AFF Program submitted comments to DOL in response to an advance notice of proposed rulemaking for child labor [NIOSH 2002] (Appendices 4.1-06, 4.1-07, 4.1-08). In its comment, the AFF Program provided the following recommendations for new HOs for nonagricultural industries and agriculture:

- Work in which youths are exposed to a hazard of falling six feet or more
- Work in confined spaces
- Work in which youths may come into direct or indirect contact with circuitry and equipment for electrical power distribution and use.

The following recommendations were made for new HOs for agriculture:

- Farm work with all-terrain vehicles
- Working alongside machinery with power take-offs or similar rotating drivelines.

In the same document, the AFF Program offered additional recommendations for strengthening child labor regulations:

- DOL should establish a mechanism by which child labor regulations are reviewed on a routine basis to ensure that the safety and health goals of these regulations are being achieved.
- DOL should ensure that youths are adequately represented in data collection efforts within DOL so that patterns of employment and injury can be routinely analyzed to support the administration of child labor laws. Employment data needed to estimate the size and characteristics of worker groups are available only for workers aged 15 and older, which is a serious deficiency for risk analysis for youths employed in agriculture.
- DOL should consider an amendment to the Fair Labor Standards Act to raise the minimum age for HOs in agriculture from 16 to 18 years. Youths in agriculture are permitted to do hazardous work at age 16, while those in nonagricultural occupations are not permitted to do hazardous work until age 18. The AFF Program noted that this distinction is justified only if agricultural work is demonstrably less hazardous. To the contrary, data on fatal and nonfatal injuries have consistently shown agriculture to be one of the most hazardous industries for workers of all ages.
- DOL should consider an amendment to the Fair Labor Standards Act to remove exemptions from child labor provisions in agriculture for youths employed by their parents (or persons standing in their place) with regard to provisions against hazardous work. Youths employed in nonagricultural occupations are not permitted to do work prohibited by HOs, even if employed by their parents. This is not the case in agriculture, where youths may perform any task while working on their family's farm. The AFF Program also noted that the absence of data on injuries to youths working on

> family farms was an impediment to accurate assessment of differences in safety and health risks for youths employed as family workers versus hired workers.

Recognizing the need for a comprehensive review of youths employment that would encompass patterns of work by youths, the relationship between employment and educational achievement, safety and health risks for working youth, and the psychosocial effects of employment, the AFF Program requested that the Board on Children, Youth, and Families of the National Research Council conduct a study of the safety and health implications of youths employment. Support for the study came from the AFF Program, the Robert Wood Johnson Foundation, the U.S. EPA, the National School-to-Work Office, the DOL, Employment Standards Administration (ESA), and the Maternal and Child Health Bureau of the U.S. DHHS. The AFF Program also provided substantial technical assistance to the 16-member committee charged with conducting the study. Results of the study were published in 1998 by the National Research Council, Institute of Medicine as *Protecting Youths at Work: Health, Safety, and Development of Working Children and Adolescents in the United States*. A full chapter in this monograph is devoted to the unique work setting and occupational hazards for youths employed in agriculture. In addition, the monograph made the following recommendation, which encompassed all types of work for youths:

> "The U.S. Department of Labor should undertake periodic reviews of its hazardous orders in order to eliminate outdated orders, strengthen inadequate orders, and develop additional orders to address new and emerging technologies and working conditions. Changes to the hazardous orders should be based on periodic reviews by the National Institute for Occupational Safety and Health of current workplace hazards and the adequacy of existing hazardous orders to address them" [National Research Council 1998].

In response to the recommendation in this monograph, DOL provided funds for the AFF Program to develop a report on the adequacy of HOs, based on a review of data and the scientific literature. The report was developed as a deliverable in interagency agreements between the AFF Program and DOL ESA in Fiscal Years 1999 to 2001. (ESA is the part of DOL that is directly responsible for developing and enforcing child labor laws). In addition to reviewing hundreds of scientific articles and reports, the AFF Program used the CFOI, SOII, NEISS, the Traumatic Injury Surveillance of Farmers survey, the CAIS, and the Current Population Survey as primary data sources. AFF Program staff resources were devoted to analyzing and interpreting data and preparing the report. They also provided supporting data. Because the agriculture industry has its own set of HOs, a large portion of this review focused on youths working on farms in the United States. (Table 4-5). In addition, a new HO was recommended by the AFF Program concerning respirator use by youths working in both agricultural and nonagricultural work settings. The final report was provided to ESA in early spring of 2002 [NIOSH 2002].

Table 4-5. Summary of NIOSH Recommendations Pertaining to Existing Agricultural Occupation HOs, 2002

Existing Agricultural HO	Retain	Revise	Specific Recommendations
HO 1: Operating a tractor more than 20 PTO horsepower or connecting or disconnecting an implement or any of its parts to or from such a tractor		X	(1) Revise to remove the 20 PTO (power take-off) horsepower thresholds; (2) revise exemption for youths aged 14-15 with tractor certification to require tractors to be equipped with a ROPS and mandate the use of seatbelts.
HO 2: Operating or assisting to operate (including starting, stopping, adjusting, feeding or any other activity involving physical contact associated with the operation) any of the following machines: corn picker, cotton picker, grain combine, hay mower, forage harvester, hay baler, potato digger, or mobile pea viner; feed grinder, crop dryer, forage blower, auger conveyor, or the unloading mechanism of a nongravity-type self-unloading wagon or trailer, or power post-hole digger, power post driver, or nonwalking-type rotary tiller		X	Combine HO 2 and HO 3 and expand prohibition from lists of specific machines to machines that perform general functions (e.g., harvesting and threshing machinery; mowing machinery; plowing, planting and fertilizing machinery; other agricultural and garden machinery; excavating machinery; loaders; wood processing machinery, such as wood chippers and debarkers; sawing machinery, including chain saws; powered conveyors; and mobile equipment, including forklifts).
HO 3: Operating or assisting to operate (including starting, stopping, adjusting, feeding, or any other activity involving physical contact associated with the operation) any of the following machines: trencher or earthmoving equipment; fork lift; potato combine; power-driven circular, band, or chain saw		X	See comments above pertaining to agricultural HO 2.
HO 4: Working on a farm in a yard, pen, or stall occupied by a (1) Bull, boar, or stud horse maintained for breeding purposes or (2) sow with suckling pigs, or cow with newborn calf (with umbilical cord present)	X		
HO 5: Felling, bucking, skidding, loading or unloading timber with butt diameter of more than 6 Inches.		X	Remove 6-inch diameter threshold.
HO 6: Working from a ladder or scaffold (painting, repairing, or building structures, pruning trees, picking fruit, etc) at a height of more than 20 feet		X	(1) Expand to include work on roofs, farm structures including silos, grain bins, windmills, and towers, and vehicles, machines, and implements and (2) reduce the maximum height at which youths may work in these settings from 20 feet to 6 feet.
HO 7: Driving a bus, truck, or automobile when transporting passengers, or riding on a tractor as a		X	(1) Expand to prohibit driving of all motor vehicles and off-road vehicles (including all-terrain vehicles), with or without passengers,

Table 4-5. Summary of NIOSH Recommendations Pertaining to Existing Agricultural Occupation HOs, 2002

Existing Agricultural HO	Retain	Revise	Specific Recommendations
passenger or helper			on or off the highway; (2) expand to prohibit work as an outside helper on a motor vehicle; (3) retain the provision prohibiting riding on a tractor as a passenger or helper, but move it under Agricultural HO 1.
HO 8: Working inside a fruit, forage, or grain storage designed to retain an oxygen deficient or toxic atmosphere; an upright silo within 2 weeks after silage has been added or when a top unloading device is in operating position; a manure pit; a horizontal silo while operating a tractor for packing purposes		X	Expand to prohibit *all* work inside (1) a fruit, forage, or grain storage, such as a silo or bin; (2) a manure pit.
HO 9: Handling or applying (including cleaning or decontaminating equipment, disposal or return of empty containers, or serving as a flagman for aircraft applying) Agricultural Chemicals classified under the Federal Insecticide, Fungicide, and Rodenticide Act (as amended by Federal Environmental Pesticide Control Act of 1972, 7 U.S.C. 136 et seq.) as Toxicity Category I, identified by the word ADanger@ and/or APoison@ with Skull and Crossbones; or Toxicity Category II, identified by the Word AWarning@ on the Label		X	Expand to be consistent with EPA Worker Protection Standard for pesticides, encompassing prohibitions against pesticides with chronic health effects as well as pesticides with recognized acute toxicity.
HO10: Handling or using a blasting, including but not limited to dynamite, black powder, sensitized ammonium nitrate, blasting caps, and primer cord	X		
HO 11: Transporting, transferring, or applying anhydrous ammonia	X		

Extramural Childhood Agricultural Injury Prevention Programs and Partnerships

National Children's Center for Rural and Agricultural Health and Safety (NCCRAHS)

The $3.75 million dedicated annually for extramural funds is primarily for R01 research grants and to fund a national children's agriculture injury prevention center. Currently, NCCRAHS, located within the National Farm Medicine Center in Marshfield, Wisconsin, receives the center portion of these funds. NCCRAHS strives to enhance the health and safety of all children exposed to hazards associated with agricultural work and rural environments. In addition to the AFF Program, NCCRAHS also receives funding from the Maternal and Child Health Bureau (MCHB). The dual sources of funding allow the Center to provide a wide range of services related to children and adolescents living in rural areas and working in agricultural environments. (Appendix 4.1-09)

A major activity undertaken by NCCRAHS has been developing the NAGCAT [North American Guidelines for Children's Agricultural Tasks 1999]; guidelines to help parents assign farm jobs to their children aged 7 to 16. NAGCAT allows children and adolescents to gain meaningful work experience, but with a reduced risk of agricultural-related injury. These recommendations were developed via a panel of agricultural safety and health and child development experts, including a representative of the AFF Program. Widely cited by both the professional and public press, the NAGCAT has been found effective in reducing youth farm injuries in one controlled study in which farm parents who used the NAGCAT reported a 50% reduction in youth farm injuries compared to youths in control farm families [Gadomski et al. 2006].

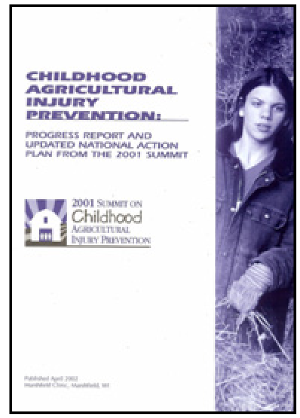
Surveillance from the AFF Program has identified that more than half of all injuries and fatalities occurring to youths on farms are not work-related [Adekoya 2001]. In response, NCCRAHS has initiated a safe play area initiative for farms to reduce youth exposures to farm hazards. The Center published *Creating Safe Play Areas on Farms* in 2003 to provide safety professionals and community leaders' guidance on addressing this emerging issue [Esser et al. 2003]. This document has increased attention to the development of safe, structured, supervised play areas for children on farms, and has prompted many Safety Day Camps for farm youths to offer parent-oriented programs to promote fenced, supervised play areas for children on farms.

Safe Play

A third major undertaking by NCCRAHS was sponsoring a third national childhood agricultural injury conference in 2001. The conference was designed to assess progress in meeting the goals of the original NCCAIP action plan and to update the plan as needed. Funding for the conference was provided by the AFF Program with funds initiated by Senator Herb Kohl (D-WI). AFF Program staff helped plan the conference and participated on special emphasis panels. Results of this conference were released in 2002 [Esser et al. 2003]. Additional NCCRAHS activities are listed on the Web site at: http://www.marshfieldclinic.org/nfmc/pages/default.aspx?page=nccrahs_welcome).

Grants

Other extramural funds from the Childhood Agricultural Injury Prevention Initiative have been used to fund 32 R01 grants since 1997. Topics addressed in the studies include occupational injury in Hispanic farm worker families, risk factors for injury among migrant and seasonal farm worker children, effects of work permits in protecting youth workers, pesticide training for adolescent migrant farm workers, and effectiveness of farm safety day camps for children. At annual meetings with R01 grant recipients, the Program shared results from its ongoing childhood agricultural injury surveillance activities.



Conferences

In 1998, the AFF Program, in conjunction with Purdue University, sponsored a workshop entitled "The Childhood Agricultural Injury Prevention Strategy Workshop: A Private Sector Perspective." Forty-three representatives from such industrial areas as agricultural chemical manufacturers, insurance companies, and safety equipment manufacturers identified budget constraints and a perceived lack of benefits to organizations as primary reasons the private sector might reject requests for support by groups such as NCCAIP. They believed the problem was a community one requiring a broad-based collaborative effort and that additional regulation was not needed. Purdue University produced a final report summarizing the workshop that has been made available through the National Technical Information Service [National Technical Information Service 1999].

In addition to this workshop, the AFF Program has organized several special sessions on the topic of childhood agricultural injuries at various conferences. Five such conferences follow:

- Fourth International Symposium: Rural Health and Safety in a Changing World, October 18–22, 1998, Saskatoon, Saskatchewan, Canada.
- Agricultural Safety and Health in a New Century, April 28–30, 2000, Cooperstown, New York.
- National Occupational Injury Research Symposium, October 17–19, 2000, Pittsburgh, Pennsylvania.
- National Institute for Farm Safety 2001 Annual Meeting, June 24–27, 2001, Pittsburgh, Pennsylvania.
- National Injury Prevention and Control Conference, May 9–11, 2005, Denver, Colorado. On September 22, 1999, NIOSH conducted a midcourse review of the Childhood Agricultural Injury Prevention Initiative. No one disagreed with the course the AFF Program had taken with the Childhood Agricultural Injury Prevention Initiative and all believed funding should be continued.

Finally, the AFF Program formed a Federal Interagency Working Group on Preventing Childhood Agricultural Injuries in 2001. Currently, 11 Federal agencies with an interest, mission, or mandate in childhood agricultural injury prevention sit on this working group (Table 4-6). The purpose of the working group is to share information about activities within the various agencies that relate to childhood agricultural injuries, and to promote the inclusion of childhood agricultural injuries in any new activities. Bi-annual meetings have been held to date.

Interactions with Extramural Partners

Table 4-6. Federal agencies participating in the NIOSH Federal Interagency Working Group on Preventing Childhood Agricultural Injuries during 2006.
Participating Federal Agencies
Consumer Product Safety Commission
HRSA, Maternal Child Health Bureau
US Department of Education, National FFA Advisor
National Center for Injury Prevention and Control
USDA, NASS
US Department of Education, Office of Migrant Education
DOL, Occupational Safety and Health Administration
CDC, Division of Community and Migrant Health Centers
National Institute of Child Health and Human Development
USDA, Cooperative State Research, Education, and Extension Service
DOL, Employment Standards Administration
DOL, Employment and Training Administration
Indian Health Service

The AFF Program has been working with our extramural partners from the beginning of the childhood agricultural injury prevention movement in the early 1990s (Appendix 4.1-09). Activities arising from these relationships include the following:

An AFF Program researcher was an invited member of the Agricultural Engineering/Structural/ Environmental working group of the 1992 Childhood Agricultural Injury Prevention Symposium. He helped to identify major injury issues and propose recommendations develop working relationships with representatives of agricultural equipment manufacturers and professional societies.

In 1999, an extramural AFF Program researcher at the National Farm Medicine Center sought assistance from intramural AFF Program researchers on a research project requiring a national sample of farms with household youths aged 7–16. The AFF Program worked with NASS to identify farms with household youths in this age range and enlist their participation as part of the CAIS data collection effort. The extramural researcher was given access to those farm families who agreed to participate. Results of her study are reported in the following publication:

Marlenga BL**,** Pickett W, Berg RL [2002]. Evaluation of an enhanced approach to the dissemination of the North American Guidelines for Children's Agricultural Tasks: a randomized controlled trial. Preventive Medicine *35*:150–159. PubMed ID: 12200100 (ISI Web of Science: Cited 7 times as of 11/17/06)

The AFF Program has also worked with NASS to provide CAIS data to Dr. Marlenga for two additional research studies. She used results from the 1998 CAIS to assess whether guidelines for assigning youths work tasks based on their age would have prevented certain types of farm injuries. Results of this research are reported in the following publication:

Marlenga BL**,** Brison RJ, Berg RL, Zentner JL, Linneman JG, Pickett W [2004]. Evaluation of the North American Guidelines for Children's Agricultural Tasks using a case series of injuries. Injury Prevention *10*:350–357. PubMed ID: 15583256 15583256 (ISI Web of Science: Cited 3 times as of 11/17/06)

Data from the 1998 CAIS and 2000 M-CAIS have also been provided to Dr. Marlenga to assess the potential impact of applying Child Labor HOs for youths working on farms to youths working on their family's farm. This research is still in progress.

4.1c Selected Outputs

Results from the Initiative have been disseminated at scientific conferences and professional meetings, through journal articles and NIOSH documents, such as statistical abstracts and informational/educational pamphlets. A search of the literature has identified a minimum of 22 peer-reviewed journal articles that have cited surveillance data from the CAIS.

Recommendations Regarding Child Labor

The AFF Program provided testimony to ESA on changes to child labor regulations in 1994. These comments formed the basis for the AFF Program's later work on a scientific-based assessment of existing child labor rules and recommendations of change submitted to ESA under an interagency agreement in 2002.

AFF Program staff used data from the 1998 CAIS to recommend changes to the agricultural HOs for the DOL. The 1998 CAIS provided the most representative and current data on occupational youth farm injuries by covering youths of all ages and farms of all types.

The lead author of the AFF Program's HOs report was invited to participate in a 2002 meeting on the development of guidelines for defining hazardous child labor, hosted by the International Labour Organization (ILO) in Geneva, Switzerland. Nations that had ratified ILO Convention No. 182 (Elimination of the Worst Forms of Child Labour) had requested assistance in meeting a requirement to identify hazardous child labor within 2 years of ratifying the convention. The author provided a copy of the AFF Program recommendations on HOs as an example of an approach that other nations could use to identify hazardous work for youths.

Nonwork Injuries and Fatalities on Farms

One significant finding from the CAIS, M-CAIS, and AFF Program death certificate studies has been the importance of nonwork injuries and fatalities to youths on farms. These findings led to developing a new recommendation in the updated 2002 Childhood Agricultural Injury Prevention National Action Plan to address nonwork injuries on farms [Esser et al. 2003]. In response to this new recommendation, the NCCRAHS produced several documents on the importance and design of safe play areas for children on farms. NCCRAHS also maintains a Web site dedicated to the topic of safe play areas on farms (http://www.marshfieldclinic.org/nfmc/pages/default.aspx?page=nfmc_nccrahs_safe_play_welcome).

Musculoskeletal Disorders

Published papers on chronic musculoskeletal disorders have served as the basis for subsequent grants and development of follow-on research proposals. Findings have also provided the impetus for funding research on preventing MSDs for youths working in agriculture. This series of studies has increased public awareness of the potential risks for youths working on farms. Results of the studies identified those tasks typically performed by youths on farms that posed a high risk of chronic low back pain and highlighted the barriers to the public adopting the recommendations. Current projects are aimed at identifying and evaluating simple solutions for many of the high risk jobs.

Prominent Outputs

A publication that identified motor vehicles and intentional causes of death to be major issues for youths living on farms [Goldcamp, et al], "Farm fatalities to youth 1995–2000: a comparison by age groups." This article was published in the *Journal of Safety Research* in 2004 [Goldcamp et al 2004].

This conference report influenced AFF Program research directions and those of other organizations after its release in 2002: *Childhood Agricultural Injury Prevention: Progress Report and Updated National Action Plan from the 2001 Summit* [Lee et al. 2002].

This 1996 report was the basis for the NIOSH Childhood Agricultural Injury Prevention Initiative: *Children and Agriculture: Opportunities for Safety and Health* [NCCAIP 1996].

Data Bases

The CAIS (data available for 1998, 2001, and 2004) is the key surveillance activity to track youth farm injuries over time. This is the primary data source used to define outcomes for the NIOSH Childhood Agricultural Injury Initiative. A similar database on minority youths is the M-CAIS (data available for 2000 and 2003).

Conferences

One of the more important conferences assessed how well the AFF Program was conducting the Childhood Agricultural Injury Prevention Initiative. The *2001 Summit on Childhood Agricultural Injury Prevention* was held in 2001 in Minnesota. It provided guidance on the types of issues the initiative should be addressing.

A complete list of outputs can be found in section 4.5 at the end of this chapter.

4.1d Intermediate Outcomes

Surveillance

AFF Program surveillance activities have influenced the types of outreach and research being done on childhood agricultural injury prevention while also providing vital information to track the changes in youth farm injuries over time. Intermediate outcomes related to the surveillance program follow:

NCCRAHS is just one of the national child safety organizations that use the results from the AFF Program youths farm injury surveillance studies. Other organizations, such as Farm Safety for Just Kids and the National Safe Kids Campaign now use the Program's injury and injury rate estimates for children on farms as their official numbers.

The estimates of youths farm injuries produced by the AFF Program have also been cited in proposed Congressional legislation. In 2005, the Children's Act for Responsible Employment (CARE) Act (HR 3482) was submitted in the House of Representatives by Representative Roybal-Allard. The CARE Act proposed changes to child labor laws in agriculture and identified the youths farm injury data collected by the AFF Program CAIS as one source of data that would be used to develop an annual report on occupational injuries to youths working on farms in the United States. At this time, no action has yet been taken on this proposed bill within Congress.

Child Labor Hazardous Orders

The AFF Program has been a leader in promoting science-based recommendations on improving the current Child Labor HOs as they apply to young agricultural workers. Intermediate outcomes from these efforts follow:

As part of a cost-benefit analysis of proposed changes to Child Labor HOs for youths working on farms, a contractor for DOL requested data from the AFF Program in 2004. The contractor, SiloSmashers, asked for information about estimates of youths under age 20 working on farms, estimates of working youths who operated farm tractors on farms, work-related injuries occurring to these youths, and nonwork injuries occurring to youths on farms. SiloSmashers concluded that the AFF Program CAIS surveillance data were the only source of these data, and were critical to conducting the cost-benefit analysis requested by DOL. This work is still in progress.

In response to the AFF Program-sponsored report, *Protecting Youths at Work*, developed by the National Research Council and Institute of Medicine, the DOL, ESA established an interagency agreement with NIOSH to develop recommendations for changes to Child Labor HOs.

Responding to the release of the AFF Program HOs recommendations, DOL, ESA convened a series of stakeholder meetings to gather input on priorities for future rulemaking. Several organizations with interests in youths work in agriculture were represented at a meeting attended by authors of the AFF Program report, including the Farmworker Justice Fund, the National Consumers League, the USDA, the Pennsylvania State University, and the Tennessee Agricultural Extension Service.

In March 2003, the Young Worker Health and Safety Network (YWH&S) released its report, NIOSH Recommendations for Changes to the Federal Child Labor Regulations: A Response from Members of the Young Worker Health and Safety Network. The network is a subcommittee of the Occupational Health and Safety section of the American Public Health Association, composed of public health professionals, advocates, educators, and government agency staff. More than 25 persons from a variety of disciplines, including representatives of NIOSH, collaborated to develop the network's response to the NIOSH HOs recommendations [Young Worker Health & Safety Network 2003]. The YWH&S Network agreed with all NIOSH recommendations pertaining to the existing HOs for agriculture, and flagged four agricultural HOs as top priorities for regulatory action.

The YWH&S Network comments were also the topic of a peer-review journal article, which further encouraged implementation of the NIOSH recommendations by DOL, ESA [Miller, Bush 2004].

In 2003, the Farmworker Justice Fund called for DOL to revise the HOs for youths in agricultural occupations, citing the AFF Program's recommendations as the basis for these revisions [Farmworker Justice Fund, Inc. 2003].

In 2005, the Child Labor Coalition (CLC) prepared a report entitled *Protecting Working Children in the United States: Is the Government's Indifference to the Safety and Health of Working Children Violating an International Treaty?* [Child Labor Coalition 2005]. The CLC is a group of nongovernmental organizations whose mission is to end child labor exploitation in the United States and abroad and to protect the health, education, and safety of working minors. The CLC report was submitted in June 2005 to the ILO Committee of Experts, an independent body charged with examining the application of ILO conventions in member States. In the report, the CLC questions whether the United States is in compliance with ILO Convention No. 182 (Elimination of the Worst Forms of Child Labour), with particular emphasis on HOs and children working in agriculture. Several pages of the report are devoted to a discussion of needed revisions to agricultural HOs, with data and rationale from the AFF Program HOs report used as the primary justification for changes. The report urges ESA to take action on AFF Program recommendations, particularly those which focus on the agricultural HOs.

At the 2006 annual meeting of the ILO in Geneva, Switzerland, the Conference Committee on the Application of Standards discussed the U.S. application of Convention No. 182 as it relates to children performing hazardous work in agriculture. The Committee of Experts report used as a resource by the ILO Conference Committee mentions the AFF Program recommendations on HOs, noting that the U.S. Government has indicated that it is "in the process of determining which recommendations concerning the Hazardous Orders will be presented in a first round of proposed rules" [International Labour Organization 2006]. The Conference Committee requested that the U.S. Government provide copies of any new HOs when adopted. In addition, the Conference Committee requested the U.S. Government to "indicate, in its next report to the Committee of Experts, the measures taken or envisaged (including but not limited to legislation) to ensure that work performed in particular in the agricultural sector was prohibited for children under 18 years where it was hazardous work within the meaning of the Convention" [International Labour Organization 2006].

The CLC followed the action by the ILO Conference Committee with a letter to Secretary of Labor Elaine Chao requesting that forthcoming proposed changes to child labor laws focus on agriculture. The letter references the 2002 NIOSH report recommending changes to HOs, and the discussions at the 2006 annual ILO meeting questioning United States compliance with ILO Convention No. 182 in relation to children working in agriculture:

The Child Labor Coalition strongly urges the Labor Department to make agricultural HOs a top priority within the anticipated child labor regulatory action in 2006. Given that the lead advocacy group (CLC) and the lead group of health and safety experts on child labor (YWH&S Network); and the government's lead agency on occupational safety and health (NIOSH) recognize the pressing need to strengthen the agricultural HOs, it would be deplorable if the 2006 proposed child labor regulations do not include agriculture in the scope of proposed rulemaking. Furthermore, in light of increased attention by the ILO on the issue of children in hazardous agricultural employment and their request for more information related to measures taken or envisaged, it would certainly not be overlooked if the DOL's regulatory changes in child labor exclude or minimize agriculture [Child Labor Coalition 2006].

In 2003 and again in 2005, Representative Tom Lantos (D-California) introduced the Youth Worker Protection Act, which would amend the FLSA of 1938 to revise requirements relating to child labor and to set forth new requirements for the employment of minors. The Act included a provision directing the Secretary of Labor to promulgate a rule relating to particularly hazardous occupations for children between the ages of 16 and 18, specifying that this rulemaking was justified based on the HOs recommendations released by the NIOSH in 2002 [GovTrack.us 2006a,b].

4.1e End Outcomes

During AFF Program activity, the total number of youths injured on farms has decreased from 37,800 in 1998 to 27,600 in 2004. For the same time period, the number of farm work-related youths injuries decreased by 51% from 16,695 to 8,130 (Table 4-1) [NIOSH CAIS]. Injury rates for household youths show that farm injury risks have decreased in all regions of the United States (Figure 4-3) [NIOSH CAIS].

Work-related farm injuries to youths living on the farms have decreased from 11,600 injuries in 1998 to 6,400 in 2004. The work-related injury rate for household youths decreased from 14.1 to 9.1 injuries per 1,000 working household youths for the same period (Figure 4-7) [NIOSH CAIS].

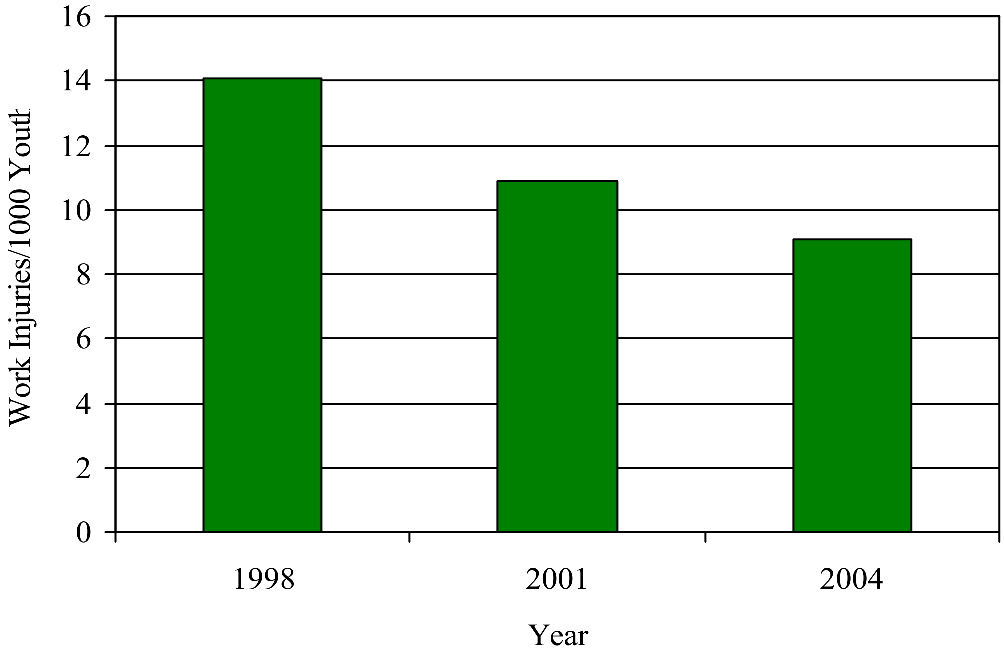


Figure 4-7: Work injuries per 1,000 household youths, 1998–2004. *Source: NIOSH CAIS.*

Males account for 58% of the household youths who work on farms, and have traditionally accounted for most of the work-related youths injuries occurring on farms. Farm injuries to young males on farms decreased 50%. A major part of this decrease was seen for work-related farm injuries to males that decreased from 11,800 in 1998 to 5,000 in 2004 [NIOSH CAIS]. The AFF Program feels it has made a contribution to this reduction in work-related farm injuries to youth.

4.1f External Factors

Even though research has indicated that education of farm workers, farm families, and youths on farms is needed to address the problem of youths injuries on farms, current child labor laws do not allow for regulatory options for youths on family farms. Therefore, education and engineering controls appear to be the only options for continuing the observed decrease in youths farm injuries.

Yet education and engineering controls are also subject to forces beyond our control. For example, education efforts can be hampered when effective surveillance methods are either unavailable or disrupted. The AFF Program is working with NCCRAHS and other external partners to better address prevention approaches for migrant and seasonal workers, an area NIOSH has not traditionally addressed. In the spring of

2005, DOL decided to discontinue NAWS. After receiving many comments from farm worker advocacy groups and Federal agencies (including NIOSH), DOL decided to retain NAWS, but not as an ongoing annual survey. DOL has not yet determined how often NAWS will be conducted, or what the sample size will be when data are collected. The AFF Program is continuing to work with DOL at this time; however, other options for collecting information for seasonal and migrant workers may be needed.

The lack of a systematic surveillance system for tracking nontraumatic MSDs (e.g., back, shoulder, and hand/arm disorders) for youths working in agriculture has made it difficult to determine the effectiveness of AFF Program efforts in this area. Without adequate surveillance data, it is not possible to obtain a true assessment of the current magnitude of the health problem, or to determine the effectiveness of any targeted interventions the AFF Program may propose. The AFF Program will continue to pursue novel surveillance methods to remove these barriers.

Changes in national leadership have also affected our work. The scope of the AFF Program recommendations on changes to HOs was delineated in interagency agreements between NIOSH and ESA in fiscal years 1999, 2000, and 2001. However, as the AFF Program report neared completion, the change in Administration in 2001 led to changes in leadership at DOL and ESA. The new leadership had no investment in the AFF Program report. In general, regulatory actions by DOL agencies have become increasingly difficult to initiate, as Federal agencies wishing to propose new rules are now required to evaluate the economic impact of these proposals. It is possible that the increased complexity of the rulemaking process has contributed to inaction by ESA on the HOs for agricultural occupations.

4.1g Future Directions

The AFF Program, through its Childhood Agricultural Injury Prevention Initiative, will continue to provide leadership in childhood agricultural injury prevention and surveillance, and will seek to address the recommendations in the National Action Plan and the 2001 Summit report. Plans are being developed for a public meeting and symposium to assess the progress and new emphasis areas for the initiative in fiscal year 2008.

Ongoing internal surveillance activities will be continued on a 3- to 5-year cycle. The AFF Program will continue its partnership with USDA, NASS. The CAIS and M-CAIS have proven to be valuable methods of data collection. In addition to filling a critical data need, the collection on nonwork farm injuries has proven to be informative. The ongoing nature of these two surveys will allow for tracking youths farm injury data over time, and the fact that some aspects of the surveys are dynamic and can be altered allows for incorporating lessons learned. Previously collected data has led to many interesting findings, including an increase in female youths farm injuries.

In the past year, the AFF Program has worked with USDA, NASS to conduct a survey of hazards on U.S. farms. Hazard surveillance systems offer several ways to improve safety and health: by identifying and quantifying exposures associated with many agricultural hazards, such as tractors without ROPS; targeting high-risk groups for intervention; evaluating the effects of engineering technologies; anticipating injury and illness; and disseminating important safety and health information to agricultural workers and farm families. After the completion of the current effort, the AFF Program will assess whether this approach should be repeated on a periodic basis similar to the CAIS and M-CAIS.

The AFF Program will continue to analyze data collected through the CPSC NEISS in the future. Current plans are to assess farm youths cases in NEISS every 3 to 4 years, depending on the number of cases available from the surveillance system.

The potential funding problems for the NAWS are a concern. If NAWS is not funded, the AFF Program will explore other options for collecting injury data on migrant and seasonal workers.

Research has shown that nonwork-related agricultural injuries remain a problem for youths on farms. The AFF Program has begun to examine some of the causes for these injuries, and will seek out additional external partners with experience in nonoccupational injuries to help address this problem.

A gap is the lack of a national surveillance program to track cases of chronic work-related MSDs in youths working in agriculture. Focus group participants, including both farm parents and farm youths, indicated that MSDs could be a problem, but no systematic collection of this type of data exists. Moreover, it is diffcult to determine the potential long-range impact of heavy physical work on farmworkers who grow up performing it from an early age. The AFF Program will continue to explore novel surveillance methods to improve the effectiveness of this MSD research program. Efforts are currently underway to develop training programs for youths that focus on identifying tasks with high risk of MSDs and ways to reduce the risk by using ergonomic principles and interventions.

4.1h List of NIOSH projects included in this section

- DSR-9278807-Fatality Assessment and Control Evaluation (FACE) Project (Appendix 3.3-01)
- DSR-9278870-State-Based Fatality Surveillance Using Face Model (Appendix 3.3-02)
- DSR-9278953-Childhood Agricultural Injury Surveillance (Appendix 4.1-01)
- DSR-VLE8866-Emerging Problems in Occupational Injury Epidemiology (Appendix 4.1-02)
- DSR-VLE8941-Injury Risk Factors in Migrant and Seasonal Workers (Appendix 4.1-03)

- DART-9277047-Workplace Hazards to Children and Adolescents in Agricultural Work Settings (Appendix 4.1-04)
- DART-927006E-Ergonomic Interventions for Youth Working in Agriculture (Appendix 4.1-05)
- DSR-9277187-Young Worker Health and Safety (Appendix 4.1-06)
- DSR-VLB8806-Surveillance of Occupational Injuries Among Children and Adolescents (Appendix 4.1-07)
- DSR-9278847-Emerging Issues in Injury Surveillance (Appendix 4.1-08)
- DSR-9278954-Childhood Agricultural Injury Prevention (Appendix 4.1-09)

4.2 Minority Populations

4.2 Goal: Reduce injuries, illnesses, and fatalities among migrant and minority farm workers.

4.2a Challenge or Issue

Health disparities by race and ethnicity have long been recognized in the U.S., but the field of occupational health has only recently given these issues attention [Frumken and Pransky, 1999]. There are numerous studies showing that agricultural workers in general are often exposed to hazards that cause injury or ill health [Kirkhorn and Schenker, 2002, Merchant et al.,1989], including: chemicals that may have long or short-term health affects [Beaumont, 1995] plants that may cause allergic reactions [Ballard 1995], heavy and/or awkward tasks that take their toll on the body's musculoskeletal system [Schenker, 1996; Villarego, 1999], livestock and machinery that may cause debilitating injuries including noise induced hearing loss [(McBride et al., 2003; Crutchfield and Sparks, 1991]and injuries or illness resulting from exposure to the elements [Arcury et al., 2002; Mobed et al.,1992;Calderon et al., 1993]. Restriction in access to health services, unfamiliarity with workplace health concerns, regulations, and disproportionate assignment to unsafe jobs may increase the risk of work-related illness or injury for minority workers [Frumken and Pransky, 1999]. Census data have shown that minority workers on average often have less education, lower income levels, and inferior housing. Cultural factors also exist that may put farm workers and farm operators at risk. Conceptions of health and disease among minority workers may also differ and lead to under-reporting of conditions.

Different farm worker groups have different problems. 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 people of 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.

Orchard workers are exposed to a variety of hazards that contribute to injury, disability, and death. Their work life and work activities vary by season and by the specific needs of the growers. Although picking fruit is often viewed as the primary role of the orchard workers, they are involved in a multitude of other tasks over the farming seasons. All of these activities are accompanied by hazards that may result in injuries and illnesses. Examples of commonly reported events are back injuries, eye injuries, sprains and strains, amputations, fractures, cuts, lacerations, burns and electrocutions, and poisonings (from chemicals and pesticides). Traumatic occurrences were related to improper operation of machinery as well as to livestock, ladders, and electricity. In addition to multiple physical hazards, orchard workers are often exposed to working conditions that increase their susceptibility to injury. For example, they may be required to work long hours under severe time constraints and their work may be hampered by weather conditions.

4.2b Activities

The AFF Program focus on minority workers in agriculture has lead to two distinct surveys of agricultural workers facing a variety of risk factors that impact occupational health: hired farm workers and farm operators (managers).

Hired Farmworkers

In 1995, NIOSH convened an expert panel on hired farm worker occupational health and safety. The panel issued an official report in 1998 that recommended new directions for surveillance of farm worker occupational health and safety. Priority areas identified in this report are musculoskeletal disorders, pesticide-related conditions, traumatic injuries, respiratory conditions, dermatitis, infectious diseases, cancer, eye conditions, and mental health. Using these recommendations as a starting point, NIOSH convened a two day working meeting in 1998 to develop the questions for the October 1998 - September 1999 Health Supplement to the National Agricultural Workers Survey (NAWS). Researchers from community organizations and research agencies with expertise in farm worker health attended the meeting. They represented academic institutions, industry, migrant advocacy groups, agricultural extension services, and government agencies, including the Department of Labor (DOL), Environmental Protection Agency (EPA), Food and Drug Administration (FDA), National Cancer Institute (NCI), Health Research and Services Administration (HRSA), and Occupational Safety and Health Administration (OSHA). (Appendix 3.2-03)

A draft questionnaire was developed in collaboration with external partners. It was translated into Spanish, and pilot tested in 1998 with farm workers in several regions of the country. Following the pilot testing, a meeting was held with AFF Program researchers and NAWS field staff to review the pilot test results and revise the questionnaire. A second set of pilot tests and final revisions followed. Once the questionnaire was finalized, a two day training session was held with the core field interviewer staff. Following the first NAWS cycle of 1999, modest alterations were made based upon input from the field interviewers. The Supplement's main purpose was to obtain national prevalence estimates for variables related to the occupational health of farm workers. Topics covered in the occupational health supplement included: pesticide safety training; pesticide handling and personal protective equipment; field sanitation; musculoskeletal pain/discomfort; skin conditions; respiratory symptoms; gastrointestinal illnesses; physician diagnosed health conditions; cigarette and alcohol use and quality of, and access to health care. The full supplement was administered in 1999, and some questions continued to be included in later years.

The survey found that hired farm workers and migrant workers are likely to be younger due to the strenuous physical demands of farm work. Low English literacy may have implications for health due to inability to read and understand warning signs, instructions, educational pamphlets, and other safety materials. In addition, because many farm workers are new to the United States, they may be unaware of laws that are in place to protect their health. They also may be unaware of health hazards. Due to their migratory lifestyle, many farm workers also experience a loss of social support, which is exacerbated by the fact that many also leave spouses and children behind. In addition, moving for work may also mean that a worker is unfamiliar with services available in the place they are working, which may result in an inability or hesitance in seeking preventative or necessary health care. Lack of legal status may affect farm workers' access to health care services, as well as seeking of medical care. Pesticide exposure may be increased due to housing proximity to fields and contamination of work clothes from the fields. Many of the hired farm workers are Latino, and a large number are also immigrants. They may be victims of various types of discrimination and subject to employment or other schemes. In contrast to the hired farm workers, farm operators or managers are frequently citizens, owners of their farms, older, and have higher socioeconomic status.

Data analyses, presentations and publications from this survey effort have been ongoing. A second phase of data collection with a focus on mental health, psychosocial factors and work organization has been underway. A national meeting of experts was held and a survey instrument was developed and translated. The questions underwent cognitive testing and piloting in FY06. The future of this survey is unknown and depends on external factors noted below.

Farm Operators

The farm operator survey was developed in collaboration with USDA and other AFF Program investigators [USDA/NASS 2002]. The opportunity to add survey questions developed with short notice as investigators needed to follow the timeline of a survey ready to be administered in the field. Investigators conducted reviews of the literature, and other national health surveys, as well as the NIOSH Farm Family and Health study, and contacted experts in the field of agricultural safety and health. (Appendix 4.2-01)

The USDA conducted the Minority Farm Operator Occupational Health Survey on behalf of the AFF Program in 2000. A stratified simple random sample of farm operators from all States was selected for interview. Hispanic/Latino, minority, and female farm operators were over-sampled. Because of a low response rate, an additional sample of Latino farm operators from California, Arizona, New Mexico, and Texas were selected for face-to-face interview to further increase the sample size. AFF Program investigators provided training for interview supervisors, and observed some of the piloting of the interviews. The response rate was 53%. Of the 7,137 respondents for whom data was available for analysis, 5,697 (80%) were farm operators, and 1,440 (20%) were farm operators' spouses (proxies), with 88% interviewed by telephone, and 12% interviewed in person. Data analyses conducted thus far include calculations of estimated prevalence of general health conditions, hearing loss, access to medical care, and mental health symptoms.

Both the Occupational Health Supplement to the NAWS and the Minority Farm Operator Occupational Health Survey were conducted in collaboration with the Office of Policy Analysis at DOL, the Health Resources and Services Administration (HRSA), and the National Agricultural Statistics Service (NASS) at USDA. Other organizations that have been consulted are *agricultural organizations* such as the National Center for Farmworker Health, Migrant Health Clinics, and the New York Center for Agricultural Safety and Health. *University academic departments* have also been collaborators, including Wake Forest School of Medicine, University of Toronto, and the University of California Davis. *Research organizations* such as Aguirre International (now called JBS International) have also collaborated with us.

One of the program's extramural components has done activities to define the epidemiology of migrant injury on a regional basis. A focus group study in 1996 led to a decision to base future surveillance upon medical records rather than interview data. A 2002 study, Estimation of New York State Migrant and Seasonal Farmworkers enabled comparison of the results to the enumeration performed by DOL. It showed substantial differences, suggesting an undercount by the DOL methodology of nearly 50 percent of the total workers in some areas.

Activities Related to the Navajo

Extramural AFF Program researchers enlisted the participation of the Cooperative Extension Service (CES) assigned to the Navajo Nation to address Navajo safety and health needs. With stakeholder input, we developed training modules on cattle handling safety, animal flight zone and appropriate use of chutes and gates to manage the animals. The module included a video, "Cattle Handling Safety" developed by the research team. The program was offered at least once in each of the 30 Chapter House areas. Chapter Houses are Navajo geographic designations for working cooperatives. 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, we 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). 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.
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. Another area of concern is that children are especially susceptible to drowning during flash flooding. An educational video in the Navajo language, called "Ditch Witches," has been acquired and distributed throughout the Navajo Nation.

Activities Related to Orchard Workers

Extramural AFF Program researchers engaged the Hispanic farm worker community through two community based participatory research projects in Washington and Idaho. They established the Northwest Community Health Worker Network and Listserv. They also trained clinicians in the diagnosis, treatment, and prevention of pesticide poisonings through training of community health workers and professional education.

Another group of extramural AFF Program researchers conducted an observational study in orchards in 1999. It recognized ergonomic problems and led to a series of orchard ergonomic intervention efforts. A pilot ergonomic study in 2001 resulted in modifications to orchard baskets aimed at displacing some of the weight of the basket from the shoulders to the hips. This change appeared to be successful. Interviews with workers involved in the trial indicated that well over 80 percent preferred the new design. The trials did point out several problems with the design that are currently being pursued.

4.2c Selected Outputs

One NIOSH document is in progress from the Hired Farmworkers survey effort: Occupational Health of Hired Farmworkers in the United States, National Agricultural Workers Survey Occupational Health Supplement, 1999 (undergoing review). It summarizes results from the survey. It will be sent to key migrant researchers, agricultural health centers, and made available on the NIOSH and DOL websites. A paper for publication in the peer-reviewed literature is underway. The National Center for Farmworker Health is eager to assist in dissemination of study results. Data will be shared with migrant health clinics, HRSA, DOL, Migrant Health Promotion, and Institutes at NIH, as well as agricultural researchers and workers at

Migrant Stream forums. This surveillance activity will provide data that is seriously lacking. It may have an impact on the health of migrant farm workers (Appendix 3.2-03).

Materials for migrants and minorities have been included in the National Agricultural Safety Database (NASD) (Appendix 4.2-02). NASD is a national repository of agricultural health, safety, and injury prevention materials for the agricultural community, especially for adaptation by agricultural safety specialists. This database contains a large compendium of educational and information resources organized by topic, state, language (Español), and form (e.g., fact sheet, news release, script, video abstract, poster). Both the Spanish and English versions of the NIOSH document *Simple Solutions: Ergonomics in Agriculture* are included.

Our efforts with orchard workers resulted in 15 publications, four questionnaires, a tool for identification of depression and other mental health disorders, courses, workshops, and websites.

A complete list of outputs can be found in section 4.5 at the end of this chapter.

4.2d Intermediate Outcomes

Testimonials of Intended Use from extramural AFF Program efforts

After a 2006 pesticide training workshop:

“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.”

"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

External Factors

These data were collected with the assistance of the Department of Labor. The NAWS survey was originally handled through the Office of Policy and Analysis, and in 2005 moved to the Education and Training Administration of DOL. DOL contracted with Aguirre International to conduct in-person interviews throughout the United States. JBS International recently bought Aguirre International. The Minority Farm Occupational Health Survey was conducted with the assistance of the USDA National Agricultural Statistics Service. Workers in the USDA’s state offices conducted computerized telephone interviews. Both surveys were done in collaboration with the NIOSH Divisions of Safety Research, and Respiratory Diseases. Approval of OMB expires in March 2007. DOL has decided not to conduct the NAWS until new approval is granted (Appendices 3.2-03, 4.2-01).

4.2e Future Directions

Work will continue to disseminate data from these two surveys. The future of a mental health, psychosocial and work organization supplement to the NAWS will depend on receipt of OMB clearance and successful negotiation of an interagency agreement with DOL to conduct the survey. Data from the 2006 survey of Minority Farm Operators will be available for analyses in FY2007-2008 (Appendices 3.2-03, 4.2-01).

4.2f List of NIOSH projects included in this section

- DSHEFS-9277323-Minority Farm Operators (Appendix 4.2-01)
- EID-9278040- National Agriculture Safety Database (Appendix 4.2-02)
- DSHEFS-9278639-National Agricultural Workers Survey (Appendix 3.2-03)

4.3 Logging

4.3 Goal: Reduce injuries, illnesses, and fatalities among logging workers.

4.3a Challenge or Issue


Logging Fatalities in the United States by Region, Cause of Death, and Other Factors — 1980 through 1988

John R. Myers and David E. Fosbroke

Logging has consistently been one of the most hazardous industries in the United States. Fatality and injury statistics from as early as 1955 reported a fatality rate of 214 deaths per 100,000 workers and a nonfatal injury rate of 16 injuries per 100 full-time workers [McCormack 1963]. These statistics changed little over the next three decades. In the 1980s, the average occupational fatality rate for logging was 161 deaths per 100,000 nonmanagerial workers—a rate 23 times the prevailing occupational fatality rate for all U.S. workers at that time [Myers and Fosbroke 1994]. The nonfatal injury rate for logging in 1988 was 19.6 injuries per 100 full-time workers, which was more than twice the injury rate for all U.S. workers that year [BLS 1990].

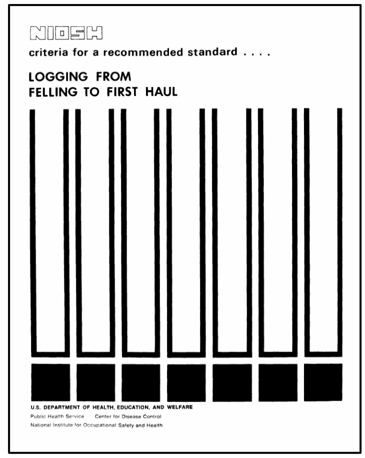
The purpose of logging is to harvest trees and transport them to a processing facility. How this is accomplished varies widely depending on where the logging is being done in the United States, the type of tree being harvested, and the harvesting techniques used. NIOSH research published in 1994 found that fatality rates differ greatly across the United States, with the highest rates found in regions using manual harvesting methods in naturally occurring forested stands where the primary product was saw timber and where no logging safety standards existed within the region [Myers and Fosbroke 1994]. In addition, the U.S. logging workforce is considered to be fairly isolated and less organized compared with other workforces [Egan 2002].

4.3b Activities

Given the high injury and fatality rates and the diversity of work methods within the logging industry, the AFF Program adopted a multiprong approach to address the injury problem. This approach included supporting OSHA's adoption of a national standard for the logging industry, coordinating a State-wide intervention program in Alaska to address occupational injuries and fatalities associated with helicopter logging, conducting investigations of selected logging fatalities through the FACE program, and assessing mechanical logging methods as a means for reducing injury risks.

Development of a National Logging Standard

In 1976, NIOSH published *Criteria for a Recommended Standard: Logging from Felling to First Haul* [NIOSH 1976]. This document provided OSHA with sufficient information to formulate a national standard for the logging industry. At that time, OSHA had adopted an existing ANSI standard for pulpwood harvesting as a national consensus standard, but it did not address saw timber harvesting. No action was taken by OSHA on a logging standard that would address both pulpwood and saw timber harvesting until 1989, when the agency requested comments on a proposed rule for the entire logging industry. This new standard was based largely on the 1976 NIOSH criteria document.



Between July 31, 1989, and October 19, 1990, NIOSH provided three sets of comments to OSHA supporting the proposed logging rule. The AFF Program provided data from the NTOF surveillance system to support the standard. NIOSH also provided OSHA with recommendations about 1) including multiple safe felling techniques, 2) making changes to the snakebite section of the standard, 3) improving work area organization and communications, 4) using ROPS and FOPS, and 5) prohibiting certain unsafe harvesting techniques. Through NIOSH, the AFF Program provided follow-up comments on July 24, 1990, to emphasize the importance of worker training in safe chain saw use, to re-emphasize the importance of ROPS and seatbelts on logging equipment, and to recommend that all workers be trained in basic first-aid and cardiopulmonary resuscitation. In 1994, OSHA adopted the final standard, which incorporated the majority of the recommendations made by the program [59 Fed. Reg.[2] 51672 (1994)].

Advancements in Helicopter Logging Safety

Because of changing environmental restrictions on road building in Alaska's national forests in the late 1980s and early 1990s, helicopters emerged as a major transportation mode for moving cut logs from logging sites. Amid the rapid growth of this new industry in Alaska, serious occupational safety and health issues quickly emerged. Between January 1, 1992, and June 30, 1993, six helicopter crashes occurred within the Alaska logging industry (Table 4-7), resulting in nine fatalities and 10 severe injuries. An even greater concern was that these six events occurred among only 25 helicopters flying in Alaska logging operations. These events led to an extraordinarily high annual crash rate of 16% and a catastrophic annual fatality rate of 5% (5,000 deaths per 100,000 pilots). NIOSH investigations revealed that all crashes involved improper operation and/or maintenance practices. (Appendix 4.3-01)

---

[2] *Federal Register*. See Fed Reg. in references.

Table 4-7. Alaska logging helicopter incidents investigated by the AFF Program between January 1992 and July 1993				
Date	**No. of deaths**	**No. of injuries**	**Type of helicopter**	**Logging company**
2/23/1992	6	5	Manufacturer A, Type A Single engine	A
3/6/1992	0	2	Manufacturer A, Type A Single engine	A
11/10/1992	0	0	Manufacturer A, Type B Single engine	A
2/19/1993	2	0	Manufacturer A, Type A Single engine	B
5/2/1993	1	1	Manufacturer A, Type C Single engine	B
5/8/1993	0	2	Manufacturer A, Type A Single engine	B

After the occurrence of two serious logging helicopter crashes during one week in May 1993, NIOSH began a series of urgent consultations culminating in an emergency session of the Alaska Interagency Working Group for the Prevention of Occupational Injuries in early July 1993. Members of this committee included representatives from the Federal Aviation Administration, National Transportation Safety Board, U.S. Coast Guard, U.S. Forest Service, OSHA, the Alaska Department of Labor, the Alaska Department of Social Services, and NIOSH. Before this meeting, NIOSH developed a draft helicopter logging event matrix to identify risk factors contributing to these crashes (Table 4-8).

The prevention-matrix approach resulted in the development of new recommendations to address these factors by the Alaska Interagency Working Group (Table 4-9). By late July 1993, all helicopter logging sites and ramps in the State had been visited by the appropriate jurisdictional agencies. These inspections resulted in having a number of operations curtailed or entirely shut down for irregularities. Since the initial actions of the Alaska Working Group in 1993, only one logging helicopter crash has occurred in the State of Alaska.

A logging helicopter crash-Dora Bay, AK

Table 4-8. Risk factors contributing to crashes during Alaska helicopter logging events*			
	Host/human	**Agent/vehicle**	**Environment**
Pre-event/ pre-injury factors	Pilot training and experience Fatigue Stress Alcohol use Ground crew training and experience	Helicopter lift and durability Maintenance and repairs Engines and controls Ergonomics Unstable work platform Surplus/improvised equipment	Terrain Weather Landing zones Oversight FAA (CFR† Part 133) of industry
Event/injury factors	Pilot reaction to emergency situation (i.e., autorotation) Task overload Ground crew reacting and avoiding	Helicopter autorotation performance Deformation on impact Fires and explosions	Terrain Weather
Post-event factors	Types of injury Severity		Little assistance available or EMS not available

*Based on investigations conducted by the AFF Program.
†Code of Federal Regulations. See CFR in references.

Table 4-9. Alaska helicopter logging injury countermeasures from the Alaska Interagency Working Group for the Prevention of Occupational Injuries, July 1993

Risk factor	Host/human	Agent/vehicle	Environment
Pre-event/ Pre-injury	Increased training for pilots and ground crew Improved work/rest cycles	Maintenance per manufacturer's recommendations Impact (g)- resistant seats NTSB - to prohibit surplus equipment	Improved interagency communication Increased FAA oversight
Event/Injury	Practical training in autorotation	——	Emergency (backup) landing zones
Post-event	——	——	——

<u>Logging Fatality Investigations</u>

NIOSH established the FACE Program in 1982, with the primary goal to conduct detailed investigations of selected fatalities within the United States and to make clear recommendations about how such deaths can be prevented. During its 25 year history, FACE has targeted several categories of occupational fatalities, addressing such hazards as confined spaces, electrocutions, falls, and machinery (Appendices 3.3-01, 3.3-02).

In 1991, the decision was made to expand the FACE model beyond a cause-specific model to include an industry sector component. Because of its high fatality rates, the logging industry was added as a target within FACE in 1991. To identify logging–related fatalities, the AFF Program collaborated with State or Federal OSHA offices within Alaska, North Carolina, South Carolina, Virginia, and West Virginia. In addition, they collaborated with the Allegheny County Corner's Office in Pennsylvania and the State Medical Examiner within the State of West Virginia. Between 1991 and 1996, the AFF Program investigated 22 fatalities associated with logging. At that time, NIOSH decided to remove logging as a targeted area for the

FACE program. Since 1996, four additional logging-related fatalities have been investigated as part of the FACE program. Two investigations were conducted in conjunction with the West Virginia State-FACE program to provide the State investigator with training in conducting investigations of logging fatalities. The remaining two investigations examined fatalities that occurred within the logging industry and involved other FACE priority areas (Hispanic workers and Machinery deaths). Table 4-10 summarizes these investigations.

Table 4-10. Number of AFF FACE investigations by cause and location of fatal event, 1991 through 2004.

Number of Investigations	Cause of fatal event	Location of fatal event
15	Falling trees/snag	Arkansas (1), North Carolina (1), Pennsylvania (2), South Carolina(3), Virginia (1), West Virginia (7)
4	Machinery	North Carolina(2), South Carolina (2)
3	Rolling logs/debris	Arkansas (3)
2	Chainsaw	South Carolina (1), West Virginia (1)
2	Loading/unloading	Arkansas (1), North Carolina (1)

As part of the FACE investigation process, we began identifying partners who could help disseminate FACE results and recommendations to the logging community. This was accomplished by providing FACE logging reports to the APA (which is now part of the Forest Resources Association [FRA]). APA would condense the information from a FACE logging report into a one-page document, incorporate the prevention recommendations, and distribute these to their members as safety news bulletins.

Evaluation of Mechanical Harvesting Techniques

Because of the high injury rate in logging, many State and Federal agencies as well as logger and industry groups have been working on ways to make logging safer. As part of this interest in identifying safer logging techniques, the AFF Program conducted a retrospective study to evaluate the impact of mechanized harvesting techniques on reducing logging injuries [Bell 2002]. The evaluation was based on the injury claim rate among West Virginia logging companies over the 6-year period from 1995 to 2000. (Appendix 4.3-02)

The study looked at the injury claim rate in 11 companies that used mechanized tree fellers. The overall injury claim rate for these companies was examined for about 2 ½ years before and about 2 years after they started using mechanical felling machines. The injury claim rate dropped significantly after mechanized felling began. The injury claim rate was 19.4 per 100 workers before mechanized felling compared with 5.2 per 100 workers after mechanized felling began. The injury claim rate for the rest of the West Virginia logging industry not using feller bunchers was 16.6 per 100 workers.

Feller buncher harvesting hardwood trees.

AFF Program staff also compared workers' compensation injury claim rates for 20 fully or partially mechanized companies and 68 nonmechanized (fully manual) companies participating in the West Virginia Logging Safety Initiative (LSI). Access to these data was made possible through collaboration with the West Virginia Forestry Association, the West Virginia Workers Compensation Commission, and the West Virginia Bureau of Employment Programs. This LSI program provided training to these companies to reduce the frequency and severity of logging injuries. The mechanized companies had an injury claim rate that was less than half that of the nonmechanized companies during the time they were in the LSI. This result demonstrates that mechanization can produce large reductions in injury claims, even within an LSI-trained group of loggers. It also highlighted the fact that even partial mechanization has substantial injury prevention benefits

4.3c Selected Outputs

Peer-Reviewed Publications

One AFF Program paper provided information showing that mechanized logging operations result in fewer injuries compared with manual timber felling operations. The State of West Virginia is looking at changing its workers' compensation rates based on a study by Bell [2002], which associates changes in logging injury rates with the use of feller bunchers in West Virginia.

Another AFF Program paper was the first peer-reviewed article using NTOF data that described fatal injury risks for loggers and how these risks vary in different parts of the United States [Myers and Fosbroke 1994]. This paper has been cited at least 19 times.

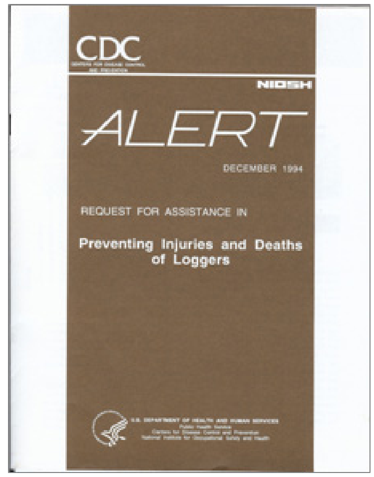
Conferences

Major workshops that lead to the adoption of helicopter logging standards within the State of Alaska and elsewhere include three workshops between 1993 and 1997 addressing the issue of helicopter logging crashes. The proceedings from these workshops are available in the NIOSH [1998], Helicopter Logging Safety: Alaska Interagency Working Group for the Prevention of Occupational Injuries.

NIOSH Testimony

Testimony by NIOSH that influenced the final OSHA logging standard (especially in the areas of safe work practices, training, and first-aid requirements) is included in NIOSH. [1989], *NIOSH Testimony on Logging Operations, July 31, 1989*.

Government Publications



On the basis of common risk factors identified in the FACE logging investigations, the AFF Program prepared a publication entitled *NIOSH Alert: Request for Assistance for in Preventing Injuries and Deaths of Loggers* in December 1994 [NIOSH 1994]. The Alert provides summaries of logging fatality statistics during this period, a synopsis of six fatal logging events, and a list of recommendations for logging operators and workers to prevent similar events in the future. As with the individual FACE reports, assistance was provided by APA to distribute this Alert to logging operators across the United States.

A criteria document prepared in 1976 [NIOSH 1976] was the basis for the final 1994 OSHA Logging Standard. The criteria document was entitled *NIOSH Criteria for a Recommended Standard: Logging from Felling to First Haul*.

Proceedings for the helicopter logging workshops highlighted above are contained in NIOSH [1998], Helicopter Logging Safety: Alaska Interagency Working Group for the Prevention of Occupational Injuries.

The AFF Program's peer-reviewed journal articles on logging have been cited 32 times in a variety of scientific journals (*Current Industrial Medicine Bulletin, Applied Ergonomics, Injury Prevention, Occupational Hazards, American Journal of Industrial Medicine, Journal of Safety Research, International Journal of Environmental and Occupational Health, Applied Ergonomics, Journal of Occupational and Environmental Medicine, Human and Ecological Risk Assessment, Journal of Forestry, Canadian Journal of Forest Resources, Forest Ecology and Management, Journal of Wildlife Management,* and *Forest Operations Review*).

NIOSH Web Sites

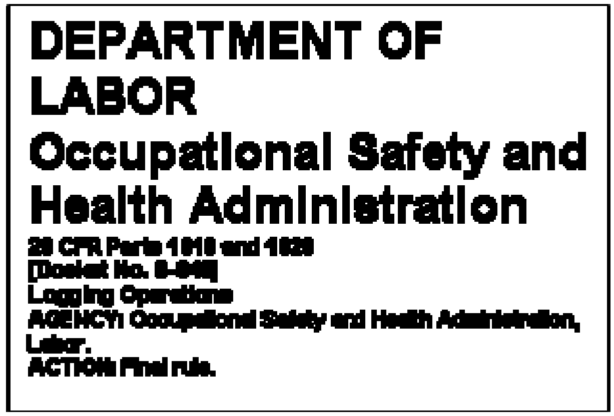
Logging Topic Page: http://www.cdc.gov/niosh/injury/traumalog.html#nioshpubs

FACE Logging Page: http://www.cdc.gov/niosh/injury/traumalgface.html

A complete list of outputs can be found in section 4.5 at the end of this chapter.

4.3d Intermediate Outcomes

OSHA used the NIOSH criteria document for a proposed logging standard [NIOSH 1976] as the basis for the 1994 OSHA logging standard [29 CFR[3] 1910.266]. Additional NIOSH recommendations for first-aid training requirements prohibited felling practices, personal protective equipment use, and equipment training requirements were adopted by OSHA in their logging standard.



DEPARTMENT OF LABOR

Occupational Safety and Health Administration

29 CFR Parts 1910 and 1928
[Docket No. S-048]
Logging Operations
AGENCY: Occupational Safety and Health Administration, Labor.
ACTION: Final rule.

Our findings from investigations of helicopter logging fatalities provided the basis for the development of interventions by the Alaska Interagency Working Group for the Prevention of Occupational Injuries in the summer of 1993 to prevent similar crashes in the future. These interventions included helping agencies such as the FFA, U.S. Forest Service, and the Alaska Department of Labor to share information about helicopter logging operations and thereby provide the basis for implementing these recommendations.

In March 1995, the Alaska Interagency Working Group for the Prevention of Occupational Injuries and the AFF Program cosponsored a Helicopter Logging Safety Workshop resulting in an improved prevention matrix for use in the logging industry. Additional workshops were held in 1996 and 1997 [NIOSH 1998]. Building on Alaska's leadership in this area, a Helicopter Logging Safety Committee was formed under the auspices of the HAI in January 1997. The goal of the committee is "to help promote the safe use of helicopters in all aspects of the helicopter logging industry." The committee has established its own helicopter logging guidelines, which address four issues: (1) general helicopter safety for forestry operations, (2) integration of ground and flight activities, (3) helicopter specific planning, and (4) a pre-accident plan [HAI 1997].

On the basis of HAI activities initiated by the AFF Program, the insurance industry has become involved by substantially discounting helicopter insurance costs for operators adhering to standards developed by the HAI Helicopter Logging Safety Committee.

Reports of AFF Program FACE investigations of logging fatalities were adapted by the APA (now part of the FRA), who distributed the case summaries and prevention recommendations to their membership.

[3] Code of Federal Regulations. See CFR in references

In 1997, the Instituto Mexicano Del Seguro Social, through the Pan American Health Organization's Center for Human Ecology and Health, requested assistance from the AFF Program to evaluate logging and wood processing plants in the Mexican State of Durango. In addition, the AFF Program was asked to provide training on how to plan and carry out injury and fatality investigations. The Program assigned the lead FACE logging investigator to Durango. During this assignment, nine site assessments were conducted with a class of 35 Mexican occupational medicine residents as part of the training process. These sites included active logging areas, sawmills, wood products processing facilities, and a paper mill. Hazard assessments were conducted for each site, and recommendations for hazard remediation were provided to the Instituto Mexicano Del Seguro Social.

Beginning in 1989, NIOSH decided to export the FACE model to the State level through its cooperative agreement and grants process. This resulted in the establishment of the State-FACE program. The primary purpose of State-FACE is to provide State health departments and other appropriate State agencies with the necessary training and resources to conduct FACE investigations for occupational fatalities occurring within their State. Since its inception, 22 States have participated in the State-Face program (Figure 4-8).

As part of this process, States are asked to conduct investigations of targeted fatalities identified by the NIOSH FACE program; however, States may also identify their own targeted investigations as well. For logging-related deaths, 65 State investigations were conducted between 1992 and 2004 in 12 different States (Table 4-11). Three States also identified logging fatalities as a State priority within their program. These were the States of Alaska, Kentucky, and West Virginia. Copies of all the State-Face logging reports are available on the NIOSH website: http://www.cdc.gov/niosh/injury/traumalgface.html.

Table 4-11. State-FACE logging-related fatality investigations by State, 1992−2004

State	Logging fatality investigations
Alaska	12
California	1
Indiana	1
Kentucky	21
Michigan	1
Missouri	1
New Jersey	1
New York	4
Oregon	4
Washington	3
West Virginia	13
Wisconsin	3

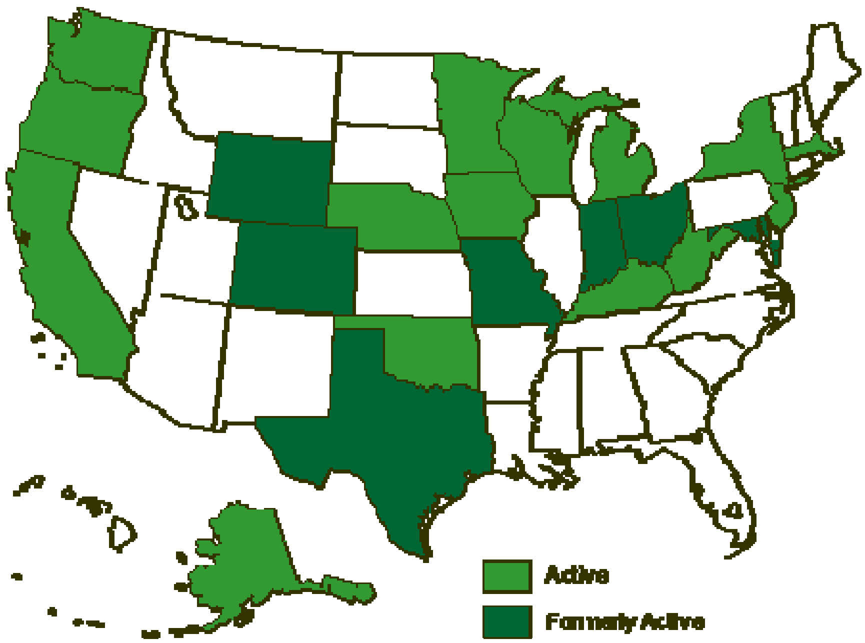


Figure 4-8: States that have or are currently participating in the NIOSH State-FACE Program.

The FRA continues to distribute the findings of NIOSH scientific research to its members. The Technical Release (05-R-31) *Mechanized Felling Reduces West Virginia WCI Claims* [NIOSH 2005] (based on the *Journal of Safety Research* publication) won an award in the FRA Appalachian Region Technical Writing Award Competition. It was also featured in their *Forest Operations Review* publication and featured in the July 2005 issue of *Occupational Hazards,* a general safety publication.

Intervention evaluation research by the AFF Program has shown that mechanized logging systems decrease injury rates in hardwood harvesting operations in the State of West Virginia. On the basis of these results, the West Virginia Workers' Compensation Board is holding meetings on incentives for logging companies, including establishment of a lower separate rate for mechanized logging companies. These lower rates could be instituted as early as January 2007.

4.3e End Outcomes

Since the initial release of the proposed OSHA logging standard in 1989, the national occupational injury and illness rate for the logging industry decreased from 19.5 to 6.4 cases per 100 full-time workers in 2003 (Figure 4-9) [BLS 2006].

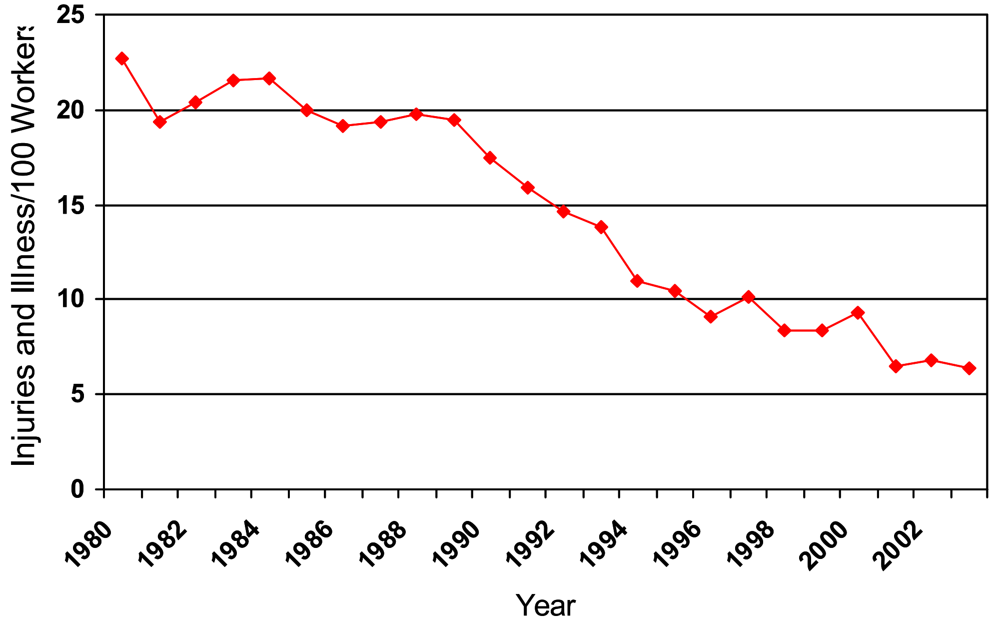


Figure 4-9: Occupational injury and illness rates per 100 full-time workers, 1980-2003.
Source: Bureau of Labor Statistics Survey of Occupational Injuries and Illness.

Nationally, occupational fatality rates have decreased from between 1984 and 2001, based on data from the NTOF surveillance system. Trends identified within NTOF are supported partly by logging fatality rates based on the BLS CFOI (Figure 4-10).

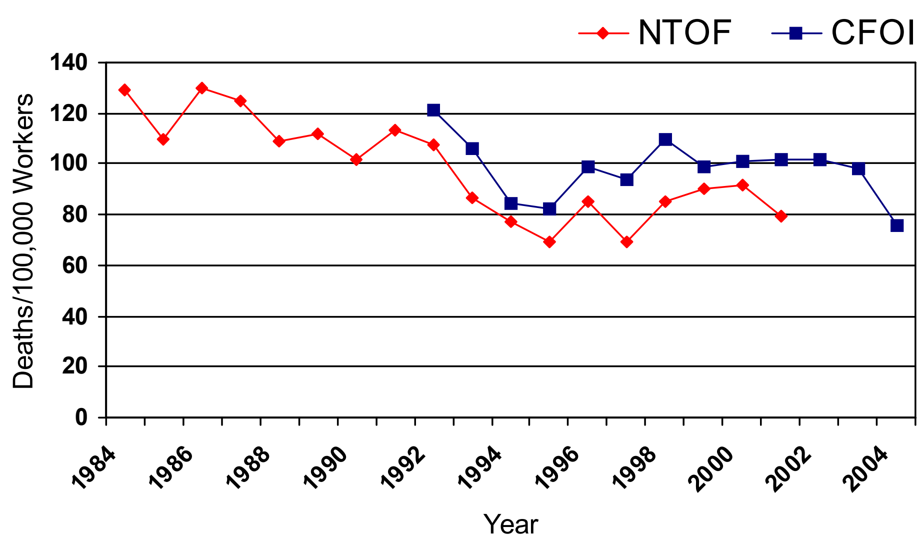


Figure 4-10: Occupational fatality rates for logging industry based on two fatality surveillance systems: NTOF [NIOSH 2006b] and CFOI [BLS 2006]

The six year average logging fatality rate before OSHA promulgated a national logging standard (based largely on the 1976 NIOSH criteria document [NIOSH 1976]) decreased 30% when compared with the 6-year period 1996-2001 (Figure 4-11).

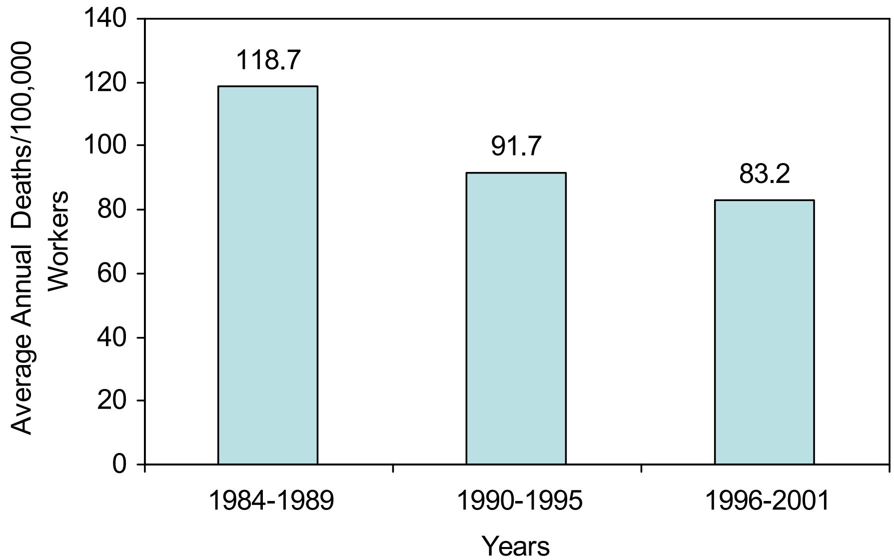


Figure 4-11: Changes in annual average logging fatality rates for three 6-year time periods between 1984 and 2001 *Source: NTOF [NIOSH 2006b]*

The AFF Program activities and outputs contributed to these declines.

Since the intervention and the implementation of the Alaska Working Group's recommendations to prevent helicopter logging crashes in July 1993, only one additional helicopter logging crash has occurred in Alaska. This July 1996 crash resulted in one fatality (Figure 4-12). No additional crashes have been reported in the State since that time.

AFF Program FACE investigations and reports conducted between 1991 and 1997 targeted two of the leading causes of death in logging—being struck by falling objects and machinery events. The summaries and recommendations were distributed nationally through the APA. Stuck by falling object rates decreased 38% and machinery deaths decreased 48% from the 6-year period 1984−1989 to the 6-year period 1996−2001 (Figure 4-13) [NIOSH 2006b]. AFF Program activities are likely to have contributed to that outcome.

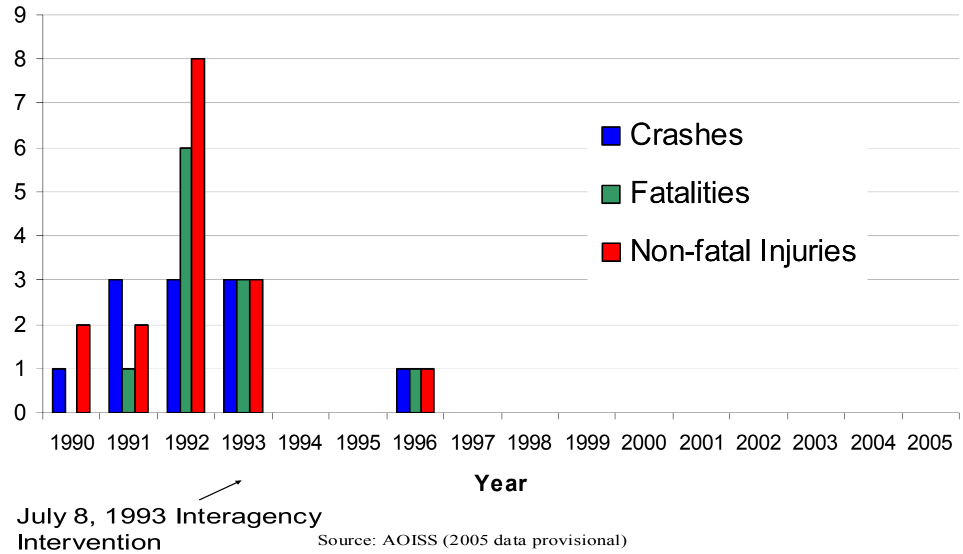


Figure 4-12: Crashes, fatalities, and nonfatal injuries in Alaska helicopter logging operations, 1990–2005. *Source: Original graph NIOSH AOISS [NIOSH 2002], updated through 2005 for this volume.*

4.3f Future Directions

The most recent BLS data from 2005 show that loggers still have the most dangerous occupation in the Nation, with a fatal injury rate of 92.4 deaths per 100,000 workers. The AFF Program will focus on quantifying determinants of State-level variations in logging fatality rates as an extenstion of the 1994 NIOSH publication [Myers and Fosbroke 1994] and OSHA's review of logging fatalities [OSHA 2000]. The program may also undertake a larger-scale study of the effect of in-the-field performance monitoring inspections on injury rates. A study of the barriers to job tenure in loggers (particularly for workers whose primary job task is chainsaw operator) is also warranted.

4.3g List of NIOSH projects included in this section

- AFS-9278893-Occupational Injury Prevention in Alaska (Appendix 4.3-01)
- DSR-9278807-Fatality Assessment and Control Evaluation (FACE) Project (Appendix 3.3-01)
- DSR-9278870-State-Based Fatality Surveillance Using Face Model (Appendix 3.3-02)
- DSR-9277123-Evaluating the Effectiveness of a Logger Safety Training Program (Appendix 4.3-02)

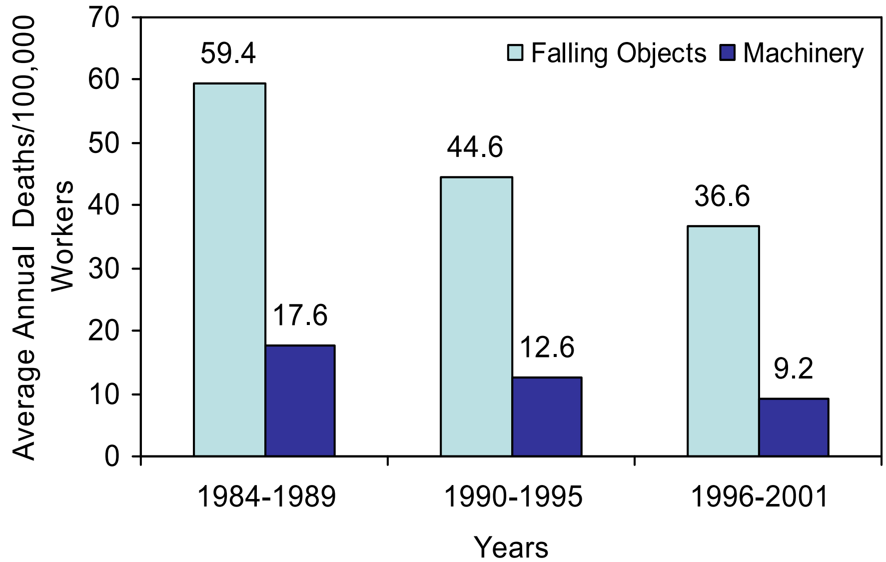


Figure 4-13: Changes in annual average logging fatality rates for three 6-year periods between 1984 and 2001: deaths due to falling objects and machinery. *Source: NTOF [NIOSH 2006b].*

4.4 Fishing

4.4 Goal: Reduce injuries, illnesses, and fatalities among commercial fishermen.

4.4a Challenge or Issue

Fishing crew on purse seine fishing vessel

Not long after the NIOSH Alaska Field Station (AFS) was established in 1991, it was clear that deaths related to commercial fishing were a principal contributor to Alaska's very high occupational fatality rate. Commercial fishermen face unique and extreme environmental risk factors because of the vast geography of the State, the remote locations of many fishing grounds, and lack of nearby rescue and emergency response systems. Alaskan commercial fishermen work the coldest waters of the United States. Cold weather and cold water contribute to worker fatigue and may exacerbate subsequent injuries. In 1991, the AFF Program began to examine work-related fatalities in Alaska. Early surveillance data for commercial fishing fatalities showed that fatalities were primarily due to vessels sinking and falls overboard.

Unlike fatalities in the commercial fishing industry, most (67%) severe nonfatal injuries occur on deck during the deployment and retrieval of fishing gear in Alaska. The deck of a fishing boat is an unstable work platform that is constantly moving and often congested with machinery and fishing equipment. Much of the machinery and work processes in current use on commercial fishing vessels are rudimentary and have inadequate guarding or other safety measures. Injuries related to machinery and fishing equipment accounted for 40% of nonfatal injuries. These machinery-related injuries resulted from cables, chains, lines, winches, hydraulic "pot launchers," and other deck equipment. Being caught in a winch caused 35% of these machinery injuries. Another 27% were due to falls.

4.4b Approach

The AFF Program set a goal in the early 1990s to decrease commercial fishing fatalities (and the commercial fishing fatality rate) 50% by 2005. In 1991−1992, we established data-sharing agreements with the USCG and Alaska State Troopers and conducted our first direct onsite investigations of several fishing fatalities. We designed and implemented a comprehensive surveillance system for occupational fatalities, the AOISS. During this time, the AFF Program established a relationship with the State of Alaska and is able to use Alaska Trauma Registry (ATR) data for serious injuries resulting in hospitalizations for injury surveillance purposes. Through these methods, a comprehensive occupational injury surveillance system was established for all work-related injuries (fatal and serious nonfatal) that occurred in Alaska. We use injury information from both the ATR and AOISS to assess the most hazardous problems that commercial fishermen face, such as vessels sinking, falls overboard, and deck injuries. We have also identified high-risk groups based on type of fishing (e.g., crab fishing) and type of gear used in the fishing process (e.g., booms and deck winches) that deserve extra attention to create safe interventions. In addition to these surveillance activities, our scientists formed and facilitated an Interagency Working Group (IAWG). Members of this working group included experts from many organizations including the USCG, the AMSEA, and the NPFVOA.

We provided a scientific assessment of the most serious problems and identified high-risk groups. We supported the development of interventions through the IAWG, and evaluated interventions that have been implemented. We have also provided technical assistance on issues to provide scientific information for decision making. These activities have focused on the following areas (Appendices 4.3-01, 4.4-01, 4.4-02):

- prevention of vessel-related fatalities
- prevention of nonfatal work-related injuries
- prevention of fatalities due to loss of vessels

4.4c Selected Outputs

The AFF Program staff members have published dozens of scientific articles, NIOSH numbered documents, MMWR articles, and industry trade articles. In addition, we have sponsored two domestic and three international scientific conferences focusing on fishing vessel safety (Figure 4.14).

The following information highlights the most important outputs and transfers to date.

Fishing Industry Safety and Health Workshop

The AFF Program has worked with its partners to initiate and facilitate conferences and workshops on safety in the commercial fishing industry. The first conference was in Anchorage, Alaska in 1992. The objectives of this Fishing Industry Safety and Health Workshop were to raise consciousness, build coalitions, disseminate information, and encourage action to prevent injury and disease in fishing. A broad range of concerned parties described injury problems among fishers and suggested solutions to these problems. All papers presented at the conference were included in a proceedings volume. The proceedings for this conference were disseminated. The participants overwhelmingly encouraged action to improve safety for fishermen. Some participants identified preventive actions that can be implemented now, and others identified research actions that are needed to discover the causes of and the solutions to these problems. There were 77 people in attendance from Alaska and the West Coast.

NIOSH Current Intelligence Bulletin

Using AOISS, the AFF Program conducted the first major assessment of commercial fishing fatalities since the passage of the Commercial Fishing Industry Vessel Safety Act (CFIVSA) of 1988. These data were analyzed and the results were published in the NIOSH CIB [NIOSH 1997]. We found that there had been a decline in the fatality rate among commercial fishermen. However, there had not been a decline in the number of vessels sinking. The CFIVSA emphasizes the use and availability of safety equipment during and after a disaster at sea. We recommended augmenting this approach by preventing these disasters in the first place, as well as continuing to prepare to react to them if they occur. A total of 11 recommendations were made calling for more attention to the prevention of these events by focusing on the improvement of vessel stability, training, avoiding harsh weather, falls overboard, and deck safety. This document has been used by many organizations as a resource for discussing the dangers of the commercial fishing industry including the Alaska Department of Fish and Game, the Alaska Fishing Job Clearinghouse [AFJC 2005], CareMarx consumer health [Caremark 2006], The University of Vermont [University of Vermont 2000], WorkSafe BC in British Columbia [Work Safe BC 2006], and Trident Marine Association [Trident Marine Associates 2004].

Figure 4-14: Timeline of NIOSH Research Activities Regarding Commercial Fishing Safety

In addition to serving as a web resource, the USCG used the CIB to develop a national plan for fishing vessel safety. They convened a task force in 1988 after acknowledging that the national regulations focused on the reaction to the emergency at sea, but not the prevention of it. In the final report called "Living to Fish, Dying to Fish," the USCG had adopted 8 of the 11 recommendations that NIOSH had made in the CIB to improve fishing vessel safety. The CIB also served as the cornerstone for the 1997 Fishing Industry Safety and Health (FISH) Workshop in Seattle, Washington.

FISH Workshop

The AFF Program sponsored and organized a FISH II workshop in Seattle in 1997. The CIB provided the scientific support and identified the most hazardous areas requiring immediate attention. Members of the IAWG were present, as well as others interested in the safety of this industry. The workshop's goal was to describe current circumstances and plan the next steps to ensure that fishermen have relatively safe workplaces.

The first workshop day defined the current problem and identified the populations at risk. The second day, participants were asked to participate in working groups. The working groups were:

- prevention of vessel-related fatalities
- prevention of Man Overboard (MOB) fatalities in the industry
- prevention of diving fatalities in the commercial fishing industry
- prevention of nonfatal work-related injuries

Each of these working groups developed recommendations that were published in the conference proceedings [NIOSH 2000]. Many of these recommendations led to successful interventions including: the NIOSH Deck Safety Project, the USCG Pre-season Dockside Inspection Program of Bering Sea crab vessels (see Intermediate Outcomes for details), and the Lobstermen Entanglement Prevention Project in Maine led by the Harvard School of Public Health. Information was used in marine safety training offered by AMSEA.

Line Entanglement in the Lobster Fishery

As a result of connections made during the FISH II conference in Seattle, the Harvard School of Public Health asked us to assist them with a study to reduce falls overboard on Maine lobster vessels. Researchers from Harvard had found that during 1993-1997, Maine lobstermen had a work-related fatality rate of more than 2.5 times the national average for all industries. Anecdotally, lobstermen indicated that entanglement of workers in the line attached to the lobster traps was the most likely cause of many fatalities. The joint project:

- gathered data on the prevalence of personal entanglement in trap line
- sought to understand the work practices associated with entanglement

- identified work practices and engineering controls that could be used to prevent fatalities

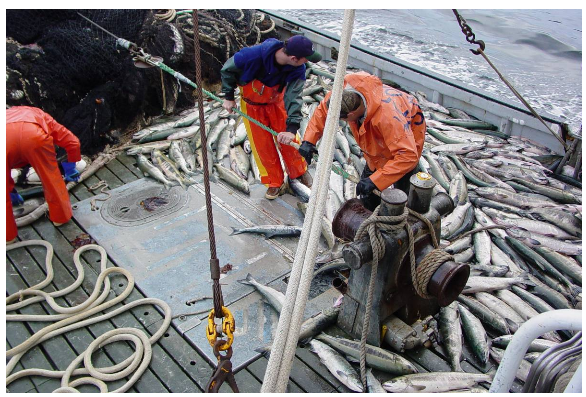
The study resulted in recommendations to prevent injuries from entanglements including work practices and engineering controls that:

- reduced the risk of entanglement
- helped the escapement from an entanglement
- facilitated re-boarding in the event that someone was pulled over

The findings from this project were compiled and published by Harvard in an industry-specific publication, "Lobstering Safety Secrets Revealed" [Harvard 2001] and distributed to commercial lobstermen in Maine. Two peer-reviewed articles were published, as well as a NIOSH Workplace Solutions document.

Deck Safety Products

In October 2000, the AFF Program started the "Deck Safety Project". This project is based on findings from the nonfatal injury data from the Alaska Trauma Registry. The goal of this project is to find practical solutions to fatal and nonfatal injuries and assist in preventing fatalities by disseminating the information to partners in the safety field and the commercial fishing industry. There were 574 severe nonfatal injuries that occurred in the commercial fishing industry during 1991-1998. This is equivalent to an annual rate for serious hospitalized injuries of 410/100,000 full-time fishermen.



Working deck of purse seine fishing vessel

The purpose of this project is to identify practical solutions to deck safety problems and disseminate the information to fishermen. The first phase of this project concentrated on deck safety for crab fishermen. We worked with NPFVOA and conducted focus groups with crab fishermen and toured vessels to view and discuss deck safety problems and potential modifications. Information about work practices and opinions regarding the effectiveness of the interventions for particular deck safety problems were received by crab fishermen. The modifications that were thought to be good solutions were published with illustrations and general installation instructions in the Deck Safety Handbook for Crab Fishermen [Jensen Maritime Consultants 2002]. A 1/10 scale deck safety model was built that illustrated all of the items in the deck safety booklet. This deck model is used at industry tradeshows to demonstrate the ideas in the booklet when discussing deck safety.

After this work, the project shifted to other types of vessels. We worked with USCG and the AMSEA to conduct focus groups with fishermen in Southeast Alaska. Findings from these focus groups revealed that fishermen were concerned about deck safety, and in particular, with the deck winch on purse seine vessels, which poses an entanglement risk.

Based on these findings, the AFF Program designed and tested a method of quickly stopping the deck winch. This type of winch requires the operator to stand near it during operation. Fishermen who lose their balance or are inattentive can become entangled in the purse line as it is winding onto the "gypsy" drum. Crushing injuries to the hand or arm (and in some cases fatalities, if the head or torso is caught) are the inevitable result.

The "e-stop" mounted on the deck winch

AFF Program engineers designed an emergency-stop (e-stop) system that allows the winch to be quickly stopped by a worker, even if the worker is caught in the winch. A fishing vessel captain and owner in Seattle, Washington partnered with us on the design and installation of the e-stop system, which was successfully tested during the 2005 and 2006 Alaska salmon seasons. Crewmembers praised the device as a significant safety and productivity improvement, and they continue to use the system.

The success of these first two stages of the Deck Safety Project demonstrates the effectiveness of combining diverse expertise to solve fishing safety problems. More than 4,000 copies of the Deck Safety Handbook have been distributed to fishermen in the Northwest, and a copy is posted on several safety websites as a resource. The e-stop system has received strong support at industry trade shows. It was demonstrated at the Pacific Marine Expo in Seattle, the largest commercial fishing trade show in the United States, with many vessel owners and operators requesting information on how to obtain the device. Work continues to produce a video on deck safety, develop a commercially available retrofit kit for the e-stop (in collaboration with the original switch manufacturer), and to publish a control technology publication to increase the distribution and impact of the e-stop.

IFISH I, II, III

In 2000, the AFF Program and Harvard SCHOOL OF PUBLIC HEALTH staff partnered to organize the 1st International Fishing Industry Safety and Health (IFISH) Workshop in Woods Hole, Massachusetts [NIOSH 2002]. This conference was designed to discuss issues in fishing safety on an international scale. More than 100 fishermen and safety professionals from 13 different countries gathered to discuss fishing vessel safety issues. Topics covered included a summary of worldwide problems and challenges in the industry, innovative approaches to investigating and preventing fishing vessel casualties, risk perception, intervention programs, surveillance, and unique approaches to safety training.

This was followed by the Second IFISH (IFISH II) conference in 2003. We partnered with AMSEA to convene and facilitate this conference in Sitka, Alaska. There were 135 registrants from 18 nations. A total of 40 speakers addressed topics ranging from deck safety needs for crabbers working in northern waters to policy changes affecting Pacific Island States. There were 7 speakers sponsored by the Food and Agriculture Organization (FOA), who provided overviews of commercial fishing safety programs in developing countries including: Tonga, Sri Lanka, Pakistan, India, Senegal, and Chile. The proceedings volume includes manuscripts submitted for 28 of the 40 presentations [NIOSH 2006].

Most recently, another conference, IFISH III (also co-sponsored by the AFF Program), took place in Chennai, India in early 2006. These international conferences disseminate research on fishing vessel safety from many parts of the world. The conference in India focused on small scale artesian fishermen and unique safety concerns for this group of workers.

Full-Time Equivalent Estimates

Enumerating fishermen to calculate rates is very difficult. Since fishermen are primarily a self-employed workforce, they do not have as many benefits or record-keeping requirements as other occupations. For example, there is generally no health insurance or workers' compensation coverage for commercial fishermen. Fishing is generally a non-unionized workforce with no monitoring of work hours, time at sea, or grievances. There are also few fisheries that are in existence year round. A fisherman may only fish for a few months a year. For all of these reasons, estimating the number of fishermen is very difficult.

The AFF Program designed a way to estimate a full time equivalent fisherman for each fishery and for the workforce. This allows us to compare rates of fatalities and injuries to other Alaskan workers. It also allows us to identify the most hazardous fisheries in Alaska to focus interventions.

A complete list of outputs can be found in section 4.5 at the end of this chapter.

4.4d Intermediate Outcomes

Pre-season Dockside Inspection Program

In follow-up to the working groups from the 1997 FISH Workshop in Seattle, the USCG in Alaska designed and implemented a Pre-season Dockside Inspection Program. USCG personnel had participated in the vessel loss prevention working group and took the lead in designing a plan to prevent vessels from sinking. USCG vessel safety examiners developed a comprehensive "at-the-dock" boarding and inspection program to identify and correct safety hazards known to exist in the Bering Sea crab fisheries. These fisheries were chosen based on NIOSH findings identifying the crab fishery with the highest fatality rate of any fishery in Alaska. Bering Sea crab fishing requires the use of crab "pots" that are 600-800 lb. steel cages to catch crab on the ocean floor. A vessel improperly loaded with crab pots, or a vessel that is covered in ice, may become dangerously unstable and capsize.

This Pre-season Dockside Inspection Program examines a large number of vessels within the fleet prior to the crab fishery opening. The examiners review vessel stability information with vessel masters and check lifesaving equipment required by the CFIVSA. If the vessel is not loaded properly, or if there is a lack of lifesaving equipment, a Captain of the Port Order is issued and the vessel is not able to fish until the discrepancy is corrected.

In winter 2005, the USCG requested that the AFF Program assist them in the evaluation of the Pre-season Dockside Inspection Program. We showed that from implementation in October 1999 until 2005, there had been 1 fatality in this fishery, which was due to a fall overboard versus an average of ~7 in each of the prior 5 years. However, another fall overboard occurred in January 2005, and the fishing vessel "Big Valley" sank resulting in 5 fatalities. The crab industry strongly supports this the Pre-season Dockside Inspection Program initiative.

Marine Safety Training

The CFIVSA regulations include a requirement that fishermen conduct monthly emergency drills, and that these drills be observed by a Certified Drill Conductor. In 1993, AMSEA received its first NIOSH Training Project Grant, to help train fishermen to meet the requirement to be qualified to become Drill Conductors for these required monthly drills.

AMSEA and the AFF Program have worked on many projects on fishing vessel safety since the early-1990s. These projects include a dive safety workshop and a deck-safety pamphlet [AMSEA 2002] that was sent to fisherman in Alaska and distributed at the 2nd IFISH Workshop in Sitka, Alaska in 2003.

AMSEA has requested technical assistance from the AFF Program to evaluate the effectiveness of their training in the prevention of commercial fishing fatalities. We compared the number of survivors of commercial fishing vessels which sunk to the number of victims (fatalities) of these vessels which sunk, and found that victims were 1.5 [95% Confidence Interval (CI) 0.9, 2.4] times more likely not to have had training. Although the CI contains 1.0, generally as sample size increases, the width of the CI decreases. With additional information on people trained, this interval should decrease and may show a statistically stronger association between the lack of training and being a victim.

In the same study, AFF Program scientists found that victims of commercial fishing vessel sinking were 7 times (95% CI 1.9, 27.4) more likely not to have worn an immersion suit, and 15 times (95% CI 4.6, 50.8) more likely not to have used a life raft. Being trained on how to use this equipment quickly and efficiently is necessary. AMSEA uses this information to seek funding and to promote their courses.

AMSEA has used AFF Program reports of commercial fishing fatalities and injuries to better understand the nature of the problems in the industry. AMSEA reports that this has been extremely useful for strategically planning in what areas of the fishing industry to focus training efforts. Since 1992, AMSEA has held more than 1,000 classes and trained more than 15,000 fishermen.

Technical Assistance for Fishery Management

This section highlights AFF Program input into fishery management regime decisions since 1992.

To prevent the depletion of fish stocks as the competition for these stocks increases, each fishery (fishery: defined by species, time, and place) has its own management plan. The challenge is to keep fisheries at sustainable levels to fish, while not ruining the economy of the fishing communities that depend on this resource. Fisheries management plans can limit the number of participants, or limit the type or amount of gear that can be carried. They can also put geographic restrictions on fishing areas and limit the number of minutes, hours, or days fleets can fish. There are other fisheries with limits on the total weight of the catch across the fleet without the use of major time constraints. The National Standards in the Magnuson-Stevens Fishery Conservation and Management Act includes 10 standards that fishery management plans must follow. One of them is that “Conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.” (16 U.S.C. 1851, Sec.201.)

Fisheries management regulations that result in short seasons sometimes cause fishermen to pursue other fish, perhaps in waters for which their vessels were not designed. In addition, they may have to change to new unfamiliar fishing gear increasing the chances for accidents to occur.

In 1995, Individual Fishing Quotas (IFQs) were implemented. The IFQ program awarded vessel owners an allowable catch limit or quota based on catch records from the previous five years. Also, they had from April to September to catch their share of fish. In 1997, the Ocean Studies Board of the National Research Council asked the AFF Program to provide testimony regarding the implications this change in the management of the halibut/sablefish fishery had on safety. We analyzed USCG data and showed that Search and Rescue missions significantly declined by 63% ($p=0.009$) after implementation of the IFQ system. We also reported that 9 fishermen died while fishing for halibut during 1992-1994, but since implementation of the IFQ’s, no fatalities had occurred in the fishery.

Another quota-based management system was recently implemented in the Bering Sea crab fisheries. Although our personnel did not provide testimony in person, our publications on the safety record of this fleet were used as foundation evidence that this is a dangerous fishery. The NIOSH AFS AFF Program researchers were cited in the member package which was distributed at one or more of the meetings where this proposed system was debated.

4.4e End Outcomes

While the work-related fatality rate for commercial fishermen in Alaska is still very high, fatalities are decreasing. Since 1990, there has been a 74% decline in deaths of commercial fishermen in Alaska, and a 51% decline in the annual fatality rate (Figure 4-15).

The successes in improving safety in the commercial fishing industry in Alaska are multifaceted. Our approach is to:

- Offer a scientific assessment of the worst problems. We did this by analyzing injury and fatality data and making recommendations.
- Identify high-risk groups through estimating denominators and calculating rates.
- Support the development of interventions by providing scientific information on which to base the interventions.
- Evaluate interventions to assess any change in the number and rate of fatalities and injuries.

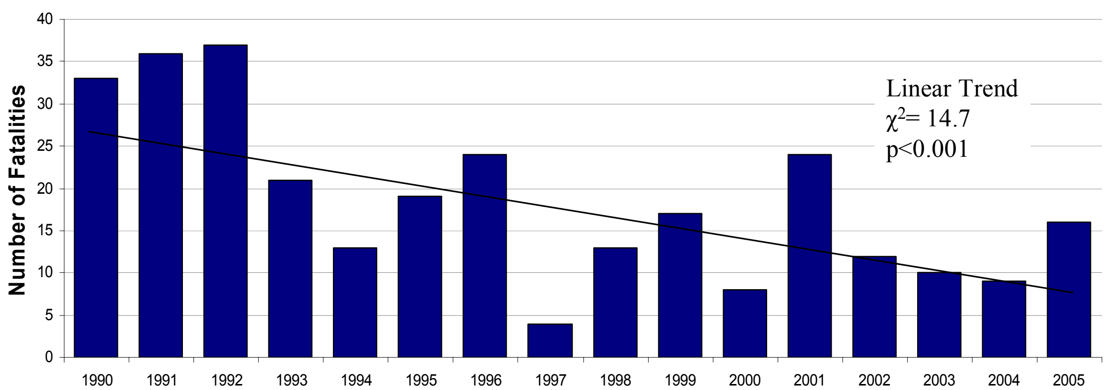


Figure 4-15: The decline of commercial fishing fatalities in Alaska from 1990-2005 (n=296).

We conducted the early assessment of the decline in commercial fishing fatalities after the implementation of the Fishing Vessel Safety Act. We found that although fatalities had decreased, vessel sinking events had not. In addition, we identified the fishery in which each fatal event had occurred. We showed that the crab fishery in the Bering Sea was the most hazardous fishery in the State, and that the problem was the loss of fishing vessels. Bringing our partners together at the FISH Workshop in Seattle in 1997, we organized the working group to prevent vessels from sinking. This resulted in the 1999 Pre-season Dockside Inspection Program.

The crab industry strongly supports this dockside enforcement initiative. Fishing fatalities continued to decline through 2005. In particular, these fatalities declined among crab fishermen (Figure 4-16). In winter 2005, the USCG requested that we assist them in the evaluation of the Pre-season Dockside Inspection Program. We showed that since its implementation in October 1999 until 2005, there had only been 1 fatality in this fishery, which was due to a fall overboard. In January 2005, however, another fall overboard occurred and the fishing vessel "Big Valley" sank, resulting in five fatalities.

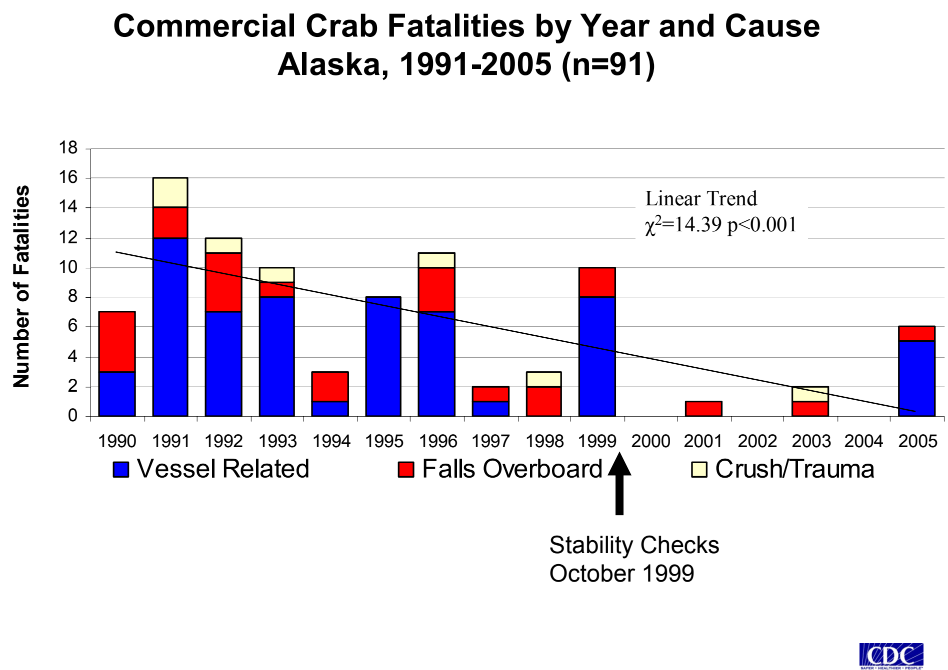


Figure 4-16: The decline in crab fishing fatalities from 1990-2005. Note the start of stability checks.

When looking at fatality rates for the 1990s versus the rates since 2000, the rate has dropped by more than 50% among crab fishermen (Figure 4-17). These types of analyses and interventions have not occurred in other parts of the country.

In addition to addressing fatal injuries in the industry, we analyzed nonfatal injuries, identifying deck machinery as a dangerous hazard with a need for practical solutions to prevent these disabling injuries. The USCG is the agency with the regulatory authority for the safety of the fleet. As an agency, they have not addressed nonfatal injuries. The AFF Program, through the NIOSH AFS, has led the way in highlighting deck hazards as an important safety area.

4.4f Future Directions

Management Regimes Impact on Safety

NIOSH recommends that all current and proposed management regimes be examined for safety concerns [NIOSH 1997]. Management of fisheries must ensure the preservation of the resource while optimizing the opportunities for fishermen, and must allow fishermen the freedom to exercise judgment about the advisability of fishing in current conditions. Fisheries management regimes can be changed to not only benefit the fish stocks, but also protect the fishermen from harsh weather or long work hours by eliminating the race to fish. Fishermen participating in a quota-based management system can choose the weather in which to catch their share of fish.

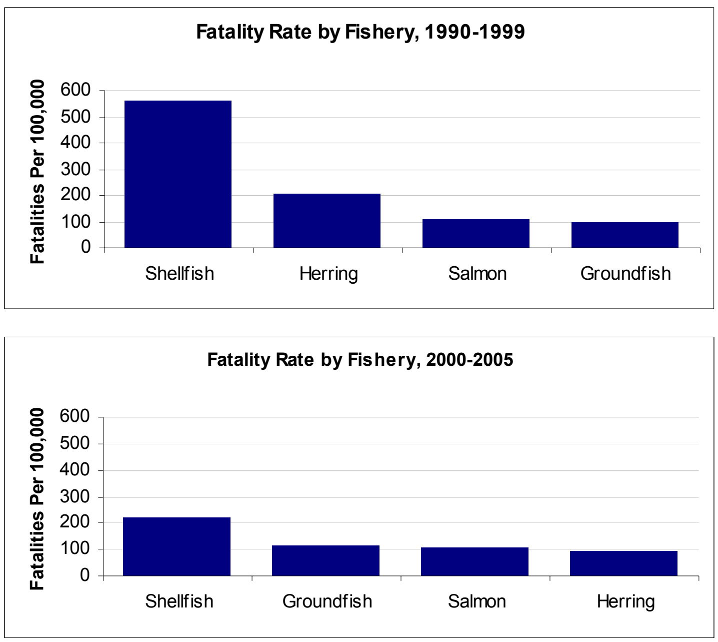


Figure 4-17: The change in the Fishery-specific fatality rate. Fatality rate from 1990-1999 compared to 2000-2005

AFF Program scientists successfully competed for a grant in 2005 from the North Pacific Research Board to evaluate the impact of the changes in fishing management regimes on safety in the halibut/sablefish fleet and the Bering Sea Aleutian Island pollock fleet. Despite the assertion by fishery managers, industry leaders, and in academic circles that vessels operating in a quota-based fishery are generally safer, there has been no systematic assessment to examine corresponding improvements in measures of safety. Rates of injuries, fatalities, search and rescue missions, and vessel sinking in fishing fleets both before and after changes in fishing management need to be examined. This systematic assessment of the change in these rates will provide more scientific evidence to support policies made by fisheries managers.

Expanding Research Program

We are expanding on the successful work in Alaska to include other commercial fishing regions of the country during 2007. This research program consists of four projects, which apply classic epidemiologic and engineering analysis methods to better understand and prevent commercial fishing fatality and injury events.

The first project is Coordination and Analysis. This project provides the core activities of data surveillance and analysis, epidemiologic expertise, and communication activities for the entire program. It provides ongoing surveillance for fatal and nonfatal fishing injuries and produces annual informational updates on research findings, current hazards, and trends. Additionally, the Coordination and Analysis Project establishes and coordinates research partner meetings at the annual Pacific Marine Expo, and will co-sponsor the next IFISH Conference.

The second project is Commercial Fishing Risk Factors and Prevention Strategies. This project's overall objective is to identify risk factors for commercial fishing fatalities for the three geographic areas which comprise the U.S. coastline, and to develop tailored injury prevention interventions. It provides a descriptive epidemiologic analysis of fatal incidents based on event, vessel, and individual factors. There will also be a comparative analysis on all vessel sinking events that have occurred in the United States from 1994-2006. The results of this project will be communicated to the USCG, maritime safety organizations, and industry so that stronger prevention and education interventions can be developed through the coordination project.

The third project is Reducing Fatalities Due to Falls Overboard, intended to reduce injuries and fatalities due to falling overboard from commercial fishing vessels. This project will involve analyzing falls overboard to understand root causes and possible interventions. It will develop improvements to deck designs or fishing equipment that can prevent falls overboard, and will evaluate commercially available crew overboard alarms, tracking devices, and rescue devices. Further, this project will design new, innovative crew overboard interventions and evaluate them on fishing vessels.

The final project is Deck Machinery Hazards Research and Development. The long-term objective of this project is to reduce fatalities and severe nonfatal injuries related to machinery on the working decks of vessels in the North Pacific commercial fishing fleet. Specifically, this project will attempt to reduce the incidence of machinery entanglements through continued development of emergency-stop (e-stop) and guarding technologies, and will attempt to reduce the incidence of long-liner hook injuries.

Further research is also underway at the NIOSH Spokane Research Laboratory aimed at reducing commercial fishing fatalities by focusing on the problem of sinking and capsizing. Sinking and capsizing are among the most dangerous of accidents at sea. Vessels can sink or capsize from a combination of factors such as overloading with catch, inability to quickly clear water from the deck, unnoticed leaks, and down-flooding through open hatches, doors, and uncovered well decks. This project's goal is to eliminate drowning associated with vessel sinking and capsizing by inventing new ways to detect, monitor, control, and prevent dangerous, uncontrolled down-flooding that can sink an otherwise intact, seaworthy vessel.

4.4g List of NIOSH projects included in this section

- AFS-9278893-Occupational Injury Prevention in Alaska (Appendix 4.3-01)
- AFS-9277394-Injury Prevention in the Commercial Fishing Industry (Appendix 4.4-01)
- AFS-92700BL-Deck Safety for Commercial Fishing Vessels (Appendix 4.4-02)

4.5 Outputs

4.5a Child Labor

Dissemination of Outputs

NIOSH has worked extensively with NASS to disseminate survey results and recommendations for keeping youth safe on farms. NASS has distributed more than 100,000 NIOSH pamphlets to farm operators across the United States, including pamphlets specifically targeting minority farm operators. These pamphlets summarize common causes of childhood farm injury and steps to foster safe and healthful farm environments for children.

National FFA and DOL representatives from the Federal Interagency Working Group on Preventing Childhood Agricultural Injuries have agreed to help disseminate brochures on findings and recommendations of the latest childhood agriculture injury surveillance.

In the three years since its release, more than 31,000 copies of the *NIOSH Young Worker Alert* have been distributed. Examples of groups through which it has been disseminated include the following:

- Maryland Occupational Safety and Health (MOSH) Training and Education; 100 copies distributed in the Teen Train-the-Trainer program
- Virginia Department of Labor and Industry; 50 copies used for consultation program
- Massachusetts Fatality Assessment and Control Evaluation program; 560 copies sent to the Massachusetts Department of Education
- Nebraska Fatality Assessment and Control Evaluation program; distributed at every presentation, briefing, or booth attended by program staff, including "Husker Harvest Days" and "Farm Safety Day Camps."

Conferences Sponsored

Childhood Agricultural Injury Prevention Strategy Workshop: A Private Sector Perspective, November 90–11, 1997, Indianapolis, IN.

Prevention of Musculoskeletal Disorders for Children and Adolescents Working in Agriculture, May 6–7, 2002, Cincinnati, OH.

Special Session: Childhood Agricultural Injuries, Fourth International Symposium: Rural Health and Safety in a Changing World, October 18–22, 1998, Saskatoon, Saskatchewan, Canada.

Special Session: Childhood Agricultural Injuries, Agricultural Safety and Health in a New Century, April 28–30, 2000, Cooperstown, NY.

Special Session: Childhood Agricultural Injury Prevention, National Occupational Injury Research Symposium, October 17, 2000, Pittsburgh, PA.

Special Session: Childhood Agricultural Injuries, National Institute for Farm Safety 2001 Annual Meeting, June 24–27, 2001, Pittsburgh, PA.

Special Session: Intervention—Safe Behaviors among Adults and Children, Surgeon General's Conference on Agricultural Safety and Health, April 1991 Des Moines, IA.

Special Session: Agricultural Injuries, National Injury Prevention and Control Conference, May 9–11, 2005, Denver, CO.

2001 Summit on Childhood Agricultural Injury Prevention, April 30–May 1, 2001, Brooklyn Park, MN.

Data bases

NIOSH has established four new surveillance systems as part of the childhood agricultural injury prevention initiative:

- Childhood Agricultural Injury Survey (CAIS): data available for 1998, 2001, and 2004.
- Childhood Agricultural Mortality System (CAMS): data available for 1995–2003.
- Minority Childhood Agricultural Injury Survey (M-CAIS): data available for 2000 and 2003.
- National Agricultural Workers Survey (NAWS) Youth Injury Module: data available for 1999, 2001–2004.

NIOSH Testimony

NIOSH [1994]. Comments of the National Institute for Occupational Safety and Health on the Department of Labor, Wage and Hour Division advance notice of proposed rulemaking on child labor regulations, orders and statements of interpretation, October 25, 1994. Cincinnati, OH: U.S. Department Health, Education, and Welfare, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health.

Publications

Adekoya N, Pratt SG [2001]. Fatal unintentional farm injuries among persons less than 20 years of age in the United States: Geographic profiles. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2001–131.

Adekoya N, Castillo DN, Myers JR [1998]. Youth agricultural work-related injuries treated in emergency departments—United States, October 1995–September 1997. MMWR *47*(35):733–737.

Allread WG, Wilkins JR III, Waters TR, Marras WS [2004]. Physical demands and low-back injury risk among children and adolescents working on farms. J Agric Safety Health *10*(4): 255–272.

Bartels S, Niederman B, Waters TR [2000]. Job hazards for musculoskeletal disorders for youth working on farms. J Agric Safety Health *6*(3):191–201. (ISI Web of Science: Cited 4 times as of 11/20/06)

Castillo DN, Adekoya N, Myers JR [1999]. Fatal work-related injuries in the agricultural production and services sectors among youth in the United States, 1992–1996. J Agromed *6*(3):27–41. (ISI Web of Science: Cited 12 times as of 11/20/06)

Castillo D, Hard D, Myers J, Pizatella T, Stout N [1998]. A national childhood agricultural injury prevention initiative. J Agric Safety Health Special Issue 1:183–191. (ISI Web of Science: Cited 2 times as of 11/20/06)

Goldcamp EM, Hendricks KJ, Myers JR [2004]. Farm fatalities to youth 1995–2000: a comparison by age groups. J Safety Res *35*(2):151–157. (ISI Web of Science: Cited 1 time as of 11/20/06)

Hard DL, Myers JR [2006]. Fatal work-related injuries in the agriculture production sector among youth in the United States, 1992–2002. J Agromedicine 11(2): 57-65.

Hard DL, Myers JR, Gerberich SG [2002]. Traumatic injuries in agriculture. J Agric Safety Health *8*(1):51–65. (ISI Web of Science: Cited 4 times as of 11/20/06)

Hard DL, Myers JR, Snyder KA, Casini VJ, Morton LL, Cianfrocco R, Fields J [1999]. Young workers at risk when working in agricultural production. Am J Ind Med *36*(Suppl l):31–33. *(cited 13 times per Google Scholar)*

Hendricks KJ, Adekoya N [2001]. Non-fatal animal related injuries to youth occurring on farms in the United States, 1998. Injury Prevention 7(4):307-311. (ISI Web of Science: Cited 4 times as of 11/20/06)

Hendricks KJ, Goldcamp EM, Myers JR [2004]. On-farm falls among youth less than 20-years old in the U.S. J Agric Safety Health *10*(1):27–38.

Hendricks KJ, Layne LA, Goldcamp EM, Myers JR [2005]. Injuries to youth living on U.S. farms in 2001 with comparison to 1998. J Agromed *10*(4):19–26.

Hendricks KJ, Myers JR, Layne LA, Goldcamp EM [2005]. Household youth on minority operated farms in the United States, 2000: exposures to and injuries from work, horses, ATVs and tractors. J Safety Res *36*(2):149–157.

Kidd P, Draime J [1998]. Non-traumatic, work-related, musculoskeletal disorders in farm youth. Unpublished final report, NIOSH Contract #79278284.

Landsittel D, Hard DL, Murphy DJ, Kiernan NE [1998]. The Pennsylvania Central Region Farm Safety Pilot project: Part II—Baseline data associations between approach-to-safety and hazard conditions. J Agric Safety Health Special Issue *1*:21–28. (ISI Web of Science: Cited 3 times as of 11/20/06)

Landsittel D, Murphy DJ, Kiernan NE, Hard DL, Kassab C [2001]. An evaluation of the effectiveness of educational interventions in the Pennsylvania Central Region farm safety pilot project. Am J Ind Med *40*(2):145–152. (ISI Web of Science: Cited 4 times as of 11/20/06)

Mardis AL, Pratt SG [2003]. NIOSH Alert: Preventing deaths, injuries, and illnesses of young workers. Cincinnati, OH: Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. DHHS (NIOSH) Pub. No. 2003–128.

Mason RW, ed. [1995]. Report to Congress on workers' home contamination study conducted under the Workers' Family Protection Act [281 pages]. NIOSH, U.S. Dept Health and Human Services, Cincinnati, OH. September, 1995. (Cited 17 times per Google Scholar) *Dr. Hard developed a section devoted to caustic farm products. Farms were also highlighted (dealing with caustic substances ingested by children and pesticide exposures) along with sections on caustic farm products and pesticides*.

Myers JR [1998]. Injuries among farm workers in the United States—1994. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health

Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 98–153.

Myers JR [2001]. Injuries among farm workers in the United States, 1995. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2001–153.

Myers JR, Hendricks KJ [2001]. Injuries among youth on farms in the United States, 1998. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2001–154.

Myers JR, Hendricks KJ, Goldcamp EM, Layne LA [2005]. Injuries and asthma among youth less than 20 years of age on Minority farm operations in the United States, 2000 Volume I: Racial minority national data. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2005–147.

Myers JR, Hendricks KJ, Layne LA, Goldcamp EM [2005]. Injuries and asthma among youth less than 20 years of age on Minority farm operations in the United States, 2000 Volume II: Hispanic national data. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2006–109.

Murphy DJ, Kiernan NE, Hard DL, Landsittel D [1998]. The Pennsylvania Central Region farm safety pilot project: Part I—Rationale and baseline results. J Agric Safety Health *4*(1):25–41. (ISI Web of Science: Cited 2 times as of 11/20/06)

Myers JR, Adekoya N [2001]. Fatal on-farm injuries among youth 16 to 19 years of age: 1982–1994. J Agric Safety Health *7*(2):101–112. Myers ML, Herrick RF, Olenchock SA, Myers JR, Parker JE, Hard DL, Wilson K, eds. [1992]. Papers and Proceedings of the Surgeon General's Conference on Agricultural Safety and Health. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Pub. No. 92–105. *(cited 20 times per Google Scholar)*

NIOSH [2002]. Recommendations to the U.S. Department of Labor for Changes to Hazardous Orders—May 3, 2002. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety And Health.

NIOSH [2004]. Injuries to youth on minority farm operations. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2004–117.

NIOSH [2004]. Asthma among household youth on minority farm operations. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2004–118.

NIOSH [2004]. Worker Health Chartbook, 2004. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2004–146 (*Agricultural fatality and nonfatal injury section, pp. 195–211).*

NIOSH [2004]. Injuries to youth on Hispanic farm operations. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2004–157.

NIOSH [2004]. Asthma among household youth on Hispanic farm operations. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2004–158.

NIOSH [2004]. Injuries among youth on farms, 2001. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Pub. No. 2004–172.

Parker DL, Wahl GL, Higgins D [1999]. Childhood work-related agricultural fatalities— Minnesota, 1994-1997. MMWR *48*(16):332–335.

Pollack SH, Struttmann TW, Zwerling C, Lundell J, Johnson W, Etre L, Hanrahan LP, Tierney J, Higgins D [1999]. Deaths among children aged less than or equal to 5 years from farm machinery runovers—Iowa, Kentucky, and Wisconsin, 1995–1998, and United States, 1990–1995. MMWR *48*(28):605–608. (ISI Web of Science: Cited 1 time as of 11/17/06)

USDA [1999]. 1998 Childhood agricultural injuries. Washington, DC: U.S. Department of Agriculture, National Agricultural Statistics Service, Sp Cr 8 (10–99).

USDA [2002]. 2000 Childhood agricultural injuries on minority-operated farms. Washington, DC: U.S. Department of Agriculture, National Agricultural Statistics Service, Sp Cr 9 (02).

USDA [2004]. 2001 Childhood agricultural-related injuries. Washington, DC: U.S. Department of Agriculture, National Agricultural Statistics Service, Sp Cr 9 (1–04).
Waters TR, Wilkins JR III.. [2004]. Conference proceedings: prevention of musculoskeletal disorders for children and adolescents working in agriculture. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Pub. No. 2004–119.

Publications (NIOSH Fatality Assessment and Control Evaluation (FACE) Reports)

NIOSH [1989]. Five family members die after entering manure waste pit on dairy farm. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 89–46.

NIOSH [1998]. 9-year-old child helping with blueberry harvest dies after being run over by cargo truck on field road. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 98–15.

NIOSH [2000]. Sixteen-year-old farm worker dies in a cotton packing machine after being covered with a load of cotton—Georgia. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 2000–06.

NIOSH [2000]. A 15-year-old male farm laborer dies after the tractor he was operating overturned into a manure pit—Pennsylvania. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 2000–18.

NIOSH [2002]. Youth farm worker dies after falling into operating feed grinder/mixer—Ohio. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 2002–10.
29 State-based investigations of child agricultural deaths are available at: http://www.cdc.gov/niosh/injury/traumayouthface.html.

Conference Reports and Papers

Goldcamp EM, Hendricks KJ, Myers JR [2002]. Farm fatalities to youth 1995–1997: a comparison by age groups. National Institute for Farm Safety 2002 Annual Meeting, June 23–27, Ponte Vedra Beach, FL. Columbia, MO: National Institute for Farm Safety.

Goldcamp EM, Myers JR, Hendricks KJ, Layne LA [2003]. Non-fatal injuries: an overview of injuries to youth on racial minority operated farms in the United States, 2000. National Institute for Farm Safety 2003 Annual Meeting, June 22–26, Windsor, Ontario, Canada. Columbia, MO: National Institute for Farm Safety.

Goldcamp EM, Myers JR, Hendricks KJ, Layne LA [2004]. Nonfatal all-terrain vehicle injuries to youth on farms in the U.S., 2001. National Institute for Farm Safety 2004 Annual Meeting, June 20–24, Keystone, CO. Columbia, MO: National Institute for Farm Safety.

Hard DL [2000]. Special Session Moderator–Childhood Agricultural Injury Prevention. National Occupational Injury Research Symposium, October 17, Pittsburgh, PA.

Hendricks KJ, Adekoya N [2001]. Non-fatal animal-related injuries to youth occurring on farms in the United States, 1998. National Institute for Farm Safety Annual Meeting, June 24–27, Pittsburgh, PA. Columbia, MO: National Institute for Farm Safety.

Hendricks KJ, Goldcamp EM, Myers JR [2002]. Fatal and non-fatal falls in United States agricultural production for youth less than 20 years old. National Institute for Farm Safety 2002 Annual Meeting, June 23–27, Ponte Vedra Beach, FL. Columbia, MO: National Institute for Farm Safety.

Hendricks KJ, Myers JR, Goldcamp EM, Layne LA [2003]. Farm hazards to household youth on minority operated farms in the United States, 2000: exposures and injuries from work, horses, ATVs and tractors. National Institute for Farm Safety 2003 Annual Meeting, June 22–26, Windsor, Ontario, Canada. Columbia, MO: National Institute for Farm Safety.

Hendricks KJ, Layne LA, Goldcamp EM, Myers JR [2004]. Injuries among youth on farms in the United States, 2001. National Institute for Farm Safety 2004 Annual Meeting, June 20–24, Keystone, CO. Columbia, MO: National Institute for Farm Safety.

Layne LA, Myers JR, Hendricks KJ, Goldcamp EM [2003]. Demographics and non-fatal injury patterns of youth less than 20 years of age on Hispanic operated farms in the United States, 2000. National Institute for Farm Safety 2003 Annual Meeting, June 22–26, Windsor, Ontario, Canada. Columbia, MO: National Institute for Farm Safety.

Layne LA [2006]. Youth Living on Hispanic Operated Farms in the United States: An Examination of Population Growth and Changes in Risk Exposure and Injury Patterns between 2000 and 2003. National Institute for Farm Safety 2006 Annual Meeting, June 25–29, Sheboygan, Wisconsin. Columbia, MO: National Institute for Farm Safety.

Lee B, Gallagher S, Marlenga B, Hard D, eds. [2002]. Childhood Agricultural Injury Prevention: Progress Report and Updated National Action Plan from the 2001 Summit. Marshfield, WI: Marshfield Clinic. *NIOSH was heavily involved in this summit meeting, due to the request of the summit organizers and because it was a cooperative agreement. In recognition of his input and involvement, Dr. Hard was invited to be an author of the final summit report.*

NCCAIP [1996]. Children and Agriculture: Opportunities for Safety and Health. A National Action Plan. Marshfield, WI: National Farm Medicine Center. *As chair of the Research work group of the NCCAIP, Dr. Hard had input into the development of the recommendations and had the responsibility of generating the research recommendations for the NAP.*

Waters T [1998]. Children in Agriculture: Ergonomic Issues. Paper presented at the North American Guidelines for Children in Agriculture symposium, March 15–18, New Orleans, LA.

Presentations

Adekoya N, Myers JR [1999]. Farm and work injuries among youth 16-19 years of age, 1982-1994. Thirteenth Annual Childhood Injury Prevention Conference, October 25–27, San Diego, CA.

Hard DL [2003]. Agricultural Injury Surveillance Conducted by NIOSH. Presented at the 5th International Symposium: future of Rural People—Rural Economy Health People, Environment, and Rural Communities, October 19–22, Saskatoon, Saskatchewan, Canada.

Hard DL [2003]. The NIOSH childhood agricultural injury prevention initiative. National Occupational Injury Research Symposium, October 28–29, Pittsburgh, PA.
Hard D, Castillo D, Myers J, Pizatella T, Olenchock S [2000]. Overview of the NIOSH childhood agriculture injury prevention initiative. National Occupational Injury Research Symposium, October 17–19, Pittsburgh, PA.

Hard DL, Layne LA [1995]. A National Sample of Nonfatal Occupational Injuries Incurred by Youth Presenting to Hospital Emergency Departments: Agriculture Compared to Other Industries. Poster presentation at the Child and Adolescent Rural Injury Control Conference, March 8–9, Marshfield, WI.

Hendricks KJ, Myers JR, Adekoya N [2000]. Non-fatal childhood agricultural injuries in the U.S.–1998. Agricultural Safety and Health in a New Century, April 28–30, Cooperstown, NY.

Myers JR, Hendricks K [2000]. NIOSH approach to childhood agricultural injury surveillance. Agricultural Safety and Health in a New Century, April 28–30, Cooperstown, NY.

Myers JR, Hendricks K [2000]. NIOSH approach to childhood agricultural injury surveillance. Presented at the National Occupational Injury Research Symposium (NOIRS), October 17–19, Pittsburgh, PA.

Myers JR, Adekoya N [2000]. Fatal on-farm Injuries to Youth 16 to 19 years of age: 1982-1994 (poster). National Institute for Farm Safety 2000 Conference, June 25–29, Dubuque, IO.

Myers JR [2001]. Building Partnerships to Improve Rural Safety and Health. CSTE/APHL Annual Conference, June 10–14, Portland, OR.

Waters TR [2003]. Two-dimensional biomechanical modeling for estimating strength of youth and adolescents for manual material handling tasks. Poster presented at 2003 Challenges in Agricultural Health and Safety Conference, September 7–9, San Francisco, CA.

Web Sites

FACE Youth Fatalities [http://www.cdc.gov/niosh/injury/traumayouthface.html]

NIOSH Childhood Agricultural Injury Prevention Initiative [http://www.cdc.gov/niosh/childag/]

NIOSH Youth Injury [http://www.cdc.gov/niosh/topics/youth/]

4.5b Minority Populations

Hired Farmworkers:

Publications

Cameron L, Lalich N, Bauer S, Booker V, Bogue HO, Samuels S, Steege AL [2006]. Occupational Health Survey of Farm Workers by Camp Health Aides. J Agric Safety and Health, 2006; 12(2):139-153.

Estill C, Steege A, Baron S [2002]. Research and Dissemination Needs for Ergonomics in Agriculture. Public Health Reports 2002;117: 440-445.

Lee K, Lawson RJ, Olenchock SA, Vallyathan V, Southard RJ, Thorne PS, Saiki C, Schenker MB [2004]. Personal Exposures to Inorganic and Organic Dust in Manual Harvest of California Citrus and Table Grapes. J Occupat Environ Hyg 2004; 1:505-514. (ISI Web of Science: Cited 2 times as of 11/17/06)

Posters

"Health surveillance of hired farm worker women from the National Agricultural Workers' Survey." North American Congress of Epidemiology, June 2006, Seattle, WA.

Presentations

Presentations have been made at the North American Congress of Epidemiology, American Public health Association (APHA), at Agricultural meetings, and Migrant stream forums.

"The Occupational Health and Injury Experience of US Farmworkers," 15th Annual East Coast Migrant Stream Forum (Savannah Georgia, October 26, 2002).

"Vulnerabilidad de la Fuerza Laboral Hispana del Sector Agrícola en las Américas: Agricultores en los Estados Unidos y Modelos de Intervención," Hispanic Forum at the National Safety Council Congress & Expo (San Diego California, October 7, 2002).

"Pesticide Illness among Farmworkers in the United States and California," International Conference on Pesticide Exposure and Health. (Bethesda Maryland, July 9, 2002).

"A National Portrait of Farmworker Occupational Health in the United States," 14th Annual East Coast Migrant Stream Forum: *Asegurando Un Futuro Sano*. (Asheville North Carolina, October 27, 2001).

"Social and Economic Impacts of Globalization: Case Study of Agricultural Workers in the U.S.," 129th Annual Meeting of the American Public Health Association (Atlanta Georgia, October 22, 2001).

"Occupational Health Data from the NAWS: An Inter-Agency Collaboration," Migrant Interagency Meeting U.S. Department of Labor (Washington DC, October 10, 2001).

"The Health Supplement of the National Agricultural Workers Survey," 13th Annual East Coast Migrant Stream Forum: Joining Forces to Eliminate Disparities. (Philadelphia Pennsylvania, November 4, 2000).

"The Health Supplement of the National Agricultural Workers Survey," Midwest Farmworker Stream Forum *Las Raices de Salud*: Planting Care, Growing Wellness, Reaping Health. (Albuquerque New Mexico, October 27, 2000).

"The Health Supplement of the National Agricultural Workers Survey," 10th Annual Western Migrant Stream Forum. (Portland Oregon, February 3, 2001).

"Occupational Health Surveillance of Hired Farmworkers," Agricultural Safety and Health in a New Century. (Cooperstown New York, April 29, 2000).

"Occupational Health of Hired Farmworkers," State of the State: NC Farmworker Health Conference (Chapel Hill North Carolina, March 31, 2000).

"NAWS Occupational Health Supplement," 1999 Midwest Farmworker Stream Forum (Austin Texas, December 2, 1999).

"Challenges of Conducting Occupational Health Surveillance on a Special Population: Migrant Farmworkers" 1999 Annual Meeting of the American Public Health Association (Chicago Illinois, November 8, 1999).

"Worker to Worker: Collecting Occupational Health Data on Farmworkers through Camp Health Aides." National Association of Community Health Centers National Migrant Health Meeting (Denver Colorado, April 24, 1999).

"Worker to Worker: Collecting Occupational Health Data on Farmworkers through Camp Health Aides." Western Farmworker Stream Forum (Sacramento California, January 29, 1999).

"Farmworker Health and Safety in the 90's." 1993 National Farmworker Conference (San Diego, California, February 25, 1993).

"Introduction to NIOSH Agricultural Program." Midwest Farmworker Stream Forum (San Antonio, Texas, November 6, 1998).

"Opening Doors to Increasing Migrant Health Research." Midwest Farmworker Stream Forum (Albuquerque, New Mexico, October 26 and 27, 2000).

"Forum Research Track: Opening Doors to Increasing Migrant Health Research" National Center for Farmworker Health Workshop (Atlanta, Georgia, February 15, 2001).

"Farmworker Forum Research Track: Participation and Rewards" National Center for Farmworker Health Workshop (Atlanta, Georgia, February 16, 2001).

"Introduction to the Research Track for the Stream Forum." Midwest Farmworker Stream Forum (New Orleans, Louisiana, November 20, 2002).

"A National Perspective on Agricultural Safety and Health." Migrant and Immigrant Health in Rural Pennsylvania: Putting Migrant Farmworkers First (State College, Pennsylvania, September 26, 2003.

Farm Operators

Manuscript

Ethnic, Racial, and Gender Variations in Health among Farm Operators in the United States. Undergoing revision and clearance for submission to the Annals of Epidemiology.

Posters

Mental Health Symptoms in a Population Based Survey of Minority Farm Operators. American Public Health Association Annual Meeting. San Francisco, CA, November 2003.

Minority and Female Farm Operator Occupational Health Survey," 130th Annual Meeting of the American Public Health Association (Philadelphia Pennsylvania, November 12, 2002).

Occupational Hearing Loss in a Population Based Survey of Minority Farm Operators. American Public Health Association Annual Meeting. San Francisco, CA, November 2003

Presentations

Minority Farm Operator Occupational Health, Black Farmers and Agriculturalists Association Meeting. (Atlanta Georgia, February 8-10, 2002).

Steege, A, Alterman T, Sestito, J, Baron S, Estill C, Lalich N, Cameron L [2000]. Occupational Health Surveillance of Hired Farm workers. Agricultural Safety and Health in a New Century, Cooperstown, NY April.

4.5c Logging

Publications

Bell JL [2002]. Changes in logging injury rates associated with the use of feller bunchers in West Virginia. J Safety Res *33*:463–471. (ISI Web of Science: Cited 3 times as of 11/20/06)

Bell JL, Grushecky ST [2006]. Evaluating the effectiveness of a logger safety training program. J Safety Res *37*:53–61.

Bell JL, Helmkamp JC [2003]. Non-fatal injuries in the West Virginia logging industry: using workers' compensation claims to assess risk from 1995 through 2001. Am J Ind Med *44*(5):502–509. (ISI Web of Science: Cited 5 times as of 11/20/06)

Centers for Disease Control and Prevention [1994]. Risk for traumatic injuries from helicopter crashes during logging operations—Southeastern Alaska, January 1992–June 1993. MMWR 43(26):472–475.

Fosbroke DE, JR Myers [1996]. Logging safety and forest management education: a necessary link. J Forestry *94*(7):21–25.
Myers JR, Fosbroke DE [1995]. The Occupational Safety and Health Administration logging standard: what it means for forest managers. J Forestry *93*(11):34–37. (ISI Web of Science: Cited 5 times as of 11/20/06)

Helmkamp JC, Bell JL, Lundstrom WJ, Ramprasad J, Haque A [2004]. Assessing safety awareness and knowledge and behavioral change among West Virginia loggers. Inj Prev *10*:233–238. (ISI Web of Science: Cited 1 time as of 11/20/06)
Jingxin W, Bell JL, Grushecky ST [2003]. Logging injuries for a 10-year period in Jilin Province of the People's Republic of China. J Safety Res *34*(3):273–279.

Myers JR, Fosbroke DE [1994]. Logging fatalities in the U.S. by region, cause of death, and other factors—1980 through 1988. J Safety Res *25*(2):97–105. (ISI Web of Science: Cited 18 times as of 11/20/06)

NIOSH [1974]. Worker safety in logging operations. Cincinnati, OH: U.S. Department Health, Education, and Welfare, Health Services and Mental Health Administration, National Institute for Occupational Safety and Health National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 74–103.

NIOSH [1976]. NIOSH criteria for a recommended standard: logging from felling to first haul. Cincinnati, OH: U.S. Department Health, Education, and Welfare, Health Services and Mental Health Administration, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 76–188.

NIOSH [1983]. Job injuries among loggers. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 83–104.

NIOSH [1994]. NIOSH Alert: request for assistance in preventing injuries and deaths of loggers. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 95–101.

NIOSH [1998]. Helicopter logging safety: Alaska Interagency Working Group for the Prevention of Occupational Injuries. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 98–147.

NIOSH [2005]. Fact sheet: mechanical timber harvesting reduces workers' compensation injury claims in West Virginia. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2005–129.

Publications (NIOSH FACE Reports)

NIOSH [1983]. Falling tree limb strikes logger. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 83–05.

NIOSH [1992]. Jarred Loose by Fallen Tree—Alaska. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 92–10.

NIOSH [1992]. Tree faller killed when struck by decayed slab. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 92–09.

NIOSH [1992]. Tree faller/bucker crushed between two logs while bucking a fallen tree—Alaska. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 92–15.

NIOSH [1992]. Tree faller crushed by dislodged tree—Alaska. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 92–15.

NIOSH [1992]. Tree faller dies after being struck by a falling snag—Pennsylvania. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 92-21.

NIOSH [1992]. Tree feller crushed by falling tree—Virginia. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 92–38.

NIOSH [1993]. Equipment operator struck and killed by skidder—South Carolina. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 92–16.

NIOSH [1993]. Timber cutter dies after being struck by a falling snag—West Virginia. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 92–13.

NIOSH [1993]. Timber cutter dies after being struck by a falling snag—West Virginia. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 93–10.

NIOSH [1993]. Tree feller crushed by dislodged tree—South Carolina. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 93–01.

NIOSH [1993]. Tree feller dies after being struck by a chain saw in the throat—South Carolina. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 93–02.

NIOSH [1993]. Tree feller killed by falling tree limb—West Virginia. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 93–05.

NIOSH [1993]. Truck driver killed when struck by log that rolled off truck during loading Operation—Alaska. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 93–03.

NIOSH [1993]. Owner of logging company crushed by rootwad of windfall tree during bucking operation—Alaska. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 93–04.

NIOSH [1994]. Timber cutter/skidder operator killed by falling tree—West Virginia. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 94–05.

NIOSH [1995]. Chokersetter killed by falling tree—South Carolina. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 95–05.

NIOSH [1995]. Machine operator struck and killed by cutting head of feller buncher machine—North Carolina. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 95–07.

NIOSH [1995]. Timber cutter killed by falling tree limb—West Virginia. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 95–03.

NIOSH [1995]. Timber cutter killed by falling tree limb—South Carolina. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 95–04.

NIOSH [1995]. Truck driver dies after being struck by log that fell from logging truck—North Carolina. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 95–08.

NIOSH [1996]. Foreman/skidder operator killed by falling tree—West Virginia. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 96–13.

NIOSH [1996]. Logger dies after falling from log skidder—South Carolina. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 96–10.

NIOSH [1996]. Tree feller killed by a piece of wood from a falling tree—Pennsylvania. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 96–14.

NIOSH [1997]. Hog farmer/logging company owner dies after being struck by a falling tree—West Virginia. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 97–05.

NIOSH [1998]. Tree feller killed when struck by chain saw—West Virginia. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 98–09.

NIOSH [2004]. Chain saw operator dies after being struck by excavator bucket during site clearing—North Carolina. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 2004–07.

NIOSH [2004]. Hispanic logger struck and killed by a falling tree cut by a feller buncher Machine—North Carolina. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, FACE Report No. 2004–04.

Conference Papers and Presentations

Bell JL [2001]. Changes in logging injury rates associated with use of feller-bunchers in West Virginia. International Mountain Logging and 11th Pacific Northwest Skyline Symposium, Seattle, WA, December 10–13.

Bell JL [2001]. Evaluating the effectiveness of a logger safety training program. 2001 Annual FACE (Fatality Assessment and Control Evaluation) Consortium Meeting, Morgantown, WV, November 13–14.

Bell JL [2003]. Evaluation of the effectiveness of a logger safety training program. National Occupational Injury Research Symposium, Pittsburgh, PA, October 28–30.

Bell JL [2004]. Evaluating the effectiveness of a logger safety training program. Council on Forest Engineering Meeting, Arkansas, April 27–29.

Fosbroke DE, Myers JR [1992]. Interpreting logging injury statistics. In: American Society of Agricultural Engineers 1992 International Winter Meeting, Nashville, TN, December 15 December 15–18, Paper No. 92–7509. (ISI Web of Science: Cited 1 time as of 11/20/06)

Fosbroke DE, Myers JR [1995]. Logging safety in forest management education. In: Proceedings of the 10th Central Hardwood Forest Conference, Morgantown, WV, March 5–8, USDA For. Ser. GTR NE–197, pp. 442–453. (ISI Web of Science: Cited 1 time as of 11/20/06)

Myers JR, Fosbroke DE [1995]. Forest management practices and the Occupational Safety and Health Administration Logging Standard. In: Proceedings of the 10th Central Hardwood Forest Conference, Morgantown, WV, March 5–8, USDA For. Ser. GTR NE–197, pp. 454–462 (ISI Web of Science: Cited 6 times as of 11/20/06)

4.5d Fishing

Databases (Surveillance)

Alaska Occupational Injury Surveillance System, 1990-2006 (Created and maintained by NIOSH AFS).

Alaska Trauma Registry, 1991-2006 (NIOSH funded since 1993).

Patents

“Electro Hydraulic Emergency Stop Device for a Winch”, Invention Report submitted Nov. 2005, Centers for Disease Control reference #I-008-06.

“Active illumination in flotation devices for man overboard rescue,” Ruff, T.M., Inventor, Invention Report submitted July 2005.

Publications

Backus AS, Brochu PJ, Lincoln JM, Bensyl DM, Ciampa JR, Smith TJ [2001]. Understanding and preventing lobsterman entanglement: a preliminary study. Marine Safety Council Proceedings *58*(2):50-53.

Conway GA, Lincoln JM [1995]. Preventing deaths in Alaska’s fishing industry (editorial). Public Health Rep *110*(6):700. (ISI Web of Science: Cited 4 times as of 11/20/06)

Conway GA, Lincoln JM, Husberg BJ, Manwaring JC, Klatt ML, Thomas TK [1999]. Alaska’s model program for surveillance and prevention of occupational injury deaths. Public Health Rep *114*(6):550-558. (ISI Web of Science: Cited 4 times as of 11/20/06)

Conway GA, Lincoln JM, Husberg BJ, Manwaring JC, Bensyl DM, Choromanski DM [2001]. Alaska's model program for occupational injury prevention: applying surveillance for effective public health practice. Int J Circumpolar Health *60*(4):714-723. (ISI Web of Science: Cited 3 times as of 11/20/06)

Husberg BJ, Lincoln JM, Conway GA [2001]. On-deck dangers in the Alaskan commercial fishing industry. Proceedings – U.S. Coast Guard journal of safety at sea, *58*(2):23-24.

Kennedy RD, Lincoln JM [1997]. The epidemiology of fatal injury in the U.S. commercial fishing industry, 1990-1994. Health and Safety in Agriculture, Forestry, and Fisheries, Langley RL, McLymore RL, Meggs,WJ, Robertson GT. Government Institutes Inc., Chapel Hill, NC, pp. 557-570.

Lincoln JM, Perkins R, Melton F, Conway GA [1996]. Drowning in Alaskan waters. Public Health Rep *111*(6):531. (ISI Web of Science: Cited 5 times as of 11/20/06)

Lincoln JM, Conway GA [1999]. Preventing commercial fishing deaths in Alaska. Occup Environ Med *56*(10):691-695. (ISI Web of Science: Cited 12 times as of 11/20/06)

Lincoln JM, Husberg BJ, Conway GA [2001]. Improving safety in the Alaskan commercial fishing industry. Int J Circumpolar Health *60*(4):705-713.

NIOSH [1994]. Preventing drowning of commercial fishermen. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94-107.

NIOSH [1994]. Proceedings of the National Fishing Industry Safety and Health Workshop. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication No. 94-109.

NIOSH [1997]. Commercial fishing fatalities in Alaska – risk factors and prevention strategies. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 97-163.

NIOSH [2000]. Proceedings of the Second National Fishing Industry Safety and Health Workshop. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2000-104.

NIOSH [2002]. Proceedings, First International Fishing Industry Safety and Health Conference. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2002-147.

NIOSH [2002]. Surveillance and prevention of occupational injuries in Alaska: a decade of progress, 1990-1999. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2002-115.

NIOSH [2005]. Danger of entanglement during lobstering. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2005-137.

NIOSH [2006]. Proceedings, Second International Fishing Industry Safety and Health Conference. Cincinnati, OH: U.S. Department of Health and Human Services Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2006-114.

NIOSH [forthcoming]. Proceedings, Third International Fishing Industry Safety and Health Conference. Cincinnati, OH: U.S. Department of Health and Human Services Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH).

Thomas TK, Lincoln JM, Husberg BJ, Conway GA [2001]. Is it safe on deck? Fatal and nonfatal workplace injuries among Alaskan commercial fishermen. Am J Ind Med *40*(6):693-702. (ISI Web of Science: Cited 11 times as of 11/20/06)

Publications (NIOSH FACE Reports)

NIOSH [1992]. Commercial fisherman presumed drowned after fishing vessel capsized. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) FACE Report No. 92-14.

NIOSH [1992]. Commercial fisherman drowned after fishing vessel capsized. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) FACE Report No. 92-32.

Sponsored Conferences and Workshops (see publications above for proceedings from these meetings)

National Fishing Industry Safety and Health Workshop, Anchorage, AK: October 9-11, 1992.
National Fishing Industry Safety and Health Workshop, Seattle, WA: November 21-22, 1997.
International Fishing Industry Safety and Health Conference, Woods Hole, MA: October 23-25, 2000.
International Fishing Industry Safety and Health Conference, Sitka, AK: September 22-24, 2003.
International Fishing Industry Safety and Health Conference, Chennai, India: February 1-4, 2006.

Recommendations from the NIOSH CIB

- A requirement for periodic stability reassessment and vessel inspection of all vessels should be seriously considered, as equipping and retrofitting can substantially affect the stability of vessels.

- Minimum specifications for watertight components and bulkheads sufficient to keep swamped or capsized vessels afloat should also be developed, implemented, and evaluated.
- A thorough assessment should be made of current training requirements and efforts, and deficiencies should be immediately corrected.
- Consideration should be given to establishing adequate watch-keeping and staffing requirements for all vessels.
- Consideration should be given to requiring the successful completion of basic fishing safety training, such as those programs currently offered by the AMSEA, before an Alaskan (State) crew license or a commercial fishing permit is issued.
- All current and proposed management regimes should be examined from a safety and health perspective.
- Weather information should be more closely heeded.
- All fishermen should wear PFDs when on the deck of any vessel.
- MOB alarms should be thoroughly evaluated and widely deployed if such evaluations demonstrate that the devices are effective.
- Thorough study of the handling of lines, especially during deployment of crab pots, should be conducted to reduce worker exposure to this hazard.
- A training curriculum should be developed, implemented, and evaluated for fishermen who are harvesting seafood or clearing lines or nets by diving.

Web Sites (NIOSH)

FACE Fishing Page: http://www.cdc.gov/niosh/injury/traumafishface.html

Fishing Topic Page: http://www.cdc.gov/niosh/injury/traumafish.html

Miscellaneous

The AFF Program provided technical assistance, and contributed text for the publication of “Deck Safety for Crab Fishermen” published by Jensen Maritime Consultants: Seattle, WA 2002.
We consulted on the publication of “Lobstering Safety Secrets Revealed!” produced by Harvard/NIOSH Education and Research Center for Occupational Safety and Health: Boston, MA 2000.

Commercial fishing deck safety models built by Jensen Maritime Consultants illustrating deck safety improvements and falls overboard avoidance interventions.

E-switch model developed by AFF Program engineers to illustrate the emergency shut off switch designed to be used on capstan style deck winches.

4.6 References Cited

Adekoya N, Castillo DN, Myers JR [1998]. Youth agricultural work-related injuries treated in emergency departments—United States, October 1995–September 1997. MMWR *47*(35):733–737.

Adekoya N, Pratt SG [2001]. Fatal unintentional farm injuries among persons less than 20 years of age in the United States: Geographic profiles. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2001–131.

AFJC [2005]. Alaska Fishing Jobs Clearinghouse: frequently asked questions. Seattle, WA: Alaska Fishing Jobs Clearinghouse. [http://www.fishingjobs.com/faq.htm].

Allread WG, Wilkins JR III, Waters TR, Marras WS [2004]. Physical demands and low-back injury risk among children and adolescents working on farms. J Agric Safety Health *10*(4):255–272.

AMSEA [2002]. Seven ways to get hurt (or killed) while commercial fishing in Alaska. Sitka, AK: Alaska Marine Safety Education Association. [http://www.amsea.org/documents/Seven%20Ways%20Brochure.pdf].

Arcury TA, Quandt SA, Elmore RC, Russell GB [2002]. Water safety among Latino farmworkers in North Carolina. J of Agromedicine 8(2):77-81.

Ballard T, Ehlers J, Freund E, Auslander M. Brandt V, Halperin W [1995]. Green tobacco sickness: Occupational nicotine poisoning in tobacco workers Archives of Environmental Medicine; 50(5):384-389.

Beaumont JJ, Goldsmith DF, Morrin LA, Schenker MB [1995]. Mortality in agricultural workers after compensation claims for respiratory disease, pesticide illness and injury. Journal of Occupational and Environmental Medicine. 37(2):160-169.

Bell JL [2002]. Changes in logging injury rates associated with the use of feller bunchers in West Virginia. Journal of Safety Research *33*:463-471.

BLS [1990]. Occupational injuries and illnesses in the U.S. by industry, 1988. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, Bulletin 2366.

BLS [2006]. Census of Fatal Occupational Injuries. [http://www.bls.gov/iff/oshfat1.htm]

BLS [2006]. Survey of Occupational Injuries and Illnesses. Database. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics.

Caremark [2006]. Caremark health information. Special report: reel jobs. Consumer Health Interactive: New York. [http://healthresources.caremark.com/topic/fishers].

Castillo DN, Adekoya N, Myers JR [1999]. Fatal work-related injuries in the agricultural production and services sectors among youth in the United States, 1992–1996. J Agromed *6*(3):27–41.

CFR. Code of Federal regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

Child Labor Coalition [2005]. Protecting working children in the United States: Is the government's indifference to the safety and health of working children violating an international treaty? Washington, DC: Child Labor Coalition. [http://www.stopchildlabor.org/pressroom/clc%20report.pdf]. Date accessed: July 18, 2006.

Child Labor Coalition [2006]. Letter from Child Labor Coalition (signed by co-chairs Antonia Cortese, Executive Vice President, American Federation of Teachers; and Linda F. Golodner, President, National Consumers League) to Secretary of Labor Elaine Chao. June 28.

CPSC [2006]. National Electronic Injury Surveillance System on line. [http://www.cpsc.gov/library/neiss.html]. Last accessed July 30, 2006.

Derstine B [1994]. Youth worker at risk of fatal injuries. Paper presented at the 122nd Annual Meeting of the American Public Health Association, October 30, Washington, DC.

DOL [2006]. The National Agricultural Workers Survey. [http://www.doleta.gov/agworker/naws.cfm]. Last accessed on July 27, 2006.

Egan AF [2002]. Uniting an independent and isolated workforce: the logger association phenomenon in the U.S. Society and Natural Resources *15*:541−552.

Esser N, Heiberger S, Lee B, eds. [2003]. Creating safe play areas on farms. Marshfield, WI: Marshfield Clinic.

Farmworker Justice Fund, Inc. [2003]. Children employed in agriculture need stronger laws to protect them against hazardous working conditions [press release]. Washington, DC: Farmworker Justice Fund, Inc. December 4. [http://www.stopchildlabor.org/childreninthefields/strongerlaws.mht]. Date accessed: July 18, 2006.

59 Fed. Reg. 51672 [1994]. Occupational Safety and Health Administration: Logging operations; final rule. Washington, DC: U.S. Department of Labor.

Frumken H, Pransky G [1999]. Special populations in occupational health. Occupational Medicine: State of the Art Reviews 1999;14(3):479-484.

Gadomski A, Ackerman S, Burdick P, Jenkins P [2006]. Efficacy of the North American guidelines for children's agricultural tasks in reducing childhood agricultural injuries. Am J Pub Health *96*(4):722–727.

Goldcamp EM, Hendricks KJ, Myers JR. [2004]. Farm fatalities to youth 1995–2000: a comparison by age groups. J Safety Res *35*(2):151–157.

GovTrack.us [2006a]. 108th Congress, 1st session. H.R. 3139: To amend the Fair Labor Standards Act of 1938 to reform the provisions relating to child labor, and for other purposes. [http://www.govtrack.us/data/us/bills.text/108/h3139.pdf]. Date accessed: July 19, 2006

GovTrack.us [2006b]. 109th Congress, 1st session. H.R. 2870: To amend the Fair Labor Standards Act of 1938 to reform the provisions relating to child labor, and for other purposes. [http://www.govtrack.us/data/us/bills.text/109/h2870.pdf]. Date accessed: July 19, 2006.

Hard DL, Myers JR [forthcoming]. Fatal work-related injuries in the agriculture production sector among youth in the United States, 1992–2002.

HAI [1997]. Helicopter Logging Committee helicopter logging guidelines. Unpublished draft. Alexandria, VA: Helicopter Association International.
Harvard School of Public Health [2001]. Lobstering safety secrets revealed! Harvard School of Public Health. Boston, MA. [abackus@hohpharvard.edu] (617) 432-3327.

International Labour Organization [2006]. Report of the Committee of Experts on the Application of Conventions and Recommendations (articles 19, 22 and 35 of the Constitution). Third item on the agenda: Information and reports on the application of conventions and recommendations; Report III, Part 1A; General Report and observations concerning particular countries, pp. 229–233. Available: [http://www.ilo.org/public/english/standards/relm/ilc/ilc95/pdf/rep-iii-1a.pdf]. Date accessed: July 18, 2006.

Jensen Maritime Consultants [2002]. Deck safety for crab fishermen. Seattle, WA. [http://www.jensenmaritime.com/articles/crabdeck.pdf#search=%22%22deck%20safety%20for%20crab%20fishermen%22%22]. Date accessed: October 2006; European Agency for Safety and Health at Work [http://int.osha.eu.int/good_practice/sector/fisheries/osh_link.2006-02-15.2905707695], [http://riskobservatory.osha.eu.int/good_practice/sector/fisheries/index_atoz?letter=P&kwpath=00001A&kwname=Political,%20social%20and%20economic%20conditio

ns]; Work Safe British Columbia [http://www2.worksafebc.com/Portals/Fishing/Prevention-VesselAndCrewSafety.asp].

Kirkhorn SR, Schenker MB [2002]. Current health effects of agricultural work: Respiratory disease, cancer, reproductive effects, musculoskeletal injuries, and pesticide-related illnesses. J Agricultural Safety and Health 2002; 8(2):199-214.

Lee BC, Gunderson PD, eds. [1992]. Childhood agricultural injury prevention: issues and interventions from multiple perspectives. Proceedings from the Childhood Agricultural Injury Prevention Symposium, April 1–2, Marshfield, WI: National Farm Medicine Center.

Lee B, Gallagher S, Marlenga B, Hard D, eds. [2002]. Childhood agricultural injury prevention: progress report and updated national action plan from the 2001 summit. Marshfield, WI: Marshfield Clinic.

McBride DI, Firth HM, Herbison GP [2003]. Noise exposure and hearing loss in agriculture: a survey of farmers and farm workers in the Southland region of New Zealand. J Occup Environ Med. 2003;45(12):1281-8.

McCormack CR [1963]. Injuries and accident causes in logging operations, 1995. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, Report No. 252.

Miller ME, Bush D. [2004]. Review of the Federal Child Labor Regulations: Updating hazardous and prohibited occupations. AJIM 45(2):218-221.

Myers JR, Fosbroke DE [1994]. Logging fatalities in the U.S. by region, cause of death, and other factors—1980 through 1988. Journal of Safety Research *25*(2):97-105.

Myers ML et al., eds. [1992]. Papers and Proceedings of the Surgeon General's Conference on Agricultural Safety and Health, Des Moines, Iowa, April 30–May 3, 1991. Cincinnati, OH: NIOSH 1992 Sep:645 pp.

Myers JR, Hendricks KJ [2001]. Injuries among youth on farms in the United States, 1998. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2001–154.

National Research Council, Institute of Medicine [1998]. Protecting youth at work: health, safety, and development of working children and adolescents in the United States. Washington, DC: National Academy Press.

National Technical Information Service [1999]. The Childhood Agricultural Injury Prevention Strategy Workshop: A Private Sector Perspective. Final Report: A Summary of Strategies and Successes, NIOSH Contract Number 0009756278, Purdue University, NTIS Accession: PB 99–147597.

NCCAIP [1996]. Children and agriculture: opportunities for safety and health. A national action plan. Marshfield, WI: National Farm Medicine Center.

NIOSH [1976]. NIOSH criteria for a recommended standard: logging from felling to first haul. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Health Services and Mental Health Administration, National Institute for Occupational Safety and Health, HEW (NIOSH) Publication No. 76−188.

NIOSH [1989]. NIOSH testimony to OSHA on logging operations, July 31, 1989. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health.

NIOSH [1994]. NIOSH Alert: request for assistance in preventing injuries and deaths of loggers. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 95−101.

NIOSH [1994]. Comments of the National Institute for Occupational Safety and Health on the Department of Labor, Wage and Hour Division advance notice of proposed rulemaking on child labor regulations, orders and statements of interpretation, October 25, 1994. Cincinnati, OH: U.S. Department Health, Education, and Welfare, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health

NIOSH [1997]. Current intelligence bulletin 58: commercial fishing fatalities and prevention strategies in Alaska. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 97-163.

NIOSH [1998]. Helicopter logging safety: Alaska interagency working group for the prevention of occupational injuries. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 98−147.

NIOSH [2000]. Proceedings of the Second National Fishing Industry Safety and Health Workshop. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2000-104.

NIOSH [2002]. National Institute for Occupational Safety and Health (NIOSH) Recommendations to the U.S. Department of Labor for changes to hazardous orders—May 3, 2002. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health.

NIOSH [2002]. Proceedings of the International Fishing Industry Safety and Health Conference. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2002-147.

NIOSH [2002]. Surveillance and Prevention of Occupational Injuries in Alaska: A Decade of Progress, 1990-1999. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2002-15.

NIOSH [2005]. Fact sheet: mechanical timber harvesting reduces workers' compensation injury claims in West Virginia. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2005–129.

NIOSH [2006]. Childhood Agricultural Fatality Investigation Reports. [http://www.cdc.gov/niosh/childag/ChildAgFACErpts.html] Date accessed on July 31, 2006.

NIOSH [2006]. Proceedings, Second International Fishing Industry Safety and Health Conference. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2006-114.

NIOSH [2006b]. National Traumatic Occupational Fatalities surveillance system. Database. Morgantown, WV: National Institute for Occupational Safety and Health

North American Guidelines for Children's Agricultural Tasks [1999]. Marshfield, WI: National Children's Center for Rural and Agricultural Health and Safety. Marshfield Clinic.

OSHA [2000]. A review of logging fatalities investigated by the Occupational Safety and Health Administration in FY 1996 and FY 1997. Washington, DC: U.S. Department of Labor.

Schenker MB [1996]. Preventive medicine and health promotion are overdue in the agricultural workplace. J Public Health Policy 17(3):275-304.

Trident Marine Associates [2004]. Fishing vessel safety. [http://www.tridentmarine.net/fishing%20vessel%20safety.htm].

University of Vermont [2000]. Listserv 14.5. Email re: Alaska fishing boat safety and NIOSH study. [http://list.uvm.edu/cgi-bin/wa?A2=ind0005d&L=safety&P=13818].

U.S. Department of Agriculture National Statistics Services Census of Agriculture [2002]. [http://www.nass.usda.gov/Census_of_Agriculture/index.asp]

Work Safe BC [2006]. The Worker's Compensation Board of British Columbia. Safety at work. Injury prevention resources for fishing – general safety. [http://www2.worksafebc.com/Portals/Fishing/Prevention-GeneralSafety.asp].

Young Worker Health & Safety Network [2003]. NIOSH Recommendations for changes to the Federal child labor regulations: A response from members of the Young Worker Health & Safety Network. Unpublished.

Chapter 5. Goal 3: Agricultural Health Outcomes Research on Exposures to Chemicals

Goal 3: Determine the chronic effects of agricultural exposures/health outcomes from toxic exposures and develop appropriate interventions to reduce the incidence of disease.

5.1 Challenge or Issue

More than 85,000 chemicals are registered for commercial use today, an ever increasing number of which are pesticides used in agriculture. It can be fairly assumed that exposures to pesticides and other toxic substances found on the farm pose a serious health risk to the farming community since many of these toxicants are known to cause cancer, adverse reproductive effects, and neurological disease. However, research is needed to determine the extent of farm workers exposure to these chemicals and to determine the extent to which such exposures contribute to disease.

5.2 Activities

AFF Program efforts in recent years have focused on both areas of research—determining the extent of exposure among agricultural workers, and determining the rates of disease such as cancer, adverse reproductive effects and neurological disease among farm workers and their families.

5.2a Extent of Exposure

Biomonitoring Research

AFF Program researchers have developed biomonitoring methods (primarily for blood and urine specimens) to measure exposures to agricultural chemicals. These methods are used to assess worker exposures in a variety of agricultural settings. A major focus of these efforts has been to develop methods that are rapid, simpler to perform, and lower in cost. These methods were used to evaluate exposures in farm families, agriculture sprayers, residential exterminators and others. Aside from giving valuable information about personal burden of pesticide exposure, these efforts have helped to determine those work practices and operations that present the greatest potential for exposures. These efforts have resulted in suggesting changes in work practices or wearing of personal protective equipment that resulted in decreased worker exposures. (Appendices 5.2a-01, 5.2a-02, 5.2a-03. 5.2a-04, 5.2a-05, 5.2a-06, 5.2a-07, 5.2a-08)

AFF Program researchers have also developed and applied biomarkers of effects to assess potential injury or toxic response in persons exposed to agricultural products or chemicals. As part of the efforts to assess biomarkers of susceptibility, researchers have focused on two specific areas: differences in metabolism of chemicals and genetic susceptibility to effects of exposoure in a rural population. Research investigating variability of metabolism was conducted in cooperation with EPA. This work has been used by EPA to re-evaluate uncertainty factors used in risk assessments and have applied them to new risk assessments [Lipscomb 2004].

Research demonstrated that immunochemical methods are suitable for use in biomonitoring studies to evaluate exposure to the agricultural chemicals that were tested. Methods were demonstrated to be rapid, accurate and much simpler to perform than traditional analytical chemistry methods [Biagini 2002, 2004]. In addition these methods have proven to be adaptable for use in the field. They usually require less sample volume than other methods, making compliance easier for participants. These new methods have often resulted in rapid dissemination of investigative results to relevant partners and stakeholders, and development of strategies to decrease exposures. Research into variation of metabolic capacity has resulted in identifying the role of specific metabolic pathways on toxicological fate of numerous chemicals [Snawder 2000].

The new exposure assessment methods improved our 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 [Winterlin 1984; Zwieg 1983; Popendorf 1979]. This information has led to recommendations that pesticide workers use gloves, aprons, and protective clothing. Current research indicates that many workers are not employing protective equipment. Intervention research is being developed to encourage workers to use protective equipment and to evaluate the barriers to their use.

Studies evaluating genetic markers of susceptibility have also explored the possible roles of polymorphisms of metabolic DNA repair enzymes and the development of glioma [Butler 2005].

Take-home Pesticide Exposure

The health effects of low level chronic exposures to pesticides are still largely unknown, and the potential for agricultural workers, farmers, and farm children to be subjected to these exposures are considerable. Families are potentially exposed to contaminants that are inadvertently brought into the home by working members of the household. (Appendix 5.2a-09)

The primary purpose of the take-home pesticide exposure study was to describe the sources of pesticide contamination in farm homes and investigate the relationship between contamination and pesticide exposure of family members in the home. A combination of environmental and biological sampling was employed. Questionnaires were administered along with observations to determine practices and behaviors that may contribute to exposure. Conclusions from the study include the following:

- Farm homes are more likely to be contaminated with pesticides then nonfarm homes and farms that apply a particular pesticide to crops have higher levels of that pesticide inside the home than farms that do not apply the pesticide.
- Farmers who reported applying a pesticide had significantly higher urinary metabolite levels of that pesticide than nonfarmers, farmers who did not apply that pesticide, and farmers who had the pesticide commercially sprayed (P-value < 0.05). No statistically significant differences in urinary pesticide metabolite levels occurred between nonfarmers, farmers who did not apply the pesticide and farmers who had the pesticide commercially applied.
- Farm children are more exposed to pesticides than nonfarm children, but the exposure is generally below EPA reference doses [Curwin 2002, 2005, 2005, 2006, submitted].

Researchers at the University of Iowa have initiated further research on the take-home pesticide issue. The study protocol was largely developed based on results from our take home study. NIOSH has been asked to be a collaborator on this initiative.

Engineering Controls

Working collaboratively with manufacturers of environmental enclosures for tractors and with commercial pesticide applicators, AFF Program researchers were able to conduct measurements of airborne particulate in the working area of the pesticide applicator to demonstrate that these enclosures were able to provide a 50-fold reduction in exposure [Heitbrink 2003; Moyer 2005]. This was accomplished in four separate projects by:

- developing partnerships with manufacturers of environmental enclosures for tractors and with commercial pesticide applicators
- developing measurement techniques for quantifying aerosol exposures of this nature in the environment of interest
- establishing a baseline exposure during application of pesticide
- establishing procedures for reducing aerosol infiltration into cab
- re-evaluating exposures during application in modified cab
- promoting procedure for reducing aerosol infiltration for industry use

To provide insights into specific causes of the workers' exposures from integrated air sampling data, direct reading instruments for continuous monitoring of a worker's environment were used. When these instruments are used in conjunction with video recording equipment, they permit better assessment of the association of events and exposures. This allows more effective and focused recommendations for controlling the air contaminant exposures. AFF researchers developed a systematic approach to help identify the sources of workers' exposures and to provide an effective means for communicating the results to workers and management [Heitbrink, 2000, 2003].

This work makes use of the ability to conduct measurements of airborne particulate over a concentration range of several orders of magnitude and the ability to classify those aerosol particulates according to size to further define their toxicological effect. The measurements of airborne particulates in the working area of the pesticide applicator demonstrated that the enclosures suggested were able to provide a 50-fold reduction in exposure [Heitbrink 2003]. The video exposure monitoring techniques developed by AFF Program researchers were used to enhance controls for materials weigh out operations, bag dumping, maintenance, and bulk loading procedures, to list a few. (Appendix 5.2a-10)

These have been used to generate and quantify nanoparticles in the environment; reduce emissions from asphalt equipment; document hearing loss in migrant farm workers; and develop guidance for protecting building environments from airborne chemical, biological, and radiological attacks.

Another effort involved reducing carbon monoxide (CO) exposure. AFF program researchers have conducted an extensive amount of work to better understand how CO poisoning can occur with small gasoline-powered engines and tools such as power washers used to clean barn floors and equipment. This effort multidisciplinary effort involved surveillance, epidemiology, industrial hygiene, and engineering controls. AFF researchers were able to document the extent of the problem, show how quickly hazardous CO concentrations can be developed and recommend control solutions. In 1996, NIOSH published the *Alert: Preventing Carbon Monoxide Poisoning from Small Gasoline-Powered Engines and Tools* (NIOSH Publication No. 96–118) in cooperation with the Colorado Department of Public Health and Environment, the U.S. Consumer Product Safety Commission, OSHA, and EPA. As with many engineering problems, the approach was to quantify the problem and identify its source, isolate and/or control the source, and re-evaluate the exposure to determine the effectiveness of the controls.

Analytical Methods Research and Field Support: Key elements in pesticide exposure field studies are the ability to accurately sample and quantify exposures, distinguish exposure route(s), and determine the impact of worker actions on exposure. The AFF Program's methods development research program provides this by developing new methods and providing analytical services. Development of 11 new multi-analyte pesticide methods has supported the following research efforts: an agricultural health study, neurological effects of organophosphate pesticides in structural applicators, herbicide exposure assessment among custom applicators, and effectiveness of hand washing in reducing agriculture worker exposure to pesticides, take-home pesticides, and greenhouse workers (Appendices 5.2a-09, 5.2a-11, 5.2a-12, 5.2a-13, 5.2a-14).

5.2b Cancer

Several projects have been developed to address the higher incidence of cancer found in farmers and their families.

Cancer Control Demonstration Projects for Farming Populations: Although, overall, farmers experience lower cancer rates than the U.S. population, they are nevertheless at increased risk for certain site-specific cancers, such as brain, stomach, lymphatic, hematopoietic, lip, prostate, and skin cancer. In addition, compared to urban populations, rural cancer patients are more likely to be diagnosed at later stages of disease and are at a more advanced state of illness when referred to home health care agencies. In an effort to more fully address the health needs of farmers and their families, AFF developed the Cancer Control Demonstration Projects for Farming Populations in 1990. (Appendix 5.2b-01)

Our health studies conducted in the past decade focusing on cancer in the agricultural population found the following:

- Wisconsin white, male farmers had significantly lower mortality risks than comparable nonfarmers for melanoma (SMR: 0.66; 95% CI: 0.33-0.99) and colon cancer (SMR: 0.76; 95% CI: 0.60-0.93), a nonsignificant decrement for non-Hodgkin's lymphoma (SMR: 0.93; 95% CI: 0.65-1.21), and a nonsignificant increase for rectal cancer (SMR: 1.01; 95% CI: 0.61-1.42). This study corroborates numerous investigations demonstrating that farmers generally experience the same or lower mortality risks for these malignancies than the U.S. population [Hanrahan 1996].
- An increase in the proportion of advanced malignancies among rural residents may be due to reduced availability of screening services, demographic characteristics, and access to health care. In at-home interviews in 33 nonmetropolitan Iowa counties, 1,126 farmers collectively were older, more likely to have health insurance, and had lower incomes than 1,092 nonfarmers. Farm men were less likely to have had a checkup or prostate cancer screening during the past year than nonfarm men. Farm women older than 50 were less likely than nonfarmers to have had mammograms but more likely to have had sigmoidoscopy. Farm women aged 40–49 were more likely than nonfarmers to have had mammograms. Farm women and men were almost twice as likely as nonfarmers to have had skin exams. Controlling for demographic characteristics and insurance coverage, farmers and nonfarmers were equally likely to use multiple screenings according to American Cancer Society guidelines. Because of the increased risk of breast cancer among women older than 50, interventions aimed at increasing utilization of mammography should be implemented. Although the farm population was more likely to use skin

examinations, prevalence should be increased substantially to counteract the continuing rise in skin cancer [Muldoon 1996].

Upper Midwest Health Study; a Population-Based Case-Control Study of Primary Intracranial Glioma Among Rural Residents: The known elevated incidence of brain cancer found among farmers was the impetus for this study. The study focused on Iowa, Michigan, Minnesota, and Wisconsin for several reasons: (1) CDC/WONDER showed elevated brain cancer incidence in the Upper Midwest; (2) collaborations had already been established with investigators in those States; and (3) those four States have substantial farm populations. The study objective was to identify rural or farm risk factors for primary intracranial gliomas and to evaluate the impact of genetic polymorphisms with their associated relevant exposures on susceptibility to gliomas (Appendix 5.2b-02). This research found the following:

- Moving to a farm as an adolescent (aged11–20) versus as an adult was associated with a greater risk of glioma [Ruder in Press]. This may point the way to interventions to protect adolescents.
- No evidence for association of pesticide exposure and glioma risk was found [Ruder 2006]. Further work may confirm that exposure levels of nonpesticide-using adults are indeed not carcinogenic, thus focusing intervention efforts on pesticide users.
- Compared with women who never breast-fed, women who breast-fed >18 months over their lifetime were at increased risk of glioma [Carreon 2005].

Another study focused on prioritizing pesticide exposure for a brain cancer case-control study using a subset of 134 pesticides that had been documented for their historical use in agricultural work [Sanderson 1997]. The methods developed for this study may be useful in prioritizing pesticides for other research studies.

5.2c Neurological Disease

Neurological Effects of Organophosphate Pesticides in Structural Applicators: Whether chronic low level pesticide exposure leads to neurological damage is an important public health question in the United States affecting potentially hundreds of thousands of agricultural and nonagricultural workers. *Neurological Effects of Organophosphate Pesticides in Structural Applicators*, funded by the EPA, began to address this question in 1996 by studying neurological function in 191 current and former termiticide applicators that had an average 2.4 years applying chlorpyrifos and 2.5 years applying other pesticides, and comparing their performance to that of 189 nonexposed controls (Appendix 5.2c-01).

Grower applies low-insecticide bait that is targeted against western corn rootworms feeding on and laying eggs in these soybeans. Source USDA 2006.

Neurobehavioral Assessment

A number of different projects and activities addressed this program area. These include the following:

- neurobehavioral testing of migrant workers with exposure to organophosphate compounds
- neurobehavioral testing of pest control operators with exposure to methyl bromide and sufuryl flouride
- neurobehavioral testing of pest control operators with exposure to chlorpyrifos
- neurobehavioral testing of orchardists (with multiple pesticide exposures) and their families in a home setting
- development and assessment of a new test battery, aimed at revealing peripheral nervous system effects

Key findings from these health studies on neurological diseases among the farming community [Dick 2001, Hines 2001, MacKenzie 2000, Steenland 2000, Steenland 1994, Calvert 1998] included the following:

Limited acute effects, primarily on measures of postural sway, were found using a chlorpyrifos urinary metabolite as a measure of current chlorpyrifos exposure. Determinants of airborne chlorpyrifos exposure included minutes of chlorpyrifos application and working inside an enclosed crawl space. Determinants of urinary metabolite levels included day-of-the-week, chlorpyrifos air concentrations 1 and 2 days before urine collection, working inside an enclosed crawl space, and treating a commercial structure. Applicator's weekly mean metabolite levels and weekly mean chlorpyrifos air concentrations were highly positively correlated.

An improved immunoassay method for the major human metabolite of chlorpyrifos in urine was strongly correlated with conventional analysis by GC/MSD. The method is useful for screening occupational exposure to chlorpyrifos.

Chlorpyrifos-exposed termiticide applicators reported more neurological symptoms than nonexposed controls. Few exposure-related effects were found for most neurological tests, and exposed and nonexposed groups did not differ for any test in clinical examination; however, exposed applicators perform less well on some tests. A pattern of delayed effects for applicators reporting prior poisoning was suggested. Organophosphate pesticide poisoning was associated with significant declines in sustained visual attention and changes in self-reported mood. Men with documented cholinesterase inhibition or who had been hospitalized for organophosphate pesticide poisoning, had significant changes in vibration sensitivity.

Sulfuryl fluoride exposure was associated with significantly reduced performance in tests of pattern memory and sense of smell. Fumigation workers also had significantly diminished dexterity in their dominant hand.

5.2d Adverse Reproductive Outcomes

Birth Defects and Parental Occupational Exposures: The relationship between parental pesticide exposure and birth defects is controversial. The *Birth Defects and Parental Occupational Exposures* project began in 2002 to focus on conducting a detailed exposure assessment of several maternal occupational exposures, including insecticides, herbicides, and agricultural fungicides. (Appendices 5.2d-01, 5.2d-02, 5.2d-03, 5.2d-04) The exposure data will be used for etiologic analyses of birth data and other information collected by CDC's NCBDDD to evaluate if maternal occupational pesticide use is related to birth defects in offspring. (Appendix 5.2d-05)

Reproductive Health Assessment of Agriculture Workers and Their Families

An ever-increasing number and variety of chemicals are used in agriculture that are known to be reproductive toxicants and endocrine disrtuptors. A prime example of these chemicals that pose great risk in agriculture are pesticides. Agriculture workers, their families, and the surrounding communities are at risk of exposure to these chemicals through the air, soil, food, or water, or through contamination brought home by agricultural workers, e.g., on their clothes.

The AFF Reproductive Health Assessment Team has taken a multipronged integrated approach to assess the reproductive health of agricultural workers and their families. A report by the President's National Science and Technology Council (NSTC) Committee on Environment and Natural Resources, "The Health and Ecological Effects of Endocrine Disrupting Chemicals: A Framework for Planning," provides a framework for planning Federal research related to the human health and ecological effects of endocrine disrupting chemicals, and categorizes three major areas needing research: 1) methods development, 2) model development, and 3) laboratory and field acquisition. AFF addressed each of these research areas by:

- developing sensitive and specific methods to biologically monitor reproductive health, (Appendices 5.2d-01, 5.2d-02, 5.2d-03, 5.2d-04)
- developing an animal model to study chemical reproductive toxicity, and
- conducting population studies using biomarkers to assess reproductive health in a variety of populations potentially exposed to a range of chemicals found in agriculture; many in these populations are underserved and vulnerable. (Appendix 5.2d-05)

Many of the studies conducted within the framework of this program evaluate the health effects of endocrine disrupting chemicals. Mixtures are generally formulated with insecticides and fungicides that are known to be synergistic (estrogenic and antiandrogenic). Male rabbits were exposed during their adolescence to demonstrate effects and provide guidance for the human study. Study populations included the following:

- young adult men and women in Hawaii exposed to a heptachlor in utero or during breast feeding

- an agriculture community in Illinois drinking ground water with high levels of atrazine
- pesticide appicators in Minnesota, Iowa, and Ontario
- a subsistence Native American community exposed to DDT in their soil, water, and food
- couples from the Texas gulf coast and Michigan exposed to pesticides in the environment, who were trying to conceive

As a result of this research, AFF has successfully developed both new methods of research and new models of research. These include the following:

Methods Developed

- sperm migration assay to measure sperm motility in specimens shipped overnight [Turner 2006]
- demonstration of the superiority of an LH immunoassay to reliably measure the preovulatory surge in urine [Kesner 1998]
- an algorithm for detecting features of the hormone profiles of the human menstrual cycle [Krieg 1999]
- endocrine markers of ovulation and of nonconceptus menstrual cycles [Baird 1999]
- silastic condoms for collection of semen samples [Schrader 1997]
- urinary creatinine measurement using multilayer dry film reagent technology [Knecht 2002]

Models Developed

- An animal model was developed to assess reproductive effects of pesticides (endocrine disruptors) during the peripubertal period. The rabbit was selected as the test species, since it has proven to be an excellent species for modeling reproductive toxicant effects in the male. The rabbit model was used to assess vinclozolin. Under the conditions of the study, vinclozolin reduced pubertal weight gain, weight of the accessory sex glands at maturity but paradoxically was associated with increased sperm count [Moorman 2000b].
- A model was developed to prioritize toxic chemicals for research. This model is ideal for use to prioritize chemicals found in agriculture, especially pesticides [Moorman 2000a].

In addition, significant findings from population studies include the following:

- 2,4D residues are present in the semen of about 50% of the participants in levels proportional to urinary 2,4-D levels [Arbuckle 1999].
- Agricultural workers who applied fungicides experienced a lower percentage of normal sperm morphology and lower sex ratio (male:female) of children they father, which in turn was correlated with serum testosterone levels of the men [Schrader 2000].

- The hand-held, backpack sprayer is the applicator method associated with highest urinary 2,4-D levels in men [Garry 2001].
- High urinary 2,4-D levels are associated with altered luteinizing hormone, follicle stimulating hormone, and testosterone levels and altered genomic stability (measured by V(D) J rearrangement frequency), which appears reversible [Garry 2001].
- Pesticide adjuvants exhibited positive dose-response for in vitro genotoxicity effects [Garry 1999].
- Preliminary data reveal that serum DDT levels in subsistence Native American women are directly correlated with follicular phase LH levels and inversely correlated with luteal phase FSH levels [Wainman 2004].

5.2e Respiratory Disease

Prevention of Occupational Respiratory Disease in Agriculture: This project addresses the knowledge gaps regarding respiratory health outcomes in agriculture including asthma, hypersensitivity pneumonitis, chronic bronchitis, and agricultural respiratory exposures. To accomplish the goal, we partnered with two existing studies to gather respiratory health outcomes data—the Agriculture Health Study (AHS) and the USDA NASS.

The AHS is one of the hallmark efforts currently underway on agricultural health in the United States. The study was initiated in 1993 by NCI, NIEHS, and EPA. The study uses a longitudinal cohort design and evaluates how lifestyle habits, genetic factors, and agricultural exposures at work and in the environment contribute to the risk of disease. More than 89,000 certified farmer pesticide applicators and their spouses from North Carolina and Iowa and licensed commercial pesticide applicators from Iowa are included in the study making it one of the largest agricultural health studies ever conducted in the United States. This large cohort provides a unique opportunity to apply our resources for the study of respiratory health outcomes in agriculture including asthma, hypersensitivity pneumonitis, and chronic bronchitis with the study of both prevalent and incident disease patterns, as well as risk factors related to pesticide and nonpesticide exposures.

This project also provides for collaboration on a national survey completed through contract with the USDA/NASS. The respiratory focus will be on asthma and respiratory exposures. The survey will target 25,000 farm operators nationally stratified by geography and commodity providing a large, representative sample. Results from these efforts will be shared with our partners nationally and applied to better direct exposure reduction and respiratory disease prevention efforts in agriculture. Study outcomes may also identify new research needs or be used to initiate new research studies addressing pesticide exposure and respiratory disease in agriculture.

Preliminary findings are showing some previously unrecognized (and unreported in the agricultural health literature) associations between pesticide exposures and respiratory health outcomes including chronic brohchitis, hypersensitivity pneumonitis, and asthma [Valcin 2006, Hoppin 2006, Hoppin Accepted]. Results from these efforts will be applied to better direct exposure reduction and respiratory disease prevention in agriculture. These preliminary findings also have moved researchers at NIOSH, NIEHS, and NCI to action in developing a new case control study addressing pesticide exposure, diesel exposure, and occupational asthma in agriculture. Study outcomes may also identify other new research needs or be used to initiate new research studies addressing pesticide exposure and respiratory disease. (Appendix 5.2e-01)

The AFF Program has also focused on preventing organic dust toxic syndrome. Some of our successes in this area include the following:

- A NIOSH Alert was developed based on composite findings from several HHE projects/ investigations to summarize findings on the occurrence of organic dust toxic syndrome and to provide national guidance on prevention [NIOSH 1994]. (Appendix 5.2e-02)
- A NIOSH hazard control was developed in conjunction with the NYCAMH. This new exposure control is focused on reducing the massive organic dust exposures from mechanically chopping bedding in animal confinement facilities. This hazard control was distributed nationally by NIOSH and by NYCAMH [NIOSH 1997].
- Two articles were published in the American Journal of Industrial Medicine (AJIM) describing our investigation of a case of acute respiratory illness, requiring hospitalization, following organic dust exposures from compost materials, and subsequent laboratory-based animal exposure studies on pulmonary response models. The articles illustrate some of the clinical difficulties in differentiating hypersensitivity pneumonitis from organic dust toxic syndrome following massive organic dust exposures, and show that animal exposure models can be useful in predicting the potential respiratory

Dusts from Silo Uncapping

Organic Dusts from Bedding Chopping

hazards associated with exposure to various organic dusts [Frazer 1993, Weber 1993]. (Appendices 5.2e-02, 5.2e-03, 5.2e-04, 5.2e-05, 5.2e-06)

5.2f Disease Interventions

Several of the studies related to specific diseases, especially cancer, included intervention efforts to reduce exposure and/or disease. Some of the findings from the interventions attempted include the following:

- An intervention of mailed pesticide information, educational programs on pesticides for physicians, elementary school training modules on pesticides, and safe pesticide handling displays in key business areas was delivered to pesticide-using farmers in two counties. The use of gloves and other protective clothing while handling pesticides increased in the intervention group over that in pesticide-using farmers in two counties not receiving interventions. Improvement was greater in those who had used protective equipment the least before the intervention [Weber 1993].
- Interventions at rural Iowa supermarkets (including flyers that identified fruits and vegetables on sale, recipes, menu ideas, a 50-cent coupon, and food demonstrations and nutrition-related signs) were evaluated with exit interviews and take-home surveys at baseline and approximately 1 year later. At follow-up, 43% of intervention store shoppers and 7% of control shoppers recalled seeing the flyer, 36% of intervention shoppers had used the coupon, and 18% had used a recipe. Purchase of fruits or vegetables on the interview day did not differ between intervention and control stores [Kristal 1997].
- Individual mailings containing information about breast cancer risk and community sources for screening, and information and screening were provided at county and community fairs. Rural participants in both intervention and control communities demonstrated significant changes in knowledge and attitudes about breast cancer. Education—rather than income, insurance coverage, or family history of breast cancer—was the most significant predictor associated with greater use of mammography [Gardiner 1995].
- Bilingual health educators met with farm worker communities near Merced and Modesto, CA, to determine barriers to seeking screening for breast and cervical cancer. Cancer education and screening program participants received a presentation in Spanish on breast and cervical cancer that included a pretest and posttest to assess increases in knowledge. Data from pretests and posttests indicated a statistically significant increase in knowledge about cancer and its prevention among participants. Clients were encouraged to receive free breast and cervical cancer screenings: 20% of participants redeemed vouchers for cancer screenings [Goldsmith 1996].
- A situation analysis identified constraints and opportunities for providing farm workers with cancer control information and services. Based on what was learned, recommendations for designing cancer control research and intervention for farm workers, especially migrant farm workers, include on-the-spot Pap smear determination so any warranted additional exam or

treatment can be done during the same visit, holding health fairs at migrant camps and day care centers, and insuring that staff include Spanish and Haitian speakers [Hooks 1996].

- Telephone interviews in six rural counties obtained data on chemically resistant glove and other protective equipment use as they relate to the type of farming practice, demographic characteristics of farmers and their farming operations, farmers' preventive health beliefs and behaviors, and factors related to their health care. Ninety-five percent of pesticide users believed in the effectiveness of protective equipment, 88% believed pesticide exposures were harmful, 56% wore chemically resistant gloves, and 22% wore other protective clothing ≥75% of the time when using pesticides. Glove use and certification to use restricted pesticides were less frequent for women [Mandel 1996].

5.3 Selected Outputs

The AFF has been successful in authoring publications of more than 400 articles in juried publications reporting the findings of our work, as well as abstracts, manuscripts, and book chapters. Almost all of these publications have been cited numerous times in the literature proving that this information is getting to its intended audiences. A bibliography is at the end of this chapter.

As cited earlier in this chapter, our research has been extremely effective in fostering new collaborative links with other Federal agencies, State health departments, universities, and the private sector. Such collaborative work has extended not only the breadth of our research, but also the reach of our findings to additional target audiences. This has enabled us to create educational materials that convert commonly understood prevention techniques and research findings into usable, occupationally specific guidance for farmers, farm workers, and their families. These materials can be used by farm worker organizations.

Selected outputs of note include the following.

NIOSH Published Analytical Methods

- NMAM 5602: Chlorinated Organonitrogen Herbicides (Air Sampling)
- NMAM 9200: Chlorinated Organonitrogen Herbicides (Hand Wash)
- NMAM 9201: Chlorinated Organonitrogen Herbicides (Dermal Patch)

These methods are detailed sampling and analytical procedures for measuring chlorinated organonitrogen herbicides in air, hand rinse, and dermal patch samples. The methods expand the capability of researches and practitioners to measure the exposure of farmers, farm workers, families, and others to this class of herbicides in several exposure matrices. In particular, two of the methods address dermal exposure, an often important route of exposure to pesticides. Accurate measurement and characterization of exposure leads to improved risk assessment.

- Method 9202: Captan and Thiophanate-methyl in hand rinse (HPLC)
- Method 9205: Captan and Thiophanate-methyl in dermal patch (HPLC)
- 6Method 9208: Captan in Air Samples by GC/MS

These methods are detailed sampling and analytical procedures for measuring captan and thiophanate-methyl in air, hand rinse, and dermal patch samples. The methods expand the capability of researchers and practitioners to measure the exposure of farmers, farm workers, families, and others to captan and thiophanate-methyl in several exposure matrices. In particular, two of the methods address dermal exposure, an often important route of exposure to pesticides. Accurate measurement and characterization of exposure leads to improved risk assessment.

From 1996 to 2005, we have developed and issued 12 methods (added to the *NIOSH Manual of Analytical Methods*, 4th ed.) and developed or updated 13 more methods that are applicable to monitoring chemicals used by agricultural workers. The NMAM (1994 ed.) had already contained 21 methods for monitoring chemicals used in agriculture. We have analyzed more than 22 sequences (more than 9,000 field samples) related to the field studies mentioned above. We have also conducted work to develop or improve the 25 methods mentioned above.

Papers

Carreón T, Butler MA, Ruder AM, Waters MA, Davis-King KE, Calvert GM, Schulte PA, Sanderson WT, Ward EM, Connally LB, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2005]. Gliomas and farm pesticide exposure in women. Environ Health Perspect *113*(5):546–551. (No evidence for association of pesticide exposure and glioma risk was found. Further work may confirm that exposure levels of nonpesticide-using adults are indeed not carcinogenic, thus focusing intervention efforts on pesticide users.)

Curwin B, Hein M, Sanderson W, Barr D, Reynolds S, Ward E, Alavanja M [2005]. Urinary and hand wipe pesticide levels among farmers and non- farmers in Iowa. *Journal of Exposure Analysis and Environmental Epidemiology* 15(6):500-508.

Hines CJ, Deddens JA, Tucker SP, Hornung RW [2001]. Distributions and determinants of pre-emergent herbicide exposures among custom applicators. Annals Occup Hyg *45*:227–239. [cited 9 times] (This paper examined the extent of exposure of custom applicators to several commonly used herbicides applied to corn and soybean fields. Custom applicators are among the heaviest herbicide users in the United States. This study had a strong design in that applicators were systematically sampled at regular intervals that included spray and nonspray days (to approximate random sampling), repeated measurements (to estimate within- and between-worker variability) were obtained on each applicator, and multiple herbicides were measured in dermal, urinary, and salivary matrices. This study was also one of the earliest applications of mixed-effect regression models to identify exposure determinants in agriculture. Among the identified determinants, wearing gloves significantly reduced hand exposure and thigh exposure when herbicide was sprayed; however, wearing gloves was significantly associated with increased atrazine hand and thigh exposure on days that nonatrazine herbicides were sprayed. Herbicide exposure on nonspray days was widespread and indicated that a complete characterization of custom applicator herbicide exposures should include both spray and nonspray days. This study involved both intramural and extramural research to identify new herbicide metabolites and to develop new and innovative analytical methods for measuring herbicides in dermal and biological samples. This paper won the NIOSH 2002 Alice Hamilton Award for best paper in Human Studies.)

Ruder AM, Waters MA, Carreón T, Butler MA, Davis-King KE, Calvert GM, Schulte PA, Ward EM, Connally LB, Lu J, Wall D, Zivkovich Z, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Brain Cancer Collaborative Study Group [2006]. The upper midwest health study, a case-control study of primary intracranial gliomas in farm and rural residents. J Agric Safe Health *12*:255-274. (Moving to a farm as an adolescent [11–20] versus as an adult was associated with a greater risk of glioma [OR 1.96, CI 1.13-3.39]. This may point the way to interventions to protect adolescents.)

Ruder AM, Waters MA, Butler MA, Carreón T, Calvert GM, Davis-King KE, Schulte PA, Sanderson WT, Ward EM, Connally LB, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2006]. Gliomas and farm pesticide exposure in men. Arch Environ Health *59*:650-657. (No evidence for association of pesticide exposure and glioma risk was found. Further work may confirm that exposure levels of nonpesticide-using adults are indeed not carcinogenic, thus focusing intervention efforts on pesticide users.)

Sanderson WT, Talaska G, Zaebst D, Davis-King K, Calvert G [1997]. Pesticide prioritization for a brain cancer case-control study. Environ Res *74*:133–144. (The methods used to select this subset of 134 pesticides document historical usage and may be useful in prioritizing pesticides for other research studies.)

National and International Presentations

Butler MA, Ruder AM, Levine AJ, Werren DM, ONeill VL, Masterson KJ, Schulte PA [1999]. Successes in biological specimen collection from cancer cases and controls in rural areas. Proc Am Assn Cancer Res *40*:612. Presented at the AACR, Philadelphia, PA, March. (This presentation and the paper [in preparation] offer guidance for collection of biological specimens in rural areas.)

Curwin B, Hein M, Sanderson W, Barr D, Reynolds S, Ward E, Alavanja M [2004]. Urinary pesticide levels among farmers and nonfarmers in Iowa [Abstract]. Presented at X2004: Exposure Assessment in a Changing Environment, Utrecht University, The Netherlands, June 16–18.

Hines CJ, Deddens JA, Striley CAF, Brown KK, Lu C, MacKenzie BA, Biagini RE, Shoemaker DA, Fenske RA, Hull RD [2004]. Biological monitoring for atrazine and

2,4-D among custom applicators. I. Results of exposure determinant modeling, X2004. Utrecht University, The Netherlands, June 16–18.

Ruder AM, Butler MA, Sanderson W, Carreón T, Waters MA [2001]. Development of a retrospective pesticide reference database. Presented at the American Public Health Association meeting, Atlanta, GA, October. (Linking the reference database to the participant data allows us to convert trade names to generics. Data can be analyzed by individual generic, by class of pesticide (organophosphate, etc.), by carcinogenicity rating from the International Agency for Research on Cancer, and by the weight of evidence as to whether a pesticide has endocrine-disrupting activity. This database will be useful to others assessing self-reported pesticide exposure histories.)

Waters M, Ruder A, Echeverria D [1999]. A new method for retrospective occupational exposure data collection in a case-control study of cancer. Proc Am Indus Hyg Conf Expos; 59A:46. Presented at the AIHCE, Toronto, Ontario, June. (Exposure specific followup questionnaires were developed for 22 exposure categories of interest, including pesticides, with questions about factors related to exposure intensity, duration, and frequency and protective equipment use. This new methodology improves the precision of exposure estimates.)

A complete list of outputs can be found in section 5.9 at the end of this chapter.

5.4 Intermediate Outcomes

5.4a Extent of Exposure

Exposure Biomonitoring: Results of our biomonitoring studies have been used by the EPA to re-evaluate uncertainty factors used in risk assessments and have applied them to new risk assessments and dose-response models [Environmental Protection Agency 2006].

Results from our take-home pesticide study have been used by researchers at the Utrecht University, The Netherlands, and the University of Iowa to further their research in this field. At Utrecht University, researchers have conducted preliminary work on take-home pesticides. Discussions have been on-going with them to conduct additional pesticide take-home work among farmers in the Netherlands based on their preliminary results and from the NIOSH take-home pesticide study results [Heederik 2006]

Research developing standards for measurement of blood cholinesterases demonstrated that widely used commercial kits and procedures to measure ChEs in the rat and human are not conducted under optimum conditions and in some situations may yield grossly inaccurate results. Our work led to an approach to optimize the colorimetric assay which has been adopted by the State of California into their guidelines for clinical laboratories.

Further results of our work on cholinesterase have had a demonstrable impact in northwest agricultural safety and health. In 1995, a TAG formed by the WSDLI found that a cholinesterase monitoring program was technically feasible and necessary to protect worker health. 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 [Washington State Department of Labor and Industries 2006]. The TAG report recommended the following:

- 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 3 to 4 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 WSDLI 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 [Washington State Department of Labor and Industries 2005].

Engineering Controls: AFF engineering control studies resulted in the development of voluntary standards by equipment manufacturers, based primarily on the EPHB particle size data, for cabs manufactured in the United States (American Society of Agricultural Engineers Standard S525). An international committee has been formed including U.S. equipment manufacturers such as John Deere, Case / International Harvester, and Adco, to promote the ISO adaptation of similar standards for production of agricultural enclosures worldwide.

Control of CO emissions resulted in the development of automatic engine shut-off sensors to stop equipment operation before CO concentrations reach hazardous levels.

5.4b Adverse Reproductive Effects

The project on Reproductive Health Assessment of Agriculture Workers and Their Families has helped direct further research in this area. In addition, a commercial diagnostics company (PerkinElmer) adapted two immunoassays developed by the program for manufacture and sales.

5.4c Neurological Effects

Subsequent to the AFF Program neurological effects study and taking into consideration other data, EPA banned the use of chlorpyrifos for residential use. This action was taken primarily to protect children. In addition, chlorpyrifos is no longer used as a termiticide, thereby eliminating its exposure to termite control workers [Environmental Protection Agency 2002].

5.5 End Outcomes

Much work has been done to determine the extent of exposure of farm workers and their families to chemicals, primarily pesticides and herbicides, and several intermediate outcomes have been accomplished as documented above. Similarly, AFF Program surveillance and health studies have shown the association of these exposures with cancer, neurological diseases, respiratory effects, and reproductive effects. In addition, various interventions have shown to be effective in reducing both exposure and disease. However, we are still working to quantitatively document reduced exposures, morbidity, and mortality.

Our efforts to date are critical to reaching our end outcomes. Without the laboratory methodologies we developed, we would be unable to measure actual exposure levels both in the environment and in humans. Similarly without surveillance we would not know the extent of disease, nor would we be able to measure any reductions. Finally, without the health studies we would be unable to draw the association between level of exposure and type of disease. All of these activities lay the foundation for achieving our end outcomes.

5.6 External Factors

Two areas that will shift the focus of AFF Program efforts relate to the changing demographics of the population of agricultural workers. First, the traditional farm family is changing. The population is aging and the number of small family farms is decreasing. With the reduction in traditional tobacco farming a large segment of small farms in the southeast United States will be changing to different crops or leaving farming altogether. Secondly, more and more farm workers are nonnative and/or migratory. Communication with these workers is difficult because of the language barrier and tracking them for any amount of time becomes problematic.

In addition, the number and variety of chemicals used in agriculture continues to increase, providing a challenge to prioritize and assess the toxicity in humans. Advances in our understanding of the toxicity of endocrine disruptors, for example, highlight the threat of many agricultural chemicals. New methods continue to be needed to provide researchers with state-of-the-art biological markers of disease.

Finally, an increased emphasis on worker protection related to terrorist and disaster incidents is anticipated.

5.7 Future Directions

AFF Program researchers will continue to develop new laboratory methods to assess worker exposures to agricultural chemicals. These methods are proceeding in two primary directions; multiplexed methods (i.e., measuring multiple analytes simultaneously in a single sample) and field portable methods. These will allow rapid determination of exposures in the field and also provide near instantaneous evaluation of control practices. NIOSH has expanded its capacity to conduct research into biomonitors of effect. New technology is allowing researchers to examine minute changes in proteins, genes, and enzymes in biological fluids that are indicative of very early stages of disease, long before clinical signs may develop. Further pursuit of these techniques will allow for very early intervention to prevent more severe disease. Engineering control research will continue. Aerosol research will also continue to develop information and measurement techniques relevant to small particle exposures, with nanoparticles becoming a significant portion of this work.
With regard to cancer research, data analysis is ongoing for *The Upper Midwest Health Study; a Case-Control Study of Primary Intracranial Gliomas among Rural Residents*, so some still unresolved questions in glioma etiology may be answered by future analyses. Analysis of data on pesticide users (on the farm, in the house and garden, and on nonfarm jobs) is the top priority. Analysis of the relation of other uniquely farm exposures (raising crops and animals, handling manure, using farm equipment) is also a high priority. This analysis may provide some understanding of why farmers are at higher risk of brain cancer, as well as pointing the way toward working to reduce the relevant exposures.

The critique of *Cancer Control Demonstration Projects for Farming Populations* suggested that one future role for the AFF Program was in publishing guidelines for organizing cancer prevention and control projects among farming populations. This overall evaluation and summation of the project remains to be done. Another role suggested was the convening of Federal agencies and national associations to assure the dissemination of findings, such as the Agricultural Safety and Health Conference held in Morgantown, West Virginia, in 1997.

As data analysis has not yet begun for *Birth Defects and Parental Occupational Exposures,* no future directions have been identified or have been planned to date.

The AFF plans to continue with some existing collaborations with the following activities:

Agricultural Health Study - This collaboration with NCI/NIEHS/EPA on a 90,000 person study will provide useful information on the potential relationship between farm exposures and a variety of health outcomes. A study of this size is only feasible via collaborative efforts with other federal agencies. NIOSH is contributing expertise in exposure assessment methods and respiratory disease.

CDC Birth Defects Registries - This collaboration with the CDC NCBDDD and several state birth defect registries is in data collection phase but will provide the opportunity to evaluate any potential relationship between occupational exposures, such as pesticides, and birth defects. This is very good example of research that would not be possible without partnering with another agencies with similar interests.

Extent of Exposure - the Environmental Protection Agency is a key partner is our efforts to better characterize exposures to pesticides. We anticipate that we will continue to develop biomonitoring methods to detect pesticide exposures in agriculture workers and to conduct field investigations to characterize the determinants of exposures and identify effective interventions.

5.8 List of NIOSH projects that are included in this chapter

- DART-92700A2-Immunochemical Biological Monitoring for Occup Exp & Dis (Appendix 5.2a-01)
- DART-9278234-Use of a Hepatocyte Model for Identifying Biomarkers (Appendix 5.2a-02)
- DART-9278314-A Method for Simultaneous Analysis of Multiple Pesticides (Appendix 5.2a-03)
- DART-9278351-Biomonitoring Methods for Agricultural Exposures (Appendix 5.2a-04)
- DART-9278159-Pesticides by GC-AED (gas chromatography-atomic emission detector) (Appendix 5.2a-05)
- DART-VQK425-Short-term Method Development to Support Field Studies (Appendix 5.2a-06)
- DART-9278484-Method development for Field Research (Appendix 5.2a-07)
- DART-9278413-Analytical Method Development for Emerging problems (Appendix 5.2a-08)
- DSHEFS-9277421-Take-home Pesticide Exposure (Appendix 5.2a-09)
- DRDS-9278113-Environmental Tractor Cab System Integrity (Appendix 5.2a-10)
- DSHEFS-9277132-Ag Health Study, Pesticide Exposure Among Farmer Applicators (Appendix 5.2a-11)
- DSHEFS-9278573-Emerging Agricultural Problems – effectiveness of hand washing in reducing agricultural worker exposure to pesticides (Appendix 5.2a-12)
- DSHEFS-9278578-Pesticide Exposure of Rose Greenhouse Workers (Appendix 5.2a-13)
- DSHEFS-9278605-Herbicide Exposure Assessment Among Custom Applicators (Appendix 5.2a-14)
- DSHEFS-9278577-Cancer Control Demonstration Projects for Farming Populations (Appendix 5.2b-01)
- DSHEFS-9278514-A Case-Control Study of Primary Intracranial Gliomas Among Rural Residents (Appendix 5.2b-02)

- DSHEFS-9278570-Neurological Effects of Organophosphate Pesticides in Structural Applicators (Appendix 5.2c-01)
- DART-VOO8006-Investigations of Pesticides as Endocrine Disruptors (Appendix 5.2d-01)
- DART-92700A1-Reproductive Health Assessment of Male Workers (Appendix 5.2d-02)
- DART-9278278-Methods for Assessing Male Reproductive Toxicity (Appendix 5.2d-03)
- DART-9278287-Methods to Evaluate Reproductive Potential of Women (Appendix 5.2d-04)
- DSHEFS-9278428-Birth Defects and Parental Occupational Exposures (Appendix 5.2d-05)
- DRDS-927Z1NG-Prevention of Occ. Respiratory Disease in Agriculture (Appendix 5.2e-01)
- DRDS- VKH8215-Ag Dusts: Field-Based Evaluation of Exposures & Acute Respiratory Illness (Appendix 5.2e-02)
- DRDS-9278165-Agricultural dusts: Animal models of asthma (Appendix 5.2e-03)
- DRDS-9278163-Agricultural Dusts: Elucidation of Disease Mechanisms (Appendix 5.2e-04)
- DART-9278430-Method Development for Fungi in Occupational Diseases (Appendix 5.2e-05)
- DART-9278456-Applied Monitoring Studies (Appendix 5.2e-06)

5.9 Outputs

Analytical Methods

A Computer Program to Promote Understanding of the Monitoring Method Evaluation Guidelines Used at NIOSH - M. T. Abell and E. R. Kennedy [1997]

A Laboratory Comparison of Two Media for Use in the Assessment of Dermal Exposure to Pesticides - C. D. Lorberau and J. L. Pride [2000]

A Sampling and Analytical Method for the Simultaneous Determination of Multiple Organonitrogen Pesticides in Air - E. R. Kennedy, J. Lin, J. M. Reynolds and J. B. Perkins [1997]

Analytical Performance Criteria Standards Activities of the ASTM International Committee on Atmospheric Sampling and Analysis - K. Ashley [2004]

An Evaluation of Worker Lead Exposures and Cleaning Effectiveness During Removal of Deteriorated Lead-Based Paint - A.L. Sussell, C. Hart, D. Wild and K. Ashley [1999]

Application of the Gas Chromatography-Fatty Acid Methy Ester System for the Identification of Environmental and Clinical Isolates of the Family Micrococcaceae - S. M. Pendergrass and P. A. Jensen [Aug. 1998]

ASTM Standards for Lead Paint Abatement and Mitigation of Lead Hazards - K. Ashley [1996]

ASTM Standards for Monitoring Chemical Hazards in the Workplace - K. Ashley and M. Harper [2004]

Chemical Sampling - E. R. Kennedy [2005]. Analytical Performance Criteria ASTM International Standards for Monitoring Chemical Hazards in Workplaces - K. Ashley and M. Harper [2005]

Chlorinated and organonitrogen herbicides (hand wash) 9200 OSHA: Datachem [1998], also 9201 [2004] (NIOSH Manual of Analytical Methods (NMAM), Fourth Edition).

Detection and Characterization of Airborne Mycobacterium tuberculosis H37Ra Particles, A Surrogate for Airborne Pathogenic M. tuberculosis - M. P. Schafer, J. E. Fernback and M. K. Ernst [1999]

Determination of Capsaicin and Dihydrocapsaicin in Air in a Pickle and Pepper processing Plant - S. P. Tucker [2001]

Development of Sampling and Analytical Methods for Concerted Determination of Commonly Used Chloracetanilide, Chlorotriazine, and 2,4-D Herbicides in Hand Wash, Dermal Patch and Air Samples. - S. P. Tucker, J. M. Reynolds, D. C. Wickman, C. J. Hines and J. B. Perkins [2001]

Direct Detection of Histoplasma Capsulatum in Soil Suspensions by Two-Stage PCR - T. M. Reid and M. P. Schafer [1999]

Evaulating a Spot Test for Detecting Air-borne Lead in the Workplace - K. Ashley and T. J. Fischbach [1996]

Exposure Assessment Research at NIOSH - A Key to Improving Worker's Health - E. R. Kennedy [2001]

Field Test of a Portable Method for the Determination of Hexavalent Chromium in Workplace Air - D. A. Marlow, J. Wang, T. J. Wise and K. Ashley [2000]

Guidelines for the Evaluation of Direct Reading Monitors - E. R. Kennedy, M. L. Woebkenberg, R. Song, D. L. Bartley and P. C. Schlecht [2002]

Histoplasmosis Protecting Workers at Risk - S. W. Lenhart, M. P. Schafer, M. Singal and R. A. Hajjeh [1997]

Interlaboratory and Intralaboratory Variabilites in the Environmental Lead Proficiency Analytical Testing (ELPAT) Program - P. C. Schlecht, R. Song, J. H. Groff, H. A. Feng and C. A. Esche [1997]

International Standard Procedure for the Extraction of Metal Compounds Having Soluble Threshold Limit Values - K. Ashley [2001]

Laboratory and Analytical Method Performance of Lead Measurements in Paint chips, Soils and Dusts - P. C. Schlecht, J. H. Groff, H. A. Feng and R. Song [1996]

Laboratory Investigation of the Mass Stability of Sampling Cassettes from Inhalable Aerosol Samplers - J. P. Smith, D. L. Bartley and E. R. Kennedy [1998]

NIOSH Analytical Methods -Evaluation and Validation - K. Ashley and E. R. Kennedy [2004]

NIOSH Publication No. 2004-146, Worker Health Chartbook 2004 Chapter 3; Focus on Agriculture [Sestito and Lunsford collaborated on document]

NMAM 2nd supplement Alachlor in Air, 5603, Bioaerosol Sampling, 0800. [http://www.cdc.gov/niosh/nmam/nmam2sup.html].

Performance Criteria and Characteristics of Field Screening Test Methods - K. Ashley, R. Song and P. C. Schlecht [2002]

Performance Criteria and Characteristics of Field Screening Test Methods - R. Song, P. C. Schlecht and K. Ashley [1998]

Performance of Laboratories Analyzing Organic Solvents in the Proficiency Analytical Testing Program - S. A. Shulman, J. H. Groff, P. C. Schlecht and D. Xue[1996]

Protecting Workers Exposed to Lead-Based Paint Hazards - K. Ashley, G. Burr, J. Gittleman, L. Mickelsen, H. Nagy, G. Piacitelli, R. Roscoe, A. Sussel and E. Whelan [1998]

Sampling and Analytical Method Development for Qualitative Assessment of Airborne Mycobacterial Species of the Mycobacterium Tuberculosis Comples - M. P. Schafer, J. E. Fernback and P. A. Jensen [1998]

Sampling Environmental Media ASTM STP 1282 - K. Ashley, P. C. Schlecht, R. Song, H. A. Feng, G. Dewalt and M.E. McKnight [1996]

Survey of Anlytical Methods - P. C. Schlecht and M. E. Cassinelli [1997]

Survey of Analytical Methods: Part II - P. C. Schlecht and M. E. Cassinelli [1997]
Ultrasonic extraction and portable anodic stripping voltammetric measurement of lead in paint, dust wipes, soil, and air: An interlaboratory evaluation - K. Ashley, R. Song, C. A. Esche, P. C. Schlecht, Baron PA and T. J. Wise [1999]

Uniformity Test of Bias When the Reference Value Contains Experimental Error - R. Song, E. R. Kennedy and D. L. Bartley [2001]

Workplace Monitoring for Volatile Organic Compounds Using Thermal-Desorption-Gas-Chromatography-Mass Spectrometry - A. A. Grote and E. R. Kennedy [2002]

Book Chapters

Schrader SM [1997]. Ch 22: Male reproductive toxicants. In: Massareo EJ, ed. CRC Handbook of Human Toxicology. New York: CRC Press, pp. 961–980 (ISI Web of Science: Cited 1 time as of 11/20/06)

Database

A DART repository contains biological specimens (blood and tumor tissue) from more than 1,000 case and control participants in the Upper Midwest Health Study. Nonidentifying case and control demographics are in a companion database. This repository is available to the scientific community for hypothesis testing to evaluate susceptibility factors in the development of glioma.

Manuscripts

Hoppin JA, Umbach DM, Henneberger PK, Kullman GJ, London SJ, Alavanja MCR, Sandler DP (forthcoming). Agricultural factors associated with farmers' lung among farm residents in the Agricultural Health Study.

Valcin M, Henneberger PK, Kullman GJ, Umbach DM, London SJ, Alavanja MCR, Sandler DP, Hoppin JA (forthcoming). Chronic bronchitis among non-smoking farm women in the Agricultural Health Study. Submitted to European Respiratory Journal.

Presentations

Baron PA. Generation and behavior of airborne biological particles. Presentation at the Public Health Response to Bioterrorism Meeting, April 8–9, Atlanta, GA.

Baron PA [2002]. Aerosol measurement. Presentation at Department of Civil and Environmental Engineering, University of Cincinnati, February 22, Cincinnati, OH.

Baron PA [2003]. Measurement of fibers. Presentation at Department of Civil and Environmental Engineering, University of Cincinnati, May 16, Cincinnati, OH.

Baron PA, Aizenberg V [2001]. Versatile output dust generation system. Presented at the American Association for Aerosol Research Meeting, October 15–19, Tacoma, WA.

Baron PA, Deye GJ [2005]. Generation of very low density fibrous carbon powders (single walled carbon nanotubes and pyrograf III). Presented at the American Association for Aerosol Research Conference, Oct. 17–21. Austin, TX.

Baron PA, Martinez A [2000]. A large-particle size distribution analyzer. Presented at the American Association for Aerosol Research Meeting, November 6–10, St Louis, MO.

Baron PA, Box M, Echt A, Shulman S [2004]. Sampling issues related to silica. Presentation at the American Society for Testing Materials Symposium on Silica: Sampling and Analysis. April 22–23, Salt Lake City, UT.

Baron PA, Deye GJ, Aizenberg V, Castranova V [2001]. Generation of size-selected fibers for a nose-only inhalation toxicity study. Presented at Inhaled Particles, September 2–6, Cambridge, UK.

Baron PA, Martinez A, Jones E [2003]. Droplet distortion effects in aerodynamic particle sizing instruments. 22nd American Association for Aerosol Research Conference. Anaheim, CA, October 20–24. Also at Particulate Matter (AAAR), March 31–April 4, Pittsburgh, PA.

Baron PA, Maynard A, Porter D, Castranova V [2002]. Measurement of an ultra-low-density particle aerosol. Am Association for Aerosol Research Annual Meeting, October, Charlotte, NC.

Baron PA, Maynard A, Reese T, Fotedar L [2001]. Preliminary measurements of carbon nanotube material in aerosol form. Nanospace, March 25–29, Galveston, TX.

Baron PA, Maynard AD, Shvedova A, Kisin K, Murray A, Gandelsman V, Foley M, Castranova V [2003]. preliminary studies of generation, exposure, and toxicity of carbon nanotubes. 22nd American Association for Aerosol Research Conference. October 20–24, Anaheim ,CA.

Baron PA, Shulman S, Ramsey D, Volkwein J, Vinson R, O'Shaughnessy P, Ramachandran G [2004]. Evaluation of size distribution measurement precision obtained with a personal cascade impactor. Presented at the European Aerosol Conference, September 6–10. Budapest, Hungary.

Butler MA, Ruder AM, Carreón T, Waters MA, Yeager M, Welch R, Chanock S, Schulte PA [2004]. Polymorphisms in the estrogen metabolism genes CYP17, CYP1B1, CYP1A2, COMT and ER alpha and susceptibility to primary intracranial brain gliomas in women. Proc Am Assn Cancer Res *45*:4511. Presented at AACR, Orlando, Florida, March.

Butler M, Ruder A, Carreón T, Waters M, Yeager M, Welch R, Chanock S, Schulte P [2005]. Polymorphisms in DNA repair genes and susceptibility to primary intracranial brain gliomas. Neuro-Oncology *7*:287. Presented at Second quadrennial meeting of the World Federation of NeuroOncology, Edinburgh, Scotland, May.

Butler MA, Ruder AM, Daly AK, Waters MA, Carreón T, Schulte PA [2003]. Polymorphisms in GSTM1, GSTT1, GSTP1, and NAT2 and susceptibility to primary intracranial brain gliomas. Proc Am Assn Cancer Res *44*:128. Presented at AACR, Washington, DC, August.

Butler MA, Ruder AM, Levine AJ, Werren DM, ONeill VL, Masterson KJ, Schulte PA [1999]. Successes in biological specimen collection from cancer cases and controls in rural areas. Proc Am Assn Cancer Res *40*:612. Presented at the AACR, Philadelphia, Pennsylvania, March.

Butler MA, Ruder AM, Waters MA, Daly AK, Schulte PA [2001]. Successes in DNA preparation for identification of biomarkers of exposure, effects of exposure, and susceptibility in cancer cases and controls in rural areas. Proc Am Assn Cancer Res *42*:885–886. Presented at the AACR, New Orleans, Louisiana, March.

Carreón T, Butler MA, Ruder AM, Waters MA, Davis-King KE, Calvert GM, Schulte PA, Connally LB, Ward EM, Sanderson WT, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G [2003]. Farm exposure to pesticides and glioma in women. Proc Am Assn Cancer Res 44:1466–1467. Presented at AACR, Washington, DC, August.

Carreon T, Ruder AM, Waters MA, Butler MA, Yeager M, Welch R, Chanock S, Schulte PA [2006]. Lead exposure and glioma among rural residents: The Upper Midwest Health Study. Am J Epidemiol *163*:S251. Presented at Congress of Epidemiology, Seattle, Washington, June.

Curwin BD, Hein MJ, Sanderson WT, Striley C, Heederik D, Kromhout H, Reynolds SJ, Alavanja M. Pesticide dose estimates for children of Iowa farmers and non-farmers. Abstract presented at the ISEA/ISEE International Conference on Environmental Epidemiology and Exposure, September 2 – 6, 2006, Paris, France

Curwin BD, Hein MJ, Sanderson WT, Striley C, Heederik D, Reynolds SJ, Alavanja M. Urinary pesticide levels in Iowa farm spouses and children. Abstract presented at the 15th Annual Conference of the International Society for Exposure Analysis, Tuscon, Arizona October 30 – November 3, 2005

Curwin BD, Hein MJ, Sanderson WT, Nishioka N, Buhler W. Nicotine Exposure and Decontamination on Tobacco Harvesters' Hands. Abstract presented at the 14th

Annual Conference of the International Society for Exposure Analysis, Philadelphia, Pennsylvania October 17-21, 2004.

Curwin BD, Hein MJ, Sanderson WT, Barr D, Reynolds SJ, Ward E, Alavanja M. Urinary Pesticide Levels Among Farmers and Non-Farmers in Iowa. Abstract presented at X2004: Exposure Assessment in a Changing Environment, Utrecht, Netherlands June 16-18, 2004

Curwin BD, Hein MJ, Sanderson WT, Reynolds SJ, Nishioka M, Ward E, Alavanja M. Farm Family Take-Home Pesticide Exposure Study. Abstract presented at 2003 American Industrial Hygiene Conference and Expo, Dallas, Texas May 12-15, 2003

Curwin BD, Brown A, Acquavella J. International Symposium on Agricultural Exposures and Cancer: Exposure Assessment Summary. Summary presented at the International Symposium of Agricultural Exposure and Cancer, Oxford, England November 18-22, 2002.

Curwin BD, Hein MJ, Sanderson WT, Nishioka N, Buhler W. Acephate Exposure and Decontamination on Tobacco Harvesters' Hands. Abstract presented at the 12th Annual conference of the International Society for Exposure Analysis, Vancouver, British Columbia, Canada August 11-15, 2002.

Curwin BD, Sanderson WT, Reynolds SJ, Nishioka M, Ward E, Alavanja M. Pesticide Contamination Inside Farm and Non-Farm Homes and Vehicles. Abstract presented at the 12th Annual conference of the International Society for Exposure Analysis, Vancouver, British Columbia, Canada August 11-15, 2002.

Curwin BD, Sanderson WT, Reynolds SJ, Hein MJ, Alavanja M. Pesticide Use and Practice Among 25 Farms Enrolled in the Iowa Farm Family Pesticide Exposure Study. Abstract presented at the 2002 American Industrial Hygiene Conference and Expo, San Diego, California June 3-6, 2002.

Doswell WM, Kesner JS, Knecht EA [1998]. Urine endocrine measurements during female pubertal onset. Society for Research on Adolescence.

Draheim L, Falk C, Anderson HA, Handrahan L, Steenport D, Schrader S, Turner T, The Great Lakes Consortium [1997]. Male reproductive function studies: challenges in recruiting men for semen collection clinics. Presentation at Health Conference 97, Montreal, Canada, May 12–15.

Hines CJ, Deddens J [2002].Biological and air monitoring of chlorpyrifos exposures among termiticide applicators: application of mixed-effect models. AIHCE, San Diego, CA, June 3–6.

Holland SE, Garry VF, Schrader SM, Kesner JS, Knecht EA [2002]. testosterone levels in male pesticide applicators and the sex of their children. 27th Annual Meeting of the American Society of Andrology, Seattle, Washington, April 24–27, Journal of Andrology Suppl.

Hoppin JA, Umbach DM, London SJ, Henneberger PK, Kullman GJ, Alavanja MCR, Sandler DP [2006]. Pesticide Exposure and Allergic and Non-Allergic Asthma in the Agricultural Health Study. 2nd North American Congress of Epidemiology, 2006 Society for Epidemiologic Research, Seattle, WA, June 21–24.

Huang K, Whelan EA, Ruder AM, Deddens J, Davis-King KE, Carreón T, Waters MA, Butler MA, Calvert GM, Schulte P, Zivkovich Z, Heineman E, Mandel J, Morton R, Reding D, Rosenman K, Brain Cancer Collaborative Study Group [2003]. Reproductive factors and risk of glioma in women. Proc Am Assn Cancer Res 44:1365. Presented at AACR, Washington, DC, August.

Kesner JS [1997]. Evaluating the effects of occupational hazards on the reproductive health of women. Indiana American Industrial Hygiene Association Conference, Indianapolis, IN, September 13.

Kesner JS [1998]. Evaluating the effects of occupational hazards on the reproductive health of women. 10th Annual Meeting, Allegheny-Erie Regional Chapter of the Society of Toxicology, Pittsburgh, PA, May 15.

Kesner JS [1999]. Evaluating the effects of occupational hazards on the reproductive health of women. Indiana American Industrial Hygiene Association Conference, Indianapolis, IN, September 13.

Kesner JS [2004]. Biological evaluation of menstrual cycle function in women exposed to occupational and environmental hazards. International Congress on the Prevention of Occupational and Environmental Disorders of Reproductive Health, June 30, Volgograd, Russia.

Kesner JS, Knecht EA, Krieg EF Jr [1997]. Measuring endocrine profiles of women in field studies. International Symposium on Environment, Lifestyle & Fertility, Aarhus, Denmark, December 9.

Kesner JS, Knecht EA, Krieg EF Jr [2003]. Assessing the endocrine effects of occupational exposures on menstrual cycle function. International Conference on Environment and Health, Perm, Russia, May 13–18.

Knecht EA, Krieg EF Jr, Clark JC, Kesner JS [2002]. Urinary creatinine measurement using a Vitros 250 chemistry analyzer compared with the Jaffe method. 54th Annual Meeting of the American Association for Clinical Chemistry, July 30, Orlando, FL. Clin Chem *48*:A55.

MoormanWJ, Cheever KL, Skaggs SR, Clark JC, Turner TW, Marlow KL, Schrader SM [1999]. Male adolescent exposure to endocrine disrupting pesticides: vinclozolin exposure in peripubertal rabbits. Presented at Molecular Aspects of Male Reproductive Toxicology. November 13–14, Rauischholzhausen, Germany.

Ruder AM for the Brain Cancer Collaborative Study Group [2004]. The Upper Midwest Health Study: Etiologic agents and susceptibility markers in adult glioma. Society for Neuro-Oncology Ninth Annual Conference, Toronto, Canada: November.

Ruder A [2006]. Polymorphisms in genes for enzymes affecting folate metabolism and risk of glioma: The Upper Midwest Health Study. Brain Tumor Epidemiology Consortium meeting, Visby, Sweden, May.

Ruder AM, Butler MA, Sanderson W, Carreón T, Waters MA [2001]. Development of a retrospective pesticide reference data base. Presented at the American Public Health Association meeting, Atlanta, Georgia, October.

Ruder AM, Waters MA, Carreón T, Butler MA, Davis-King KE, Calvert GM, Schulte PA, Ward EM, Connally LB, Lu J, Wall D, Zivkovich Z, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2003]. The Upper Midwest Health Study: A case-control study of primary intracranial gliomas among rural residents: demographics. Am J Epidemiol 157:S14. Presented at SER, Atlanta, Georgia, June.

Ruder AM, Waters MA, Butler MA, Carreón T, Calvert GM, Davis-King KE, Schulte PA, Sanderson WT, Ward EM, Connally LB, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2003]. Farm exposure to individual pesticides and glioma in men. Proc Am Assn Cancer Res 44:1466. Presented at AACR, Washington, DC, August.

Schrader SM [1998]. Methods of assessing male reproductive capacity. Hazardous Substances and Male Reproductive Health—An International Conference. New York, May 14–15.

Schrader SM [2003]. Occupational exposures and altered semen quality; what are the risk factors? Presented at the 28th meeting of the American Society of Andrology, Phoenix, AZ. March 31.

Schrader SM, Garry VF [2001]. Abnormal sperm morphology and offspring sex ratio in male fungicide applicators. International Workshop on Endocrine Disrupting Chemicals and Their Toxicological Evaluation. Presented in Tsukiba, Japan, Feburary.

Valcin M, Henneberger PK, Kullman GJ, Umbach DM, London SJ, Alavanja MCR, Sandler DP, Hoppin JA [2006]. Risk factors for chronic bronchitis among non-smoking farm women in the agricultural health study. 2nd North American Congress of Epidemiology, 2006 Society for Epidemiologic Research, Seattle, Washington, June 21–24.

Wainman B, Tsuji L, Nieboer E, Kesner J, Weber J-P, Vasquez R [2004]. The effects of persistent organic pollutants (POPs) and toxic metals (TMs) on menstrual cycle function in the Cree of Western James Bay, Canada [Abstract]. International Federation of Fertility Societies 18th World Congress on Fertility & Sterility. May 23–28, Montreal, Canada.

Waters M, Ruder A, Echeverria D [1999]. A new method for retrospective occupational exposure data collection in a case-control study of cancer. Proc Am Indus Hyg Conf Expos 59A:46. Presented at the AIHCE, Toronto, Ontario, June.

Waters M, Stewart P [1999]. Development of a solvent exposure data base for use in case-control studies. Presented at the International Symposium on Occupational Exposure Databases and Their Application for the Next Millennium, London, England, November.

Waters M, Stewart P, Ruder A [2003]. Development of a chlorinated solvent exposure data base for use in case-control studies. Presented at the International Society for Exposure Assessment, Stresa, Italy, September.

Waters MA, Stewart PA, Ruder AM [2004]. Some specific examples using an exposure determinants data base for case-control exposure assessment. Tijdschrift voor toegepaste Arbowetenschap *2*(Suppl):5. Presented at Exposure Assessment in a Changing Environment, Utrecht, The Netherlands, June.

Publications

Aizenberg VA, Choe K, Grinshpun SA, Willeke K, Baron PA [2001 Evaluation of personal aerosol samplers challenged with large particles. J Aerosol Sci *32*(6):779–793. (ISI Web of Science: Cited 10 times as of 11/20/06)

Aizenberg V, Grinshpun SA, Willeke K, Smith JP, Baron PA [2000]. Performance characteristics of the button personal aerosol sampler. Am Ind Hyg Assoc J *61*(3):398–404. (ISI Web of Science: Cited 25 times as of 11/20/06)

Aizenberg V, Grinshpun SA, Willeke K, Smith JP, Baron PA [2000]. Measurement of the sampling efficiency of personal inhalable aerosol samplers. J Aerosol Sci *31*:169–179. (ISI Web of Science: Cited 11 times as of 11/20/06)

Ames RG, Steenland K, Jenkins B, Chrislip DW, Russo JR [1995]. Chronic neurologic sequelae to cholinesterase inhibition among agricultural pesticide applicators. Arch Environ Hlth *50*(6):440–444. (IS I Web of Science: Cited 42 times as of 11/20/06)

Anger WK, Letz R, Chrislip DW, Frumkin H, Hudnell K, Russo JM, ChappellW, Hutchinson L [1994]. Neurobehavioral test methods for environmental health studies of adults. Neurobehavioral Toxico Teratol *16*(5):489–497. (IS I Web of Science: Cited 31 times as of 11/20/06)

Arbuckle TE, Schrader SM, Cole D, Hall JC, Bancej CM, Turner LA, Claman P [1999]. 2,4-D residues in semen of Ontario farmers. Reproductive Toxicol *13*:421–429. (ISI Web of Science: Cited 24 times as of 11/20/06)

Baird DD, Weinberg CR, Zhou H, Kamel F, McConnaughey DR, Kesner JS, Wilcox AJ [1999]. Preimplantation urinary hormone profiles and the probability of conception in healthy women. Fertil Steril *71*:40–49. (ISI Web of Science: Cited 24 times as of 11/20/06)

Baron PA [1991]. Measurement of airborne fibers: a review. Ind Health (Japan) *39*(2):39–50.

Baron PA [2001]. Evaluation of alternate cyclones for respirable dust sampling. Technical Report Submitted to OSHA.

Baron PA [2002]. Using a Filter bypass leakage test for aerosol sampling cassettes. (Case Studies Column, Dawn Tharr, ed.) Appl Occup Environ Hyg *17*(9):593–597.

Baron PA [2004]. Chapter L: Measurement of Fibers. In: NIOSH Manual of Analytical Methods. Cincinnati, NIOSH.

Baron PA [2004]. Chapter N: Aerosol sampling: minimizing particle loss from cassette bypass leakage. In: NIOSH Manual of Analytical Methods. Cincinnati, NIOSH.

Baron PA [2004]. Chapter O: Factors affecting aerosol sampling. In: NIOSH Manual of Analytical Methods. Cincinnati, NIOSH.

Baron PA, Bennett J [2002]. Calculation of leakage in plastic filter cassettes. Aerosol Sci Technol *36*(5):632–641. (ISI Web of Science: Cited 2 times as of 11/20/06)

Baron PA, John W [2000]. Sampling for thoracic aerosol. In: ACGIH Monograph on Particle Size Selective Sampling in the Workplace ACGIH, Cincinnati OH.

Baron PA, Heitbrink W [2001]. An approach to performing aerosol measurements. In: Baron PA, Willeke J, eds. Aerosol Measurement: Principles, Techniques, and Applications. J. Wiley & Sons.

Baron PA, Willeke K, eds. [2001]. Aerosol Measurement: Principles, Techniques, and Applications. 2nd ed., J. Wiley & Sons.

Baron PA, Willeke K [2001]. Bridging science and application in aerosol measurement: accessing available tools. In: Ruzer L, Harley N, eds. Aerosol Measurement: Principles, Techniques, and Applications. 2nd ed., J. Wiley & Sons.

Baron PA, Willeke K [2001]. Aerosol fundamentals. In: Baron PA, Willeke K, eds. Aerosol Measurement: Principles, Techniques, and Applications. J. Wiley & Sons..

Baron PA, Willeke K [2001]. Gas and particle motion. In: Baron PA, Willeke J, eds. Aerosol Measurement: Principles, Techniques, and Applications. J. Wiley & Sons.

Baron P, Deye GJ, Aizenberg V, Castranova V [2002]. Generation of size-selected fibers for a nose-only inhalation toxicity study. In: Ogden TL, Donaldson K, Cherry N, eds. Inhaled Particles IX. Annals of Occupational Hygiene.

Baron PA, Khanina A, Grinshpun S [2002]. Preventing leakage and dust loss in plastic filter cassettes: a particle count leak test. Aerosol Sci Technol (2002) 36(8) 857-865.

Baron PA, Maynard AD, Foley M [2003]. Evaluation of aerosol release during the handling of unrefined carbon nanotube material. NIOSH Report NTIS PB2003–102401.

Baron PA, Mazumder MK, Chen YS [2001]. Direct Reading Techniques Using Optical Particle Detection. In: Baron PA, Willeke J, eds. Aerosol Measurement: Principles, Techniques, and Applications. J. Wiley & Sons.

Baron PA, Sorenson CM, Brockmann JM [2001]. nonspherical particles: shape factors, fractals and fibers. In: Baron PA, Willeke J, eds. Aerosol Measurement: Principles, Techniques, and Applications. J. Wiley & Sons.

Barr D, Landsittel D, Nishioka M, Thomas K, Curwin B, Raymer J, Donnelly KC, McCauley L, Lasarev M, Ryan PB [2006]. A survey of laboratory and statistical issues related to farmworker studies. Environmental Health Perspectives 114(6):961-968 doi:10.1289/ehp.8528. [Online 16 February 2006]

Barr D, Thomas K, Curwin B, Landsittel D, Raymer J, Lu C, Donnelly KC, Acquavella J [2006]. Biomonitoring of exposure in farmworker studies. Environmental Health Perspectives 114(6):936-942 doi:10.1289/ehp.8527. [Online 16 February 2006]

Bartley D L, Martinez, AB, Baron PA, Secker DR, Hirst E [2000]. droplet distortion in accelerating flow. J Aerosol Sci *31*(12):1447–1460. (ISI Web of Science: Cited 4 times as of 11/20/06)

Biagini RE, MacKenzie BA, Sammons DL, Smith JP, Striley CAF, Robertson SK, Snawder JE [2004]. Evaluation of the prevalence of antiwheat-, anti-flour dust, and anti-alpha-amylase specific IgE antibodies in US blood donors. Ann Allergy Asthma Immun *92*(6):649–653, (ISI Web of Science: Cited 1 time as of 11/20/06) NN: 20025383.

Biagini RE, Murphy DM, Sammons DL, Smith JP, Striley CA, MacKenzie BA [2002]. Development of multiplexed fluorescence microbead covalent assays

(FMCAs) for pesticide biomonitoring. Bull Environ Contam Toxicol *68*(4):470–477, NN: 20023004.(ISI Web of Science: Cited 6 times as of 11/20/06)

Biagini RE, Smith JP, Sammons DL, MacKenzie BA, Striley CA, Robertson SK, Snawder JE [2004]. Development of a sensitivity enhanced multiplexed fluorescence covalent microbead immunosorbent assay (FCMIA) for the measurement of glyphosate, atrazine and metolachlor mercapturate in water and urine. Anal Bioanal Chem *379*(3):368–374, NN 20026130. (ISI Web of Science: Cited 2 times as of 11/20/06)

Buck, GM, Lynch CD, Stanford JB, Sweeney AM, Schieve LA, Rockett JC, Selevan SG, Schrader SM [2004]. Prospective pregnancy study designs for assessing reproductive and developmental toxicants. Environ Health Perspect *112*:79–86. (ISI Web of Science: Cited 11 times as of 11/20/06)

Butler MA, Ruder AM, Carreón T, Waters MA, Yeager M, Welch R, Chanock S, Schulte PA [2004]. Polymorphisms in the estrogen metabolism genes CYP17, CYP1B1, CYP1A2, COMT and ER alpha and susceptibility to primary intracranial brain gliomas in women. Proc Am Assn Cancer Res *45*:4511.

Butler M, Ruder A, Carreón T, Waters M, Yeager M, Welch R, Chanock S, Schulte P [2005]. Polymorphisms in DNA repair genes and susceptibility to primary intracranial brain gliomas. Neuro-Oncology *7*:287.

Butler MA, Ruder AM, Daly AK, Waters MA, Carreón T, Schulte PA [2003]. Polymorphisms in GSTM1, GSTT1, GSTP1, and NAT2 and susceptibility to primary intracranial brain gliomas. Proc Am Assn Cancer Res *44*:128.

Butler MA, Ruder AM, Levine AJ, Werren DM, ONeill VL, Masterson KJ, Schulte PA [1999]. Successes in biological specimen collection from cancer cases and controls in rural areas. Proc Am Assn Cancer Res *40*:612.

Butler MA, Ruder AM, Waters MA, Daly AK, Schulte PA [2001]. Successes in DNA preparation for identification of biomarkers of exposure, effects of exposure, and susceptibility in cancer cases and controls in rural areas. Proc Am Assn Cancer Res *42*:885–886.

Calvert GM, Mueller CA, Fajen JM, Chrislip D, Russo J, Briggle T, Fleming LE, Suruda AJ, Steenland K [1998]. Health effects associated with sulfuryl fluoride and methyl bromide exposure among structural fumigation workers. Am J Public Health *88*:1774–1780. (ISI Web of Science: Cited 10 times as of 11/20/06)

Carreón T, Butler MA, Ruder AM, Waters MA, Davis-King KE, Calvert GM, Schulte PA, Connally LB, Ward EM, Sanderson WT, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G [2003]. Farm exposure to pesticides and glioma in women. Proc Am Assn Cancer Res 44:1466–1467.

Carreón T, Butler MA, Ruder AM, Waters MA, Davis-King KE, Calvert GM, Schulte PA, Sanderson WT, Ward EM, Connally LB, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2005]. Gliomas and farm pesticide exposure in women. *Environ Health Perspect 113*(5):546–551. (ISI Web of Science: Cited 1 time as of 11/20/06)

Carreon T, Ruder AM, Waters MA, Butler MA, Yeager M, Welch R, Chanock S, Schulte PA [2006]. Lead exposure and glioma among rural residents: The Upper Midwest Health Study. Am J Epidemiol *163*:S251.

Connally LB, Schulte PA [1996]. Cancer control in rural farm populations. J Rural Health 12:255–257.

Connally LB, Schulte PA, Alderfer RJ, Goldenhar LM, Calvert GM, Davis-King KE et al. [1996]. Developing the National Institute for Occupational Safety and Health's cancer control demonstration projects for farm populations. J Rural Health *12*:258–264. (IS I Web of Science: Cited 2 times as of 11/20/06)

Castranova V, Jones W, Blake T, Ye J, Shi X, Deye JG, Baron P [2000]. Critical role of fiber length in the bioactivity and cytotoxicity of glass fibers. In 23rd Cotton and Other Organic Dusts Conference. Memphis, TN, National Cotton Council.

Chen C-C, Yu T-S. Shih T-S, Baron P [2001]. computer simulation of particle count overlap in fiber count samples. AIHAJ *62*(3):281–287.

Curwin B, Sanderson W, Reynolds S, Hein M, Alavanja M [2002]. Pesticide use and practices in an Iowa farm family pesticide exposure study. J Agric Saf Health 8: 423-33.

Curwin B, Brown A, Acquavella J [2005]. International symposium on agricultural exposures and cancer: Sessions on exposure assessment. Scandinavian Journal of Work, Environment and Health 31(suppl 1):63-65

Curwin BD, Hein MJ, Sanderson WT, Barr DB, Heederik D, Reynolds SJ et al. [2005]. Urinary and hand wipe pesticide levels among farmers and nonfarmers in Iowa. J Expo Anal Environ Epidemiol 15: 500-8

Curwin BD, Hein MJ, Sanderson WT, Nishioka M, Reynolds SJ, Ward E, Alavanja M [2005]. Pesticide contamination inside farm and non-farm homes. Journal of Occupational and Environmental Hygiene 2(7):357-367

Curwin BD, Hein MJ, Sanderson WT, Striley C, Heederik D, Kromhout H, Reynolds SJ, Alavanja M [006] Urinary pesticide concentrations among children, mothers, and fathers living in farm and non-farm households in Iowa. Annals of Occupational Hygiene doi:10.1093/annhyg/mel062 [online September 19, 2006]

Curwin BD, Hein MJ, Sanderson WT, Nishioka M, Buhler W [2005] Nicotine exposure and decontamination on tobacco harvesters' hands. Ann Occ Hyg 49(5):407-413 doi:10.1093/annhyg/meh112

Curwin BD, Hein MJ, Sanderson WT, Nishioka M, Buhler W [2003]. Acephate exposure and decontamination on tobacco harvesters' hands. Journal of Exposure Analysis and Environmental Epidemiology 13(3):203-210

Dick RB, Steenland K, Krieg EF, Hines CJ [2003]. Evaluation of acute sensory-motor effects and test sensitivity using termiticide workers exposed to chlorpyrifos. Neurotoxicol Teratol 2001; 23:381–393. (ISI Web of Science: Cited 9 times as of 11/20/06)

Dunn KH [2003]. NIOSH research on controlling carbon monoxide poisoning on boats, U.S. DHHS, CDC, NIOSH.

Dunn KH [2003]. NIOSH research on generator exhaust configurations and carbon monoxide houseboats, U.S. DHHS, CDC, NIOSH.

Dunn, KH, Shulman S, et al[2003]. Carbon monoxide and houseboats: an evaluation of a stack exhaust system to reduce poisonings associated with generator exhaust. Professional Safety: 47–5

Dunson DB, Weinberg CR, Baird DD, Kesner JS, Wilcox AJ [2001]. Assessing human fertility using several markers of ovulation. Stat Med *20*:965–978. (IS I Web of Science: Cited 17 times as of 11/20/06)

Earnest GS, Dunn KH, et al.[2003]. Computational fluid dynamic modeling of carbon monoxide emissions and exposures on a ski boat, U.S. DHHS, CDC, NIOSH.

Earnest GS, Echt A, et al.[2003]. Carbon monoxide emissions and exposures on recreation boats under various operating conditions at Lake Mead, Nevada, and Lake Powell, Arizona, April 22–25, 2002, U.S. DHHS, CDC, NIOSH.

Earnest GS, Echt A, et al. [2004]. Carbon monoxide emissions and exposures on recreational boats, U.S. DHHS, CDC, NIOSH.

Earnest GS, Hall R, et al. [2003]. An evaluation of vertical exhaust stacks and aged production emission control devices to prevent carbon monoxide poisonings from houseboat generator exhaust at Callville Bay Marina, Boulder City, NV, September 30–October 3, 2002, U.S. DHHS, CDC, NIOSH.

Earnest G , Hammond D, et al.[2003]. An update on recreational boating carbon monoxide control work under the NIOSH—Coast Guard IAG, U.S. DHHS, CDC, NIOSH.

Earnest GS, Mickelsen RL, McCammon JB, O'Brien DO [1997]. Carbon monoxide poisoning from small gasoline-powered engines: just what is a well-ventilated area? Am Ind Hyg Assoc J *58*:787–791. (ISI Web of Science: Cited 4 times as of 11/20/06)

Echt A, Earnest GS, et al. [2003]. Carbon monoxide emissions and exposures on recreation boats under various operating conditions at Lake Norman, North Carolina, Arizona, May 13–16, 2002, U.S. DHHS, CDC, NIOSH.

Gao P, Chen BT, Baron PA, Soderholm SC [2002]. A numerical study of the performance of an aerosol sampler with a curved, blunt, multi-orificed inlet. J Aerosol Sci *36*(5):540–553. (ISI Web of Science: Cited 1 time as of 11/20/06)

Garry VF, Burroughs B, Tarone R, Kesner JS [1999] Pesticides and adjuvants: an evolving view. Toxicol Ind Health *15*:159–167. (IS I Web of Science: Cited 13 times as of 11/20/06)

Garry VF, Tarone RE, Kirsch IR, Abdallah JM, Lombardi DP, Long LK, Burroughs BL, Barr DB, Kesner JS [2001]. Biomarker correlations of urinary 2,4-D levels in foresters: genomic instability and endocrine disruption. Environ Health Perspect *109*:495–500. (IS I Web of Science: Cited 16 times as of 11/20/06)

Gardiner JC, Mullan PB, Rosenman KD, Zhu Z, Swanson GM [1995]. Mammography usage and knowledge about breast cancer in a Michigan farm population before and after an educational intervention. J Cancer Educ *10*:155–162. (IS I Web of Science: Cited 15 times as of 11/20/06)

Goldsmith DF, Sisneros GC [1996]. Cancer prevention strategies among California farm workers: preliminary findings. J Rural Health *12*:343–348. (IS I Web of Science: Cited 5 times as of 11/20/06)

Gressel MG, Kovein, RK [2002]. Current methods and future trends in video exposure monitoring, U.S. DHHS, PHS, CDC, NIOSH.

Gressel MG, Kovein RJ, Hentz PA [1994]. Potential problems associated with the rustrack ranger date logger's data storage technique. Am Ind Hyg Assoc J *55*:970.

Hall RM, Heitbrink WA [1996]. Agriculture environmental enclosure project and aerosol complications. U.S. DHHS, PHS, CDC, NIOSH.

Hall RM, Heitbrink WA [1996]. Closeout letter for lift-top cab. Yakima, Washington, February 14, U.S. DHHS, PHS, CDC, NIOSH.

Hall RM, Heitbrink WA [1996]. Protocol for a field evaluation of agricultural enclosures. U.S. DHHS, PHS, CDC, NIOSH.

Hall RM, Heitbrink WA [1996]. In-depth survey report: control technology for agricultural enclosures at John Deere Manufacturing Co., Inc., April 15–19 and August 5–9. (U.S. DHHS, PHS, CDC, NIOSH, July 1997.) Engineering Control Technology Report Number ECTB 223–13a.

Hall RM, Heitbrink WA, et al. [2000]. Evaluation of a tractor cab using real-time aerosol counting instrumentation. Appl Occup Environ Hyg

Hall RM, Heitbrink WA, McGlothlin JD [1997]. In-Depth Survey Report: Control technology for agricultural enclosures at Nelson Manufacturing Co., Inc., Yuba City, CA, October 9–11, 1996. U.S. DHHS, PHS, CDC, NIOSH, July 1997. Engineering Control Technology Report Number ECTB 223–11b.

Hall R M, Earnest G, et al. [2004]. Evaluation of houseboat stack exhaust systems used with gasoline generators, U.S. DHHS, CDC, NIOSH.

Hall R M, Earnest G, et al. [2005]. Evaluation of carbon monoxide emissions from engines on recreational boats equipped with prototype catalysts. Appl Occup Environ Hyg.

Hall RM, Earnest G [2003]. Control of carbon monoxide exposures on houseboats, U.S. DHHS, CDC, NIOSH.

Hall RM, McCammon JB, et al. [2003]. NIOSH efforts to prevent carbon monoxide poisonings on houseboats and other vessels, U.S. DHHS, CDC, NIOSH.

Hammond D, Earnest G, et al. [2003]. An evaluation of issues related to the performance of dry exhaust stacks to prevent carbon monoxide poisonings on houseboats, U.S. DHHS, CDC, NIOSH.

Hammond D, Earnest G, et al. [2004]. an evaluation of factors that might influence exhaust stack performance to prevent carbon monoxide poisonings from houseboat generator exhaust at Lee's Ford Marina, Somerset, Kentucky, August 4–7, 2003, U.S. DHHS, CDC, NIOSH.

Hammond D, Marlow DA [2004]. Follow up evaluation of design changes to a houseboat generator exhaust stack system, at Sumerset Acquisitions LLC, Somerset, Kentucky, August 27, 2003, U.S. DHHS, CDC, NIOSH.

Hanrahan LP, Anderson HA, Haskins LK, Olson J, Lappe K, Reding D. 1996. Wisconsin farmer cancer mortality, 1981 to 1990: selected malignancies. J Rural Health 12: 273-7. (IS I Web of Science: Cited 2 times as of 11/20/06)

Heitbrink WA [1998]. Practical Air Contaminant Control Lessons Learned by NIOSH's Engineering Control Technology Branch. U.S. DHHS, PHS, CDC, NIOSH.

Heitbrink WA, Earnest GS, et al. [1999]. Evaluation of leakage from a metal machining center using tracer gas methods: a case study. Am Ind Hyg Assoc J *60*(6):785–788.

Heitbrink WA, Hall RM [1998]. Closeout letter for Griffith Farms, Exeter, California, September 24–25, U.S. DHHS, PHS, CDC, NIOSH.

Heitbrink WA, Hall RM, et al. [1999]. Review of ambient aerosol test procedures at ASAE Standard S525. J Agric Safety Health *4*(4):255–266.

Heitbrink WA, Hall RM, et al. [1999]. Use of ambient aerosol for testing agricultural cabs for protection against pesticide aerosol. Am J Ind Med *1*(Suppl):75–76.

Heitbrink WA, Moyer E [2000]. In-Depth Survey Report: Control Technology for Environmental Enclosures: An Evaluation of In-Use Enclosures at San Joaquin Helicopter Company, Delano, CA, September 20–22 and October 26–28, U.S. DHHS, PHS, CDC, NIOSH.

Heitbrink WA, Moyer E [2000]. In-Depth Survey Report: Control Technology for Environmental Enclosures: An Evaluation of In-Use Enclosures at Sun Pacific, Bakersfield, CA, October 27, U.S. DHHS, PHS, CDC, NIOSH.

Heitbrink WA, Moyer E, et al. [2001]. Environmental agricultural tractor cab filter efficiency and field evaluation. Am Ind Hyg Assoc J.

Heitbrink WA, Moyer E, et al. [2002]. Environmental Tractor Cab(s), Filter Efficiency, and Field Evaluation. University of Iowa/U.S. DHHS, PHS, CDC, NIOSH.

Heitbrink WA, Thimons E [1999]. In-Depth Survey Report: Control Technology for Environmental Enclosures—The Effect of Wind Speed Upon Aerosol Penetration into an Enclosure at Clean Air Filter, Defiance, Iowa, August 3–7 and October 19–23, 1998, U.S. DHHS, PHS, CDC, NIOSH.

Heitbrink WA, Thimons ED, et al. [2000]. Static Pressure Requirements for Ventilated Enclosures. Ventilation 2000, 6th International Symposium on Ventilation for Contaminant Control, Helsinki, Finland, Finnish Institute of Occupational Health.

Hines CJ, Deddens JA [2001]. Determinants of chlorpyrifos exposure and urinary 3,5,6-trichloro-2-pyridinol among termiticide applicators. Ann Occup Hyg *45*:309–321. (IS I Web of Science: Cited 14 times as of 11/20/06)

Hines CJ, Deddens JA, Striley CAF, Biagini RE, Shoemaker DA, Brown KK, Mackenzie BA, Hull RD [2003]. Biological monitoring for selected herbicide biomarkers in the urine of exposed custom applicators: application of mixed-effect models. Ann Occup Hyg *47*(6):503–517, (ISI Web of Science: Cited 6 times as of 11/20/06) NN: 20023365.

Hines CJ, Deddens JA, Lu CS, Fenske R, Striley CAF [2006]. Mixed-effect models for evaluating multiple measures of atrazine exposure among custom applicators. J Occup Environ Hyg *3*(5):274–283; NN: 20030196.

Holland SE, Garry VF, Schrader SM, Kesner JS, Knecht EA [2002]. testosterone levels in male pesticide applicators and the sex of their children. 27th Annual Meeting of the American Society of Andrology, Seattle, Washington, April 24–27, Journal of Andrology Suppl.

Hooks C, Ugarte C, Silsby J, Brown R, Weinman J, Fernandez G, Foxwell J, Newton N, Connally, LB [1996]. Obstacles and opportunities in designing cancer control communication research for farm workers on the Delmarva Peninsula. J Rural Health *12*:332–342. (IS I Web of Science: Cited 4 times as of 11/20/06)

Huang K, Whelan EA, Ruder AM, Deddens J, Davis-King KE, Carreón T, Waters MA, Butler MA, Calvert GM, Schulte P, Zivkovich Z, Heineman E, Mandel J, Morton R, Reding D, Rosenman K, Brain Cancer Collaborative Study Group [2003]. Reproductive factors and risk of glioma in women. Proc Am Assn Cancer Res 44:1365.

Huang K, Whelan EA, Ruder AM, Deddens J, Davis-King KE, Carreón T, Waters MA, Butler MA, Calvert GM, Schulte P, Zivkovich Z, Heineman E, Mandel J, Morton R, Reding D, Rosenman K, Brain Cancer Collaborative Study Group [2004]. Reproductive factors and risk of glioma in women. Cancer Epidem Biomark Prevent 13:1583–1588. (ISI Web of Science: Cited 3 times as of 11/20/06)

Kesner JS, Knecht EA, Krieg EF Jr, Wilcox AJ, O'Connor JF [1998]. Detecting preovulatory luteinizing hormone surges in urine. Human Reprod *13*:15–21. (IS I Web of Science: Cited 13 times as of 11/20/06)

Kesner JS, Knecht EA, Krieg EF Jr [1999]. Measuring endocrine profiles of women in field studies. Scand J Work Environ Health *25*(Suppl 1):17–19. (IS I Web of Science: Cited 3 times as of 11/20/06)

Kesner JS, Knecht EA, Krieg EF Jr [2003]. Assessing the endocrine effects of occupational exposures on menstrual cycle function. In: Izmerov NF, Zaitseva NV, May IV, Shur PZ, Brazhkin AV, Khoroshavin VA, eds. Environmental Health. Russian Health Ministry Scientific & Development Centre for Environmental Safety, Perm, Russia, pp. 194–197 [85–88].

Kesner JS, Lynch DW, Schnorr TM, Schrader SM, Wess JA [1999]. The effects of workplace hazards on female reproductive health. DHHS (NIOSH) Publication No. 99–104.

Krieg EF Jr, Kesner JS, Knecht EA [1999]. An algorithm for detecting features of the hormone profiles of the human menstrual cycle. Computers Biol Med *29*:229–242. Kristal AR, Goldenhar L, Muldoon J, Morton RF [1997]. Evaluation of a supermarket intervention to increase consumption of fruits and vegetables. Am J Health Promot *11*:422–425. (IS I Web of Science: Cited 12 times as of 11/20/06)

Key-Schwartz R J, Baron PA, Bartley DL, Rice FL, Schlecht PC [2004]. Determination of airborne crystalline silica. In: NIOSH Manual of Analytical Methods. Cincinnati, NIOSH.

Ku B-K, Maynard AD, Baron PA, Deye GJ [2005]. Anomalous responses (arcing electrical discharge) in a differential mobility analyzer caused by ultrafine fibrous carbon aerosols. Presented at the American Association for Aerosol Research Conference, Oct. 17–21, Austin, TX.

Lawson CC, Schnorr TM, Daston GP, Grawjeski B, Marcus M, McDiarmind M, Murono E, Perreault SD, Shelby M, Schrader SM [2003]. An occupational reproductive research agenda for the third millennium. Environ Hlth Perspec *111*:584–591. (ISI Web of Science: Cited 2 times as of 11/20/06)

Lipscomb JC, Barton HA, Tornero Velez R, Evans MV, Alcasey S, Snawder JE, Laskey J [2004]. The metabolic rate constants and specific activity of human and rat hepatic cytochrome P-450 2E1 toward toluene and chloroform. J Toxicol Environ Health, *67*(7):537–553, (ISI Web of Science: Cited 2 times as of 11/20/06)
NN: 20024735..

MacKenzie BA, Striley CAF, Biagini RE, Stettler LE, Hines CJ [2000]. Improved rapid analytical method for the urinary determination of 3,5,6 trichloro-2-pyridinol, a metabolite of chlorpyrifos. Bull Environ Contam Toxicol *65*:1–7. (ISI Web of Science: Cited 10 times as of 11/20/06)

MacKenzie BA, Biagini RE, Sammons DL, Smith JP, Snawder JE, Striley CAF [2003]. Is it really doses and responses instead of dose response? Applying Biomarkers to Occupational Health Practice, Santa Fe, NM, March 24–25, Atlanta, GA: Centers for Disease Control, NN: 20027213.

Mainelis G, Gorny RL, Reponen T, Trunov M, Grinshpun S, Baron P, Yadav J, Willeke K [2002]. Effect of electrical charges and fields on injury and viability of airborne bacteria. Biotechnol Bioeng *79*(2):229–241. (IS I Web of Science: Cited 11 times as of 11/20/06)

Mainelis G, Willeke K, Baron P, Reponen T, Grinshpun S, Gorny RL, Trakumas S [2001]. Electrical charges on airborne microorganisms. J Aerosol Sci *32*(9):1087–1110. (IS I Web of Science: Cited 17 times as of 11/20/06)

Mainelis G, Willeke K, Baron P, Grinshpun S, Reponen T [2002]. Induction charging and electrostatic classification of micrometer-size particles for investigating the electrobiological properties of airborne microorganisms. Aerosol Sci. Technol *36*(4) 479–491. (ISI Web of Science: Cited 5 times as of 11/20/06)

Mainelis B, Willeke K, Baron P, Grinshpun S, Reponen T [2002]. Classification of micrometer-size particles for investigating the electrobiological properties of airborne microorganisms. Aerosol Sci Technol *36*(4):1–13. (ISI Web of Science: Cited 5 times as of 11/20/06)

Mandel JH, Carr WP, Hillmer T, Leonard PR, Halberg JU, Sanderson WT et al. [1996]. Factors associated with safe use of agricultural pesticides in Minnesota. J Rural Health *12*:301–310. (ISI Web of Science: Cited 6 times as of 11/20/06)
Mandel JH, Carr WP, Hillmer T, Leonard PR, Halberg JU, Sanderson WT et al. [2000]. Safe handling of agricultural pesticides in Minnesota: results of a county-wide educational intervention. J Rural Health *16*:148–54. (ISI Web of Science: Cited 2 times as of 11/20/06)

Marlow DA, Guishard C, et al. [2004]. Evaluation of the "fresh air exhausttm" system to reduce carbon monoxide exposure during motor boating and wake surfing at Lake Austin, Texas, May 24–25, U.S. DHHS, CDC, NIOSH.

Mastin JP, Striley CAF, Biagini RE, Hines CJ, Hull RD, MacKenzie BA, Robertson SK [1998]. Use of immunoassays for biomonitoring of herbicide metabolites in urine. Anal Chim Acta *376*(1):119–124, NN: 20027943. (ISI Web of Science: Cited 9 times as of 11/20/06)

Maynard AD, Baron PA [2005]. Aerosols in the industrial environment. In: Ruzer L, Harley N, eds. Aerosols Handbook: Measurement Dosimetry and Health Effects. CRC Press.

Maynard AD, Baron PA, Foley M, Shvedova AA, Kisin ER, Castranova V [2004]. Exposure to carbon nanotube material. I: aerosol release during the handling of unrefined single walled carbon nanotube material. J Tox Environ Health *67*(1):87–107. (IS I Web of Science: Cited 47 times as of 11/20/06)

Moline JM, AL Golden, N Bar-Chama, E Smith, ME Rauch, RE Chapin, SD Perreault, SM Schrader, WA Suk, Landrigan PJ [2000]. Exposure to hazardous substances and male reproductive health: a research framework. Env Health Persp *108*:803–813. (IS I Web of Science: Cited 18 times as of 11/20/06)

Moorman WJ, Ahlers HW, Chapin RE, Daston GP, Foster PMD, Kavlock RJ, Morawetz JS, Schnorr TM, Schrader SM [2000]. Prioritization of NTP reproductive toxicants for field studies. Reprod Toxicol *14*:293–301. (ISI Web of Science: Cited 8 times as of 11/20/06)

MoormanWJ, Cheever KL, Skaggs SR, Clark JC, Turner TW, Marlow KL, Schrader SM [2000]. Male adolescent exposure to endocrine disrupting pesticides: vinclozolin exposure in peripubertal rabbits. Andrologia *32*:285–293. (ISI Web of Science: Cited 5 times as of 11/20/06)

Muldoon JT, Schootman M, Morton RF [1996]. Utilization of cancer early detection services among farm and rural nonfarm adults in Iowa. J Rural Health *12*: 21–31. (IS I Web of Science: Cited 7 times as of 11/20/06)

NIOSH [1993]. Update: NIOSH warns of deadly carbon monoxide hazard from using pressure washers indoors. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 93–117.

NIOSH [1996]. ALERT: Preventing carbon monoxide poisoning from small gasoline-powered engines and tools. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 96–118.

NIOSH/CDPHE/CPSC/OSHA/EPA [1996]. Alert: Preventing Carbon Monoxide Poisoning from Small Gasoline-Powered Engines. National Institute for Occupational Safety and Health, Colorado Department of Public Health and Environment, Consumer Product Safety Commission, Occupational Safety and Health Administration, Environmental Protection Agency, USDHHS, PHS, CDC, NIOSH, Cincinnati, Ohio.

Organiscak JA, Cecala AB, et al. [2002]. NIOSH/Industry collaborative efforts show improved mining equipment cab dust protection. SME 2003 Conference.

Page S, Volkwein JJ, Baron PA, Deye GJ [2000]. Particulate penetration of porous foam used as a low flow rate respirable dust size classifier. Appl Occup Environ Hyg *15*(7):561–568. (IS I Web of Science: Cited 3 times as of 11/20/06)

Peters TM, Evans DE, et al. [2005]. Ultrafine particles in an engine machining and assembly center. Ann Occup Hyg.

Peters TM, Heitbrink WA, et al. [2005]. Particle Concentration Mapping in a Diesel Engine Machining and Assembly Center, U.S. DHHS, CDC, NIOSH/University of Iowa.

Reding D, Anderson H, Lappe K, Hanrahan L, Haskins L [1991]. The Wisconsin Farmers' Cancer Control Project. Wis Med J *90*:443–445. (IS I Web of Science: Cited 3 times as of 11/20/06)

Ruder AM, Waters MA, Butler MA, Carreón T, Calvert GM, Davis-King KE, Schulte PA, Sanderson WT, Ward EM, Connally LB, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2003]. Farm exposure to individual pesticides and glioma in men. Proc Am Assn Cancer Res 44:1466.

Ruder AM, Waters MA, Butler MA, Carreón T, Calvert GM, Davis-King KE, Schulte PA, Sanderson WT, Ward EM, Connally LB, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2006]. Gliomas and farm pesticide exposure in men. Arch Environ Health 2004 *59*: 650–657 (published June 2006).

Ruder AM, Waters MA, Carreón T, Butler MA, Davis-King KE, Calvert GM, Schulte PA, Ward EM, Connally LB, Lu J, Wall D, Zivkovich Z, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Brain Cancer Collaborative Study Group [2006]. The upper midwest health study, a case-control study of primary intracranial gliomas in farm and rural residents. J Agric Safe Health 2006; 12(4).

Ruder AM, Waters MA, Carreón T, Butler MA, Davis-King KE, Calvert GM, Schulte PA, Ward EM, Connally LB, Lu J, Wall D, Zivkovich Z, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2003]. The Upper Midwest Health Study: A case-control study of primary intracranial gliomas among rural residents: demographics. Am J Epidemiol 157:S14.

Ryan TJ, Burroughs GE, et al. [2002]. Video exposure assessments demonstrate excessive laboratory formaldehyde exposures." Applied Occupational and Environmental Hygiene. Analyzing Workplace Exposures Using Direct Reading Instruments and Video Exposure Monitoring Techniques, NIOSH Publication No. 92–104.

Sanderson WT, Talaska G, Zaebst D, Davis-King K, Calvert G [1997]. Pesticide prioritization for a brain cancer case-control study. *Environ Res 74*:133–144. (ISI Web of Science: Cited 7 times as of 11/20/06)

Schrader SM [2003]. Man and the workplace: assessing his reproductive health. Chem Hlth Safety *10*:11–16.

Schrader SM, Arbuckle T, Turner L, Ritter L [1997]. The use of silastic condoms in an exposure assessment occupational field study. J Androl *17*:P–31

Schrader SM, Kesner JS [2002]. Reproductive health: developing partnerships in the study of reproductive hazards in the workplace. DHHS (NIOSH) Publication No. 2002–152.

Schrader SM, Schnorr TM, Wess JA [1996]. The effects of workplace hazards on male reproductive health. DHHS (NIOSH) Publication No. 96–132.
Schrader SM, Turner TW, Shaw PB, Erickson LL, Holland S, Garry VF [2000]. Semen quality of men applying pesticides in Northwest Minnesota. J Androl Suppl 21:50.

Scialli AR, Swan SH, Amler RW, Baird DD, Eskenazi B, Gist G, Hatch MC, Kesner JS, Lemasters GK, Marcus M, Paul ME, Schulte P, Taylor Z, Wilcox AJ, Zahniser C [1997]. Assessment of reproductive disorders and birth defects in communities near hazardous chemical sites. II. Female reproductive disorders. Reprod Toxicol *11*:231–242. (IS I Web of Science: Cited 10 times as of 11/20/06)

Shulte PA, Rice FL, Key-Schwartz RJ, Bartley DL, Baron PA, Schlecht PC, Gressel MG, Echt A [2002]. NIOSH Hazard Review: Health effects of occupational exposure to respirable crystalline silica. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2002–129.

Shvedova AA, Kisin ER, Murray AR, Gandelsman VA, Maynard AD, Baron PA, Castranova V [2003]. Exposure to carbon nanotube material ii: assessment of the biological effects of nanotube materials using human keratinocyte. Cells J Toxicol Environ Health *66*(20):1909–1926. (IS I Web of Science: Cited 66 times as of 11/20/06)

Shvedova A, Kisin A, Murray ER, Schwegler-Berry AR, Gandelsman A, Baron P, Maynard A, , Gunther M, Castranova V [2004]. Exposure of human bronchial epithelial cells to carbon nanotubes caused oxidative stress and cytotoxicity. Meeting of the Society for Free Radical Research, European Section. Ioannina, Greece. June 26–29, 2003. ISBN 88–7587–002.

Smith J, Sammons D, Biagini R, Robertson S, Striley C, MacKenzie B, Snawder J [2005]. The use of fluorescence covalent microbead immunosorbent assays (FCMIAS) for multiplexed pesticide biomonitoring. 2005 Toxicology and Risk Assessment Conference, April 25–28, Holiday Inn Conference Center, Fairborn, OH, April, NN: 20030189.

Snawder JE, Lipscomb JC [2000]. Interindividual variance of cytochrome P450 forms in human hepatic microsomes: correlation of individual forms with xenobiotic metabolism and implications in risk assessment. Regul Toxicol Pharmacol *32*(2):200–209, NN: 20020814. (ISI Web of Science: Cited 25 times as of 11/20/06)

Snawder JE, MacKenzie BA, Biagini RE, Sammons DL, Smith JP, Striley CAF [2003]. Development and application of new and existing biological monitoring methods to assess workers exposure to toxic chemicals and their role in hazard identification, evaluation and control. Applying Biomarkers to Occupational Health Practice, Santa Fe, NM, March 24–25, Atlanta, GA: Centers for Disease Control, NN: 20027215.

Steenland K, Dick RB, Howell RJ, Chrislip DW, Hines CJ, Reid TM, Lehman E, Laber P, Krieg EF, Knott C [2000]. Neurologic function among termiticide applicators exposed to chlorpyrifos. Environ Health Perspect *108*:293–300. (IS I Web of Science: Cited 30 times as of 11/20/06)

Steenland K, Jenkins B, Ames RG, O'Malley M, Chrislip DW, Russo JR [1994]. Chronic neurologic sequelae to acute organophosphate pesticide poisoning. Am J Public Health *84*(5):731–736. (IS I Web of Science: Cited 127 times as of 11/20/06)
Strauss S, Wasil JR, et al. [2004]. Carbon monoxide emissions from marine outboard engines. Society of Automotive Engineers, Technical Paper: 1–11. (ISI Web of Science: Cited 7 times as of 11/20/06)

Striley CAF, Biagini RE, Snawder JE, Hines CJ, MacKenzie BA [2000]. Clinical biological monitoring using immunobiochemical methods. Abstracts of the 8th Annual USEPA/NERL Immunochemistry Summit VIII/219th American Chemical Society National Meeting. Part 1, San Francisco, CA: American Chemical Society, p.106, NN: 20021075.

Turner TW, Schrader SM [2006]. Sperm migration assay as measure of recently ejaculated sperm motility in specimens shipped overnight. J Andrology 27 (supplement).

Wang Z, Hopke PK, Baron PA, Deye JG, Cheng Y-S, Su W-C [2005]. Investigation of glass fiber deposition onto inner walls of straight brass tubing. Presented at the American Association for Aerosol Research Conference, Oct. 17–21. Austin, TX.

Wang Z, Hopke PK, Baron PA, Ahmadi G, Cheng Y-S, Deye GJ, Su W-C [2005]. Fiber classification and the influence of average air humidity. Aerosol Sci Technol *39*(11):1056–1063.

Wyrobek AJ, Schrader SM, Perreault SD, Fenster L, Huszar G, Katz DF, Osorio AM, Sublet V, Evenson D [1997]. Guidelines for field studies of male reproductive disorders. Reproduc Toxicol *11*:243–259. (IS I Web of Science: Cited 22 times as of 11/20/06)

Ye J, Shi X, Jones W, Rojanasakul Y, Cheng N, Schwegler-Berry D, Baron PA, Deye JG Li, C, Castronova V [1999]. critical production and transcription factor□role of glass fiber length in tnf- activation in macrophages. Am J Physiol (Lung, Cellular and Molecular Physiology) *276* (Mar (3 Pt 1):L426–L434. (IS I Web of Science: Cited 1 time as of 11/20/06)

Ye J, Zeidler P, Young S-H, Martinez A, Robinson VA, Jones W, Baron P, Shi X, Castranova V [2001]. Activation of mitogen-activated protein kinase p38 and extracellular signal-regulated kinase is involved in production in macrophages. J Biol glass fiber-induced tumor necrosis factor– Chem *276*(7):5360–5367. (IS I Web of Science: Cited 13 times as of 11/20/06)

Zeidler PC, Calhoun WJ, Ameredes BT, Deye GJ, Baron PA, Blake T, Castranova V [2003]. Cytotoxicity of size-selected manville code 100 (jm-100) glass fibers on human alveoloar macrophages. Society of Toxicology Annual Meeting, March 9–13, Salt Lake City, UT.

Zeidler PC, Ye J, Jones J, Baron P, Martinez, A, Robinson VA, Landsittel DP, Castranova V [2001] Use of size-selected fibers to evaluate the contribution of length versus chemistry in fiber cytotoxicity. The Toxicol *60*(1):A942.

Zeidler PC, Ye J, Jones W, Baron P, Martinez A, Robinson VA, Landsittel DP, Castranova V [2001]. Use of size-selected fibers to evaluate the contribution of length versus chemistry in fiber cytotoxicity. Society of Toxicology Meeting, March 25–29, San FranciscoCA.

Zeidler-Erdely P, Calhoun WJ, Ameredes BT, Clark MP, Deye GJ, Baron P, Jones W, Blake T, Castranova V [2006]. In vitro cytotoxicity of Manville Code 100 glass fibers: effect of fiber length on human alveolar macrophages. Part. Fibre Toxicol *3*:5.

Zimmer A, Biswas P, Baron P [2001]. The influence of operating parameters on number-weighted aerosol size distribution generated from a gas metal arc welding process. J Aerosol Sci. *33*(3):519–532.

Zimmer AT, Baron PA, Biswas P [2001]. Exhaust recirculation and the control of submicrometer aerosols generated from gas metal arc welding processes. Presented at the American Association for Aerosol Research Meeting, October 15-19, Tacoma, WA.

Zimmer AT, Earnest GS, et al. [2005]. An evaluation of catalytic emission controls and vertical exhaust stacks to prevent carbon monoxide poisonings from houseboat generator exhaust at Callville Bay Marina, Boulder City, Nevada, March 7–9, U.S. DHHS, CDC, NIOSH.

Thesis

Cragin LA [in progress]. Menstrual cycle characteristics and reproductive patterns in women exposed to atrazine in drinking water. Thesis for the Degree of Ph.D. from Colorado State University.

5.10 References Cited

Arbuckle TE, Schrader SM, Cole D, Hall JC, Bancej CM, Turner LA, Claman P [1999]. 2,4-D Residues in Semen of Ontario Farmers. Reproductive Toxicology 13:421-429.

Baird DD, Weinberg CR, Zhou H, Kamel F, McConnaughey DR, Kesner JS, Wilcox AJ [1999]. Preimplantation urinary hormone profiles and the probability of conception in healthy women. Fertil Steril 71:40-49.

Biagini RE, Murphy DM, Sammons DL, Smith JP, Striley CA, MacKenzie BA [2002]. Development of multiplexed fluorescence microbead covalent assays (FMCAs) for pesticide biomonitoring. Bull Environ Contam Toxicol *68*(4):470–477.

Biagini RE, Smith JP, Sammons DL, MacKenzie BA, Striley CA, Robertson SK, Snawder JE [2004]. Development of a sensitivity enhanced multiplexed fluorescence covalent microbead immunosorbent assay (FCMIA) for the measurement of glyphosate, atrazine and metolachlor mercapturate in water and urine. Anal Bioanal Chem *379*(3):368–374.

Butler M, Ruder A, Carreon T, Waters M, Yeager M, Welch R, Chanock S, Schulte P [2005]. Polymorphisms in DNA repair genes and susceptibility to primary intracranial brain gliomas Neuro-Oncology Jul; 7(3):283.

Calvert GM, Mueller CA, Fajen JM, Chrislip DW, Russo J, Briggle T, Fleming LE, Suruda AJ, Steenland K [1998]. Health effects associated with sulfuryl fluoride and methyl bromide exposure among structural fumigation workers. Am J Public Health 88, 1774-80.

Carreón T, Butler MA, Ruder AM, Waters MA, Davis-King KE, Calvert GM, Schulte PA, Sanderson WT, Ward EM, Connally LB, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2005]. Gliomas and farm pesticide exposure in women. Environ Health Perspect *113*(5):546–551.

Curwin BD, Hein MJ, Sanderson WT, Striley C, Heederick D, Reynolds SJ, Alavanja M, Kromhout H [submitted]. Pesticide dose estimates for children of Iowa farmers. Environmental Health Perspectives

Curwin BD, Sanderson W, Reynolds S, Hein M, Alavanja M [2002]. Pesticide use and practices in an Iowa farm family pesticide exposure study. J Agric Saf Health 8: 423-33.

Curwin BD, Hein MJ, Sanderson WT, Barr DB, Heederik D, Reynolds SJ et al [2005]. Urinary and hand wipe pesticide levels among farmers and nonfarmers in Iowa. J Expo Anal Environ Epidemiol 15: 500-8.

Curwin BD, Hein MJ, Sanderson WT, Nishioka M, Reynolds SJ, Ward E, Alavanja M [2005]. Pesticide contamination inside farm and non-farm homes. Journal of Occupational and Environmental Hygiene 2(7):357-367.

Curwin BD, Hein MJ, Sanderson WT, Striley C, Heederick D, Reynolds SJ, Alavanja M, Kromhout H [2006]. Urinary pesticide concentrations among children, mothers, and fathers living in farm and non-farm households in Iowa. Annals of Occupational Hygiene doi:10.1093/annhyg/mel062 [online September 19, 2006].

Dick RB, Steenland K, Krieg EF, Hines CJ [2001]. Evaluation of acute sensory--motor effects and test sensitivity using termiticide workers exposed to chlorpyrifos. Neurotoxicol Teratol 23: 381-93.

EPA [2002]. Interim Reregistration Eigibility Decision for Chlorpyrifos (Case No. 0100) EPA 738-R-01-007. Washington, DC: U.S. Environmental Protection Agency, Office of Pesticide Programs, Health Effects Division.

EPA [2006]. Organophosphate Cumulative Risk Assessment; Notice of Availability", Federal Register: August 2, 2006 (Volume 71, Number 148), [Notices] [Page 43740-43742] From the Federal Register Online via GPO Access [wais.access.gpo.gov].

Frazer DG, Jones WG, Petsonk EL, Kullman GJ, Barger MW, Afshari A, Jones T, Castranova V [1993]. Organic dust exposure from compost handling: response of an animal model. AJIM *24*:375–385.

Gardiner JC, Mullan PB, Rosenman KD, Zhu Z, Swanson GM [1995]. Mammography usage and knowledge about breast cancer in a Michigan farm population before and after an educational intervention. J Cancer Educ 10: 155-62.

Garry VF, Burroughs B, Tarone R, Kesner JS [1999]. Herbicides and adjuvants: an evolving view. Toxicol and Ind Health 15: 159-167.

Garry VF, Tarone RE, Kirsch IR, Abdallah JM, Lombardi DP, Long LK, Burroughs BL, Barr DB, Kesner JS [2001]. Biomarker correlations of urinary 2,4-D levels in foresters: genomic instability and endocrine disruption. Environ Health Perspect 109:495-500.

Goldsmith DF, Sisneros GC [1996]. Cancer prevention strategies among California farmworkers: preliminary findings. J Rural Health 12: 343-8.

Hanrahan LP, Anderson HA, Haskins LK, Olson J, Lappe K, Reding D [1996]. Wisconsin farmer cancer mortality, 1981 to 1990: selected malignancies. J Rural Health 12: 273-7.

Heederik D [2006]. Personal communication, May, 2006.

Heitbrink WA, Thimons ED, Organiscak JA, Cecala AB, Schmitz M, Ahrenholtz E [2000]. Static Pressure Requirements for Ventilated Enclosures. Ventilation 2000, 6th International Symposium on Ventilation for Contaminant Control [2] pp.97-99.

Heitbrink WA, Moyer ES, Jensen PA, Watkins DS, Martin SB Jr [2003]. Environmental agricultural tractor cab filter efficiency and field evaluation. Am. Ind. Hyg. Assoc. J. 64:394-400.

Hines CJ, Deddens JA [2001]. Determinants of chlorpyrifos exposures and urinary 3,5,6-trichloro-2-pyridinol levels among termiticide applicators. Ann Occup Hyg 45: 309-21.

Hooks C, Ugarte C, Silsby J, Brown R, Weinman J, Fernandez G et al [1996]. Obstacles and opportunities in designing cancer control communication research for farmworkers on the Delmarva Peninsula. J Rural Health 12: 332-42.

Hoppin JA, Umbach DM, Henneberger PK, Kullman GJ, London SJ, Alavanja MCR. Sandler DP [accepted]. Agricultural factors associated with Farmers Lung among Farm Residents in the Agricultural Health Study, accepted by *OEM*.

Hoppin JA, Umbach DM, London SJ, Henneberger PK, Kullman GJ, Alavanja MCR. Sandler DP [2006]. Pesticide Exposure and Allergic and Non-Allergic Asthma in the Agricultural Health Study. 2nd North American Congress of Epidemiology, 2006 Society for Epidemiologic Research, Seattle,Washington, June 21–24.

Kesner JS, Knecht EA, Krieg EF Jr, Wilcox AJ, O'Connor JF [1998]. Detecting preovulatory luteinizing hormone surges in urine. Human Reprod 13: 15-21.

Knecht EA, Krieg EF Jr, Clark JC, Kesner JS [2002]. Urinary creatinine measurement using a Vitros 250 chemistry analyzer compared with the Jaffe method. 54th Annual Meeting of the American Association for Clinical Chemistry, July 30, Orlando, FL, Clin Chem 48:A55, 2002.

Krieg EF Jr, Kesner JS, Knecht EA [1999]. An algorithm for detecting features of the hormone profiles of the human menstrual cycle. Computers in Biol Med 29:229-242.

Kristal AR, Goldenhar L, Muldoon J, Morton RF [1997]. Evaluation of a supermarket intervention to increase consumption of fruits and vegetables. Am J Health Promot 11: 422-5.

Lipscomb JC, Barton HA, Tornero-Velez R, Evans MV, Alcasey S, Snawder JE, Laskey J [2004]. The metabolic rate constants and specific activity of human and rat hepatic cytochrome P-450 2E1 toward toluene and chloroform. J Toxicol Environ Health, A Apr; 67(7):537-553.

MacKenzie BA, Striley CA, Biagini RE, Stettler LE, Hines CJ [2000]. Improved rapid analytical method for the urinary determination of 3, 5,6 trichloro-2-pyridinol, a metabolite of chlorpyrifos. Bull Environ Contam Toxicol 65: 1-7.

Mandel JH, Carr WP, Hillmer T, Leonard PR, Halberg JU, Sanderson WT et al [1996]. Factors associated with safe use of agricultural pesticides in Minnesota. J Rural Health 12: 301-10.

Moorman WJ, Ahlers HW, Chapin RE, Daston GP, Foster PMD, Kavlock RJ, Morawetz JS, Schnorr TM, Schrader SM [2000a]. Prioritization of NTP Reproductive Toxicants for Field Studies. Reproductive Toxicology 14:293-301.

Moorman WJ, Cheever KL, Skaggs SR, Clark JC, Turner TW, Marlow KL, Schrader SM [2000b]. Male Adolescent Exposure to Endocrine Disrupting Pesticides: Vinclozolin Exposure in Peripubertal Rabbits. Andrologia 32:285-293.

Moyer ES, Heitbrink WA, Jensen PA [2005]. Test for the Integrity of Environmental Tractor Cab Filtration Systems. J Occup Environ Hyg 2:516-523.

Muldoon JT, Schootman M, Morton RF [1996]. Utilization of cancer early detection services among farm and rural nonfarm adults in Iowa. J Rural Health 12: 321-31.

NIOSH [1994]. Alert. Request for assistance in preventing organic dust toxic syndrome. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational lSafety and Health, DHHS (NIOSH) Publication No. 94–102.

Popendorf WJ, Spear RC, Leffingwell JT, Yager J, Kahn E [1979]. Harvester Exposure to Zolone (Phosalone) Residues in Peach Orchards. *J Occup Med*. 21(3):189-194.

Ruder AM, Waters MA, Butler MA, Carreón T, Calvert GM, Davis-King KE, Schulte PA, Sanderson WT, Ward EM, Connally LB, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Talaska G, Brain Cancer Collaborative Study Group [2006]. Gliomas and farm pesticide exposure in men. Arch Environ Health *59*:650–657.

Ruder AM, Waters MA, Carreón T, Butler MA, Davis-King KE, Calvert GM, Schulte PA, Ward EM, Connally LB, Lu J, Wall D, Zivkovich Z, Heineman EF, Mandel JS, Morton RF, Reding DJ, Rosenman KD, Brain Cancer Collaborative Study Group [2006]. The upper midwest health study, a case-control study of primary intracranial gliomas in farm and rural residents. J Agric Safe Health *12*:255-274.

Sanderson WT, Talaska G, Zaebst D, Davis-King K, Calvert G [1997]. Pesticide prioritization for a brain cancer case-control study. Environ Res *74*:133–144.

Schrader SM, Turner TW, Shaw PB, Erickson LL, Holland S, Garry VF [2000]. Semen Quality of Men Applying Pesticides in Northwest Minnesota. Journal of Andrology Suppl 21:50

Schrader SM, Arbuckle T, Turner L, Ritter L [1997]. The Use of Silastic Condoms in an Exposure Assessment Occupational Field Study. Journal of Andrology 17:P-31.

Snawder JE, Lipscomb JC [2000] . Interindividual variance of cytochrome P450 forms in human hepatic microsomes: correlation of individual forms with xenobiotic metabolism and implications in risk assessment Regul Toxicol Pharmacol Oct; 32(2):200-209.

Steenland K, Jenkins B, Ames RG, O'Malley M, Chrislip D, Russo J [1994]. Chronic neurological sequelae to organophosphate pesticide poisoning. Am J Public Health 84: 731-6.

Steenland K, Dick RB, Howell RJ, Chrislip DW, Hines CJ, Reid TM et al [2000]. Neurologic function among termiticide applicators exposed to chlorpyrifos. Environ Health Perspect 108: 293-300.

Turner TW, Schrader SM [2006]. Sperm Migration Assay As Measure Of Recently Ejaculated Sperm Motility In Specimens Shipped Overnight. J Andrology 27 (supplement).

Valcin M, Henneberger PK, Kullman GJ, Umbach DM, London SJ, Alavanja MCR, Sandler DP, Hoppin JA [2006]. Risk Factors for Chronic Bronchitis Among Non-Smoking Farm Women in the Agricultural Health Study. 2nd North American Congress of Epidemiology, 2006 Society for Epidemiologic Research, Seattle, Washington, June 21 – 24.

Wainman B, Tsuji L, Nieboer E, Kesner J, Weber J-P, Vasquez R [2004]. The effects of persistent organic pollutants (POPs) and toxic metals (TMs) on menstrual cycle function in the Cree of Western James Bay, Canada. International Federation of Fertility Societies 18th World Congress on Fertility & Sterility. May 23-28 Montreal, Canada. Abstract.

Washington State Department of Labor and Industries [2005]. Cholinesterase Monitoring in Agriculture, WAC 296-307-148. Washington State Department of Labor and Industries, January 6, 2005. Cholinesterase Monitoring of Pesticide Handlers in Agriculture Report to the Legislature, 26 pages.

Washington State Department of Labor and Industries [2006]. Safety Standards for Agriculture; Chapter 296-307 WAC, Part J-1, Cholinesterase Monitoring, 17 pages. Rule effective Feb [http://www.lni.wa.gov/WISHA/Rules/agriculture/HTML/part-j-1.htm] Accessed Nov. 20, 2006.

Weber S, Petsonk, E, Kullman GJ, Jones W, Olenchock S, Sorenson W, and Parker J Marcelo-Baciu R, Frazer D, Castranova V [1993]. Organic dust exposures from compost handling: case presentation and respiratory exposure assessment. AJIM *24*:365–374.

Winterlin WL, Kilgore WW, Mourer C, Schoen SR. Worker reentry studies for Captan Applied to Strawberries in California [1984]. *J. Agric. Food Chem*. 32:664-672

Zwieg G, Gao R, Popendorf WJ. Simultaneous Dermal Exposure to Captan and Benomyl by Strawberry Harvesters [1983]. *J. Agric Food. Chem*. 31:1109-1113

Chapter 6. Goal 4: Hazard Control Systems

Reduce injuries and illnesses in AFF Program-related industries by developing and demonstrating control systems and making them available.

6.1 Tractor Safety

- Reduce injuries that result from tractor overturns
- Stimulate farmers to retrofit their tractors with ROPS or a folding ROPS
- Evaluate safety zones in terms of body size.

6.1a Challenge or Issue

According to data from the BLS CFOI, 2,869 agricultural workers died from tractor-related events between 1992 and 2005; 1,412 of these deaths were due to tractor overturns (Figure 6-1) [BLS 2006]. The use of ROPS has been shown to be effective in preventing tractor overturn-related deaths and injuries [Thelin 1990; Cole et al. 2004]. These findings have been corroborated by fatality data from Nebraska. Between 1967 and 2000, the State of Nebraska investigated all 310 tractor overturn fatalities that occurred within the State. Only one of these deaths involved a tractor with a ROPS. However, data from the AFF Program found that only 38% of tractors used on farms in the United States had a ROPS in 1993; this had increased to 50% in 2001 [Myers 2003; Myers and Snyder 1995]. Since 1992, a modest but not statistically significant decrease has occurred in the fatality rate for farm workers from tractor overturns (Figure 6-2).

Figure 6-1. Agricultural Tractor-related Fatalities by Type of Injury Event, 1992-2005. *Source: BLS CFOI**

Tractor data from the TISF survey provided additional information about the types of tractors without ROPS used on farms. These data indicated that many of these tractors were manufactured before the release of ROPS as an option on farm tractors in the mid- to late-1960s [Myers and Snyder 1995; Arndt 1971]. In addition, these non-ROPS tractors were primarily small to medium size (between 20 and 90 horsepower)

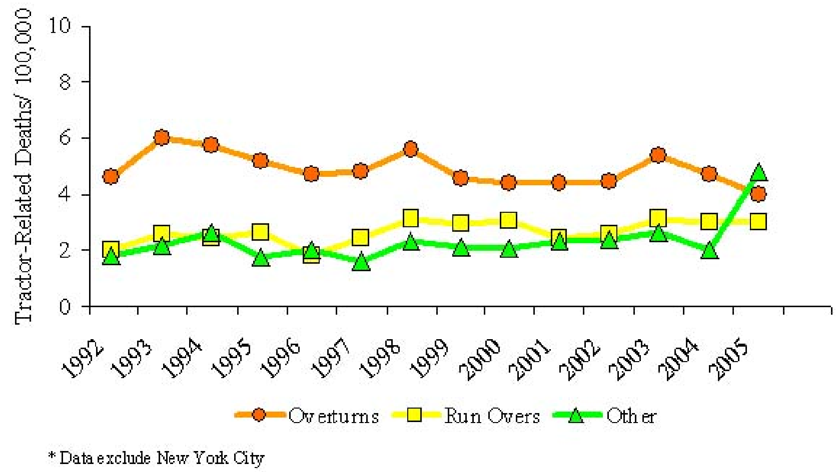


Figure 6-2. Agricultural Tractor-related Fatality Rates by Cause and Year, 1992-2005. *Source: BLS CFOI.**

and used primarily on farms such as livestock operations (including dairies), field crop operations, and fruit and vegetable operations. Agricultural safety professionals have identified several barriers to farm operators placing ROPS on tractors. Common reasons include the cost of placing ROPS on older farm tractors, the inconvenience of having the ROPS placed on the tractor, and the possibility of ROPS interfering with the use of tractors in low-clearance areas, such as animal facilities and orchards.

6.1b Activities

On the basis of the tractor demographic data and the barriers to ROPS use identified by others, the AFF Program has undertaken an intramural and extramural program to increase the use of ROPS on farms in the United States. The intramural program involves surveillance of ROPS use on farms, evaluating the cost-benefit of placing ROPS on tractors, and an engineering research program to develop ROPS designs to address these issues. The engineering program is focused on developing an auto-deploying ROPS for use in low-clearance areas and low-cost retrofit ROPS designs. While conducting this work, AFF Program researchers began to have concerns about the anthropometric data used to define the ROPS protective zone for national consensus ROPS standards. This resulted in a separate research project to collect anthropometric data on a large sample of farm workers. Extramural activities are exploring different methods of promoting the use of ROPS.

Surveillance

Fatalities are the primary issue associated with farm tractors in the agricultural production industry. Farm tractors account for nearly 37% of all work-related farming deaths between 1992 and 2000 [Myers 2003]. The rate of these tractor-related deaths differs by region of the United States (Figure 6-3) with the highest rates occurring in the Northeastern States and the lowest in the West. The majority of these deaths involve farmers and farm workers over age 55 (Figure 6-4); this same age group also has the highest fatality rates due to tractors (Figure 6-5). (Appendices 3.2-01, 3.2-02, 3.2-04)

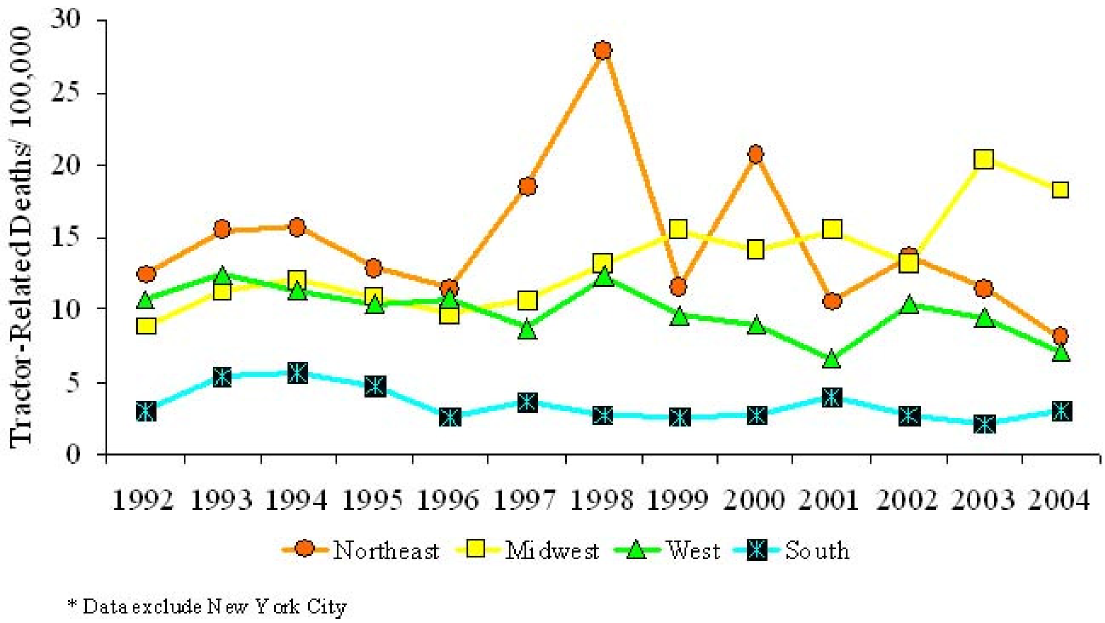


Figure 6-3. Agricultural Tractor-related Fatality Rates by Region and Year, 1992-2004.
*Source: BLS CFOI**

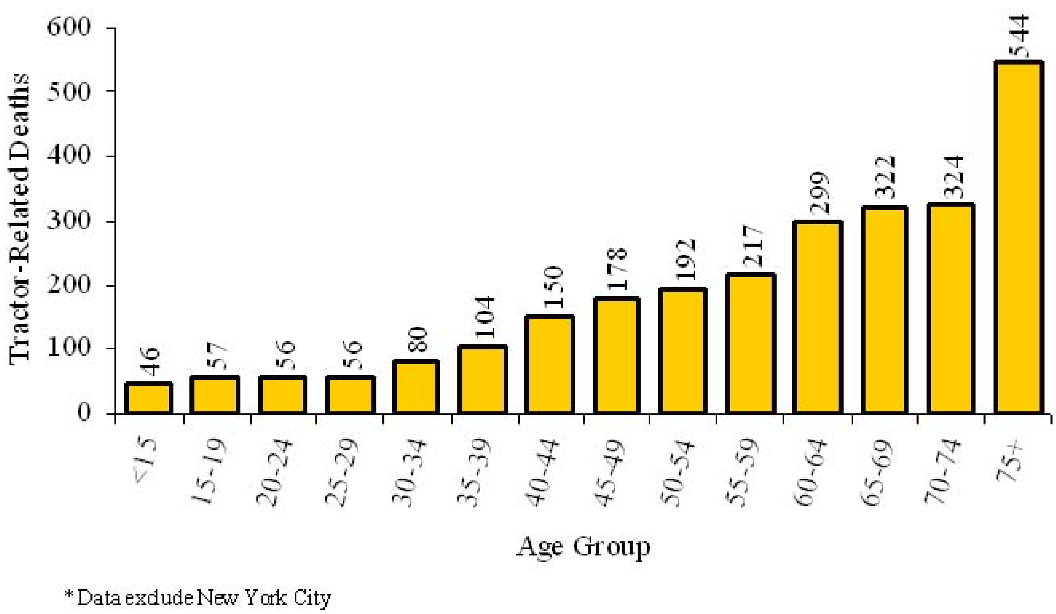


Figure 6-4. Agricultural Tractor-related Fatalities by Age Group, 1992-2004.
*Source: BLS CFOI**

Figure 6-5. Agricultural Tractor-related Fatality Rates by Age Group, 1992-2004
*Source: BLS CFOI**

In 1994, the AFF Program established the TISF system as a means of collecting occupational injury data for farmers and farm workers across the United States. In addition to injury information, the TISF collected data on tractors used on U.S. farms and whether these tractors had ROPS. These data were considered important because tractor overturns were the leading cause of death among farm workers. ROPS were considered the best method of preventing overturn-related deaths and their efficacy was well documented by the early 1990s [Thelin 1990]. However, no data were available to identify the farm tractors in common use and whether they had ROPS in place or could be retrofitted with ROPS. TISF collected the tractor manufacturer, model, and age of each tractor on a farm, ROPS status, and the hours of use for each tractor. Farms averaged more than two tractors; each tractor was on the average more than 20 years old. More than 60% of U.S. farm tractors were without ROPS (Table 6-1). Unfortunately, the 1993 tractor survey did not have any information on the age of the farm operator.

Table 6-1. Summary of farm tractors used on farms in the U.S. in 1993.

	Estimate
Tractors in use	4,800,000
Average Tractor age	22.8 years
Tractors per farm	2.3
Tractors with ROPS	1,824,000
ROPS Roll bar	*528,000*
ROPS Cab	*1,296,000*
Tractors without ROPS	2,980,000
ROPS tractors per farm	0.90
Source: TISF	

In addition to providing baseline tractor information for the AFF Program and others in the agricultural safety and health community, the

TISF tractor data also provided estimates of the most common tractors used on farms that were without ROPS (Table 6-2). The AFF Program used these data to identify common older tractor models to target engineering research designing new ROPS and assessing the structural integrity of older tractors to support ROPS structures during overturns.

Table 6-2. The five most common farm tractors without ROPS in use on U.S. farms, 1993

Manufacturer and Model	Non-ROPS units in use
John Deere 4020	100,000
Ford 8N/9N	84,000
International Farmall M	77,000
International Farmall H	66,000
John Deere 3020	56,000
Source: TISF	

Because of budgetary constraints, TISF was discontinued in 1997.

In 2001, the AFF Program re-established surveillance of occupational injuries occurring to farmers and farm workers through the OISPA project. As with the TISF before it, OISPA collected demographic and ROPS use information about tractors used on farms in the United States These data indicated that the use of ROPS increased in the United States between 1993 and 2001, with nearly 50% of all tractors in use on farms having either a ROPS roll bar or ROPS cab (Table 6-3) in 2001. Roll bar style ROPS showed the largest increase in use (75%). Historically, tractors have had a long useful lifetime, and the average age increased somewhat over the 8 years between surveys. The distribution of the most common tractors without ROPS changed little between the surveys with the oldest tractors, the Farmalls, being slowly taken out of service.

Table 6-3. Summary of farm tractors used on farms in the United States, 2001.

	Estimate
Tractors in use	4,700,000
Average Tractor age	25.7 years
Tractors per farm	2.5
Tractors with ROPS	2,326,000
ROPS Roll bar	*926,000*
ROPS Cab	*1,400,000*
Tractors without ROPS	2,374,000
ROPS tractors per farm	1.2
Source: OISPA	

<u>Economic Assessments of ROPS Use</u>

On the basis of the tractor information collected through the TISF, the AFF Program conducted a cost-effectiveness assessment of retrofitting tractors with ROPS [Myers and Snyder 1995]. The study concentrated exclusively on fatalities due to tractor overturns. The key findings from the study were that the immediate ROPS retrofitting of the most common farm tractor in 1993 would save nearly 1,500 lives over 20 years at an estimated cost of $825,000 per life saved. The paper also found that the 1985 ASAE voluntary standard to place ROPS on all farm tractors manufactured after 1985 was having an impact on the use of ROPS. But the paper concluded that it would take 20 to 25 years for the increased use of ROPS on farms to cause a major reduction in tractor overturn deaths. (Appendix 3.2-01)

This analysis was followed by more complex economic analyses that incorporated the cost of nonfatal injuries with the cost of fatal injuries associated with tractor overturns [Pana-Cryan and Myers 2000, 2002]. This analysis found that retrofitting tractors with ROPS would save approximately $490,000 per averted injury, and that the United States could save approximately $1.5 billion by retrofitting tractor with ROPS within its borders.

The NIOSH-funded Agriculture Safety and Health Center at the University of Kentucky is using OISPA tractor prevalence data from 2001 and 2004 for an economic analysis project of ROPS use on farms. The project includes analysis of tractor and ROPS use by hours worked, farming operation, and the need and feasibility of retrofitting ROPS to existing tractors. This project is part of a larger national AFF Program—the Agricultural Research Centers tractor initiative.

AutoROPS prototype test, September 1999.

Engineering Controls—AutoROPS

The three types of farming where clearance is a major issue are livestock operations, dairy operations, and fruit and nut tree operations. This is because tractors are driven into animal facilities or through rows of trees. According to the 1993 tractor survey, these farms accounted for about 2.7 million tractors, of which 67% did not have ROPS [Myers and Snyder 1995]. Although it is not possible to say that all of these tractors do not have ROPS because of clearance issues, it does show that these farms had lower than average ROPS usage. We are not aware of any data on whether these types of farmers deferred buying new tractors because of ROPS being on new tractors. Although fold-down ROPS are available for low clearance use on new tractors, they still require the operator to manually put the folded ROPS into the upright position once he leaves the low clearance area. (Appendices 6.1-01, 6.1-02, 6.1-03)

In 1993, the AFF Program began development of AutoROPS, and in 1995, it began development of an AutoROPS overturn sensor. The first project developed a ROPS that could be lowered and latched for day to day use, but that could deploy during an overturn. The second project developed an overturn sensor that monitored tractor operating conditions and provided a signal that would deployed the AutoROPS when needed.

Third generation AutoROPS in a retracted position

By 1999, these projects had developed workable devices. The AutoROPS was tested at West Virginia University, and the sensor was tested in an intramural AFF Program laboratory. However, to verify that the components would work together, we conducted field tests.

In 2000, a new NORA project continued the AutoROPS work and included research for CROPS and composite ROPS (described separately). The project included funding for the development of a remote control test tractor and a field overturn test site at the NIOSH Pittsburgh Research Laboratory (PRL).

In the spring of 2000, the first AutoROPS overturn test was conducted at PRL. It showed that the AutoROPS worked. Subsequent testing refined the AutoROPS structure and sensor designs. The structure design was refined to make the AutoROPS smaller and lighter. The latching mechanisms were redesigned for easier operation and better manufacturing. The sensor was redesigned to replace obsolete parts and to incorporate other functions to reduce false deployments. One of the issues we encountered when trying to interest manufacturers in these designs was their reluctance to adopt new technologies because of liability issues. Tractor manufacturers encouraged us to further refine the technology before serious consideration could be given to full collaboration in transferring the AutoROPS design for application on new tractors.

In June, 2003, we solicited equipment manufacturers for a partnership with an announcement in the Federal Business Opportunities publication, a common method of identifying private companies interested in contracting work with Federal agencies. Through this advertisement, we entered into a partnership with SCAG Power Equipment. They were interested to see if we could develop an AutoROPS for their line of zero turn lawn mowers.

Retracted Deployed

An AutoROPS adapted for a zero turn lawn mower.

With the NORA project coming to a close, we applied for a grant through the California State University San Bernardino Office of Technology Transfer and Commercialization (OTTC) to continue work with SCAG. OTTC's mission is to promote the transition of new technologies to the marketplace [OTTC 2006].Our grant was awarded at the end of 2004, and the new AutoROPS was developed with SCAG for its Turf Tiger zero-turn mower.

During our work with OTTC to transfer the new ROPS technology, it came to our attention that another major barrier to adoption by manufacturers was the lack of an appropriate standard for testing the AutoROPS design. With assistance from Emerging Growth, LLC, we petitioned ASABE to begin work on a performance standard for the AutoROPS. Once a standard is issued, manufacturers such as SCAG can begin producing the AutoROPS.

Engineering Controls - CROPS

In 2000, a new NORA project continued the AutoROPS work. It included research for CROPS and composite ROPS. The CROPS research investigated the use of readily available commercial parts to construct a ROPS for different model tractors. The AFF Program team looked at data estimating the most common tractors in use without ROPS. On the basis of the data, the team chose 10 tractor models for CROPS designs. Initially, the researchers investigated different CROPS designs for a Ford 4600 model tractor (because we already owned one). In 2002, the team successfully designed, built, and tested a CROPS design that passed the ASAE–J2194 industry ROPS standard. (Appendix 6.1-04)

Having successfully demonstrated that commercially available components could be used to build a valid ROPS, the team began work on five more CROPS designs. Through Federal Business Opportunities, we solicited help from a ROPS manufacturer. A partnership with FEMCO resulted. FEMCO was responsible for manufacturing two of the five CROPS designs. Because of FEMCO's production schedule, they have not yet produced any CROPS.

CROPS design for a Ford 4600 tractor.

The AFF Program team completed the designs for all five tractor models. However, there were more models identified that required a CROPS design. We plan to complete five additional CROPS designs and are seeking a new partnership with a ROPS manufacturer for production and sale of CROPS.

Anthropometry of Agricultural Populations

Inappropriate fit of people to workplace vehicles and equipment can directly or indirectly result in injury to workers. People in the United States are becoming taller and heavier with time. In addition, much of the anthropometric data available regarding the fit or design of machines in the workplace are two dimensional. In addition, anthropometric data on working women and minorities is typically not available. (Appendix 6.1-05)

To address this gap in reliable anthropometry data, the AFF Program invested in the lastest whole-body scanning technology, and began collection 3-D body measurements of specific worker populations, including farmers and farm workers. The use of 3-D body form models allows designers and manufacturers to deliver more accurate and better fitting products through a substantial reduction in measurement error and a reduced reliance on body form assumptions.

3-dimensional scanned image of an agricultural worker.

A total of 100 agricultural workers were scanned using the 3-D system [Hsiao et al. 2005]. The results showed that the vertical clearance for the current Society of Automotive Engineers ROPS standard is approximately 12% too short. We are sharing these data with the Society of Automotive Engineers J2194 standard committee so that the tractor cab dimension standard might be updated. Other uses of these data are also being explored.

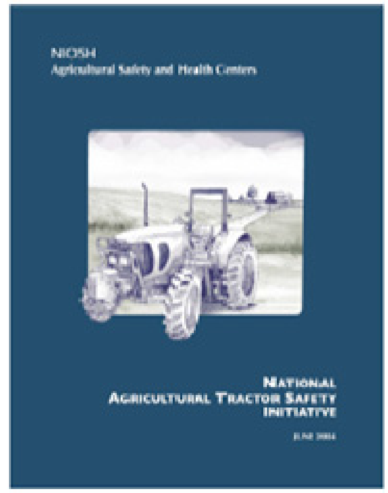
Tractor Hazard Control Policy

In 1997, extramural AFF Program staff at the University of Iowa sponsored the TRAC Policy Conference. The purpose of the event was to develop a consensus approach to implementing a tractor-related injury and fatality prevention program. This program was based in part on the TRAC-Safe program developed by the University of Iowa [NIOSH 1996]. Representatives from the farming community, research community, Federal agencies, and Iowa State legislature staff participated in the conference.

The conference ended with a list of recommendations:

- Increase the use of ROPS on tractors
- Reduce injuries and deaths due to collisions between tractors and motor vehicles on public roadways
- Reduce injuries and deaths from being run over by tractors
- Reduce the incidence of tractor-related injuries and death to youth on farms [Donham et al. 1998].

However, no clear consensus was reached on all aspects of this topic, which has prevented the recommendations from being implemented in Iowa and elsewhere.



The NIOSH Centers for Agricultural Safety and Health convened a Tractor-Related Injury and Death Meeting in Pittsburgh in 2003. AFF Program researchers met with partners to address tractor-related injuries and fatalities. The Centers published goals and recommendations to reduce the number of tractor-related injuries and fatalities in the United States. The AFF Program is currently funding five grants to address these goals and recommendations.

6.1c Selected Outputs

Hsiao H, Whitestone J, Bradtmiller B, Zwiener J, Whistler R, Kau T, Gross M, Lafferty C. [2005]. Anthropometry criteria for the design of tractor cabs and protection frames. Ergonomics 48(4):323-353. (Current research that applied newly collected anthropometric data to identify areas where the existing Roll-Over Protective Structure standard can be improved. These changes in the ROPS standard are currently being developed by the Society of Automotive Engineers. Paper has been cited at least 3 times based on a literature citation search. The results of this work were presented at the 2005 National Institute for Farm Safety Annual Conference, June 28, 2005, Wintergreen, VA.)

Pana-Cryan, Myers ML. [2000]. Prevention effectiveness of Roll-Over Protective Structures-Part III: economic analysis. Journal of Agricultural Safety and Health 6(1):57-70. (Paper provides the most comprehensive economic analysis by NIOSH of the cost benefit of using ROPS on farm tractors. The paper included the benefits of preventing nonfatal injuries along with the benefits of preventing fatal injuries from tractor overturns in the US. Paper has been cited at least 5 times based on a literature citation search.)

Myers JR, Snyder KA. [1995]. Roll-over protective structure use and the cost of retrofitting tractors in the United States, 1993. Journal of Agricultural Safety and Health 1(3):185-197. (Paper presented ROPS use information for the first time at the national level, defined what specific tractors needed retrofitted with ROPS, and provided an estimate of the cost to do the retrofitting of ROPS on these tractors. Results lead to NIOSH and other extramural partners work on developing inexpensive ROPS designs for older farm tractors. Paper has been cited at least 29 times based on a literature citation search. Results of this work were presented at the Tractor Risk Abatement and Control Policy Conference, September 10-12, 1997, University of Iowa, Iowa City, IA.)

A complete list of outputs can be found in section 6.3 at the end of this chapter.

6.1d Intermediate Outcomes

ROPS Development

In 1985, ASAE adopted the voluntary standard S318.10, which recommended that all new farm tractors sold in the United States be fitted with a ROPS. We estimate that more than 95% of all tractors used on farms manufactured after the adoption of this voluntary standard have ROPS. The use of these newer ROPS–equipped tractors accounts for most of the 12% increase in ROPS use on farms.

A new standard for AutoROPS, Standardized Deployment Performance of an Automatic Telescoping ROPS for Agricultural Equipment (ASABE–X599), is in draft form and has undergone its first review by ASABE. This standard, once issued, will give the manufacturers criteria to build, test, and sell AutoROPS to consumers.

Anthropometry

Anthropometry data from the AFF Program are being used by the ASAE J2194 standard committee to examine updating the tractor cab dimension standard, which will have a potential impact on the design of the next generation tractor cabs, affording better protection to the estimated six million tractor/farm machine operators in the United States.

Surveillance

Tractor data collected through the TISF survey were used by Colorado State University. Engineering research was conducted to evaluate the ability of pre-ROPS tractors to withstand the forces of a tractor overturn if ROPS were designed and mounted on them. TISF tractor prevalence data were used to identify common tractors by manufacturer and model for ROPS retrofit evaluations (e.g., Ford 8–N). The TISF data were the only information source for prioritizing these research evaluations.

6.1e External Factors

An external factor affecting our efforts on tractor safety is the workforce's lack of perceived need for ROPS or urgency to obtain ROPS [May et al. 2006; Hallman 2005; Kelsey et al. 1996].

Another external factor was manufacturers' attitudes and behaviors. We learned that some manufacturers are reluctant to help prove the concept or adopt new safety technology relevant to their products because of concerns about liability. If new safety technology has been proven but has not been adopted or integrated into a manufacturer's product, the manufacturer may be liable for injuries that the technology could have prevented. Thus, manufacturers, particularly those with a large share of the market, proceed slowly to finalize and prove new safety technology. Manufacturers are also reluctant to implement new technology without a specific consensus standard addressing building and testing criteria. In addition, we learned that the patent process is very time consuming and can significantly delay product adoption.

We learned that small companies are often more willing than large name-brand companies to partner with researchers and take risks to gain stature in the market, so we worked with smaller manufacturers. Another strategy was to engage with manufacturing partners (and relevant trade associations) early in the development process to seek their input and ensure their buy-in of the end product. In the final stages of prototyping and testing, partnership agreements that share and formalize roles and responsibilities of both the government and the manufacturers help to avoid manufacturer efforts to forestall progress towards a proven safety technology. The importance of facilitating the development of product standards simultaneously with new technology was also an important lesson. The cost-benefit of patenting AFF Program-developed technology, in terms of both time and cost, is an ongoing lesson we are learning.

Voluntary standards from organizations like ASABE or ASAE are critical to getting manufacturers to adopt new technology. Regulatory mandates for the use of ROPS have not occurred, despite mandates in other nations, such as Sweden.

6.1f Future Directions

The AFF Program plans to continue tracking the use of ROPS on farms through the OISPA project. We plan to continue efforts in the development of the X599 AutoROPS Performance Standard within ASABE. The goal is to have the standard published within the next two years. The CROPS project will not be complete until the end of 2007. By this time, we hope to have a ROPS manufacturer offering CROPS as an alternative for consumers.

6.1g List of NIOSH projects that are included in this section

- DSR-VLB827-Occupational Traumatic Injury Surveillance of Farmers (Appendix 3.2-01)
- DSR-9277135-Occupational Injury Surveillance of Production Agriculture (Appendix 3.2-02)
- DSR-9278951-Analysis of Surveillance Data for Agricultural Injuries (Appendix 3.3-04)
- DSR-9277178-New Technology to Increase ROPS Use on Tractors (Appendix 6.1-01)
- DSR-9278818-Development of Automatic ROPS (Appendix 6.1-02)
- DSR-9278885-Development of Automatic ROPS Overturn Sensor (Appendix 6.1-03)
- DSR-927006T-Commercialization of a Cost-effective ROPS (CROPS) Design (Appendix 6.1-04)
- DSR-9278933-Anthropometry of Agriculture Populations (Appendix 6.1-05)

6.2 Ergonomic Interventions

Reduce musculoskeletal morbidity resulting from work in AFF Program industries by introducing ergonomics to reduce harmful exposures while potentially increasing productivity as an incentive.

6.2a Challenges and Issues

At the 1991 Surgeons General's conference on Agricultural Safety and Health, MSDs were recognized as the second leading work-related disease or injury in agriculture [DHHS 1992]. Farm work is typically hard physical labor. Researchers have found that backaches and pain in the shoulders, arms, and hands are the most common ailments farm workers report [Mobed K et al]. One third of farm worker sprain/strain injures and one quarter of their back injuries result in missed work [BLS 1996]. In other industries that are prone to MSDs, reengineering work procedures or redesigning tools has commonly been used to reduce injuries [NIOSH 1997]. However, very little has changed in the way most farm work is performed. Field work is still performed in a stooped position; workers often carry heavy weights in awkward positions, kneel frequently, work with their arms above shoulder level, or perform repetitive movements with their hands and wrists. These jobs can be made safer.

In 1998, the AFF Program convened a conference of researchers who were working in the area of agriculture and musculoskeletal disorders. The partners determined that until recently, ergonomic research for farm workers in this area had been minimal and not widely known. It was speculated that only five or six researchers in the United States were working in this area.

6.2b Activities

AFF Program work on ergonomic issues in the agriculture industry has been done by university researchers through extramural NIOSH funding mechanisms. (Appendix 3.1-04)

AFF Program researchers at the University of California Davis have conducted ergonomic research among tree nursery workers and wine grape and tree fruit harvesters from 1990 to the present. Over the years, the research with these different groups had a cumulative effect, with newer research building on the results of earlier studies. Between 1990 and 1994, we worked with nursery workers and employers to identify the most strenuous tasks and then find ways to make them easier. Together we developed a nursery pot carrier system for reducing bending and stooping movements.

The AFF Program researchers began working with the wine grape harvesters in 1996. We worked on reducing the size of the grape bins used by the workers, thus reducing lifting demands. Adjustments were also made in the material used for the bin handles to reduce workers' gripping effort requirements. Musculoskeletal pain was significantly without reducing production significantly by the use of lighter, slightly smaller bins for harvesting. More recently, AFF Program researchers worked to develop a "bolt-on" tractor apparatus that helps workers move the smaller bins with less bending and lifting.

Use of small bins with better grips reduces musculoskeletal pain without reducing production

Organizational partners in the California research include four major wine grape producers with their own vineyards; the California Farm Bureau, the California State Compensation Insurance Fund (the State's largest workers' compensation insurer), USDA extension advisors for wine grape growing in Napa and Sonoma counties; two large farm labor contractors; equipment manufacturers; commodity-focused agricultural organizations (e.g., the California Pear Advisory Board, Avocado Commission and Citrus Research Board); and other California universities.

Use of bin mover reduces lifting and carrying in grape harvesting

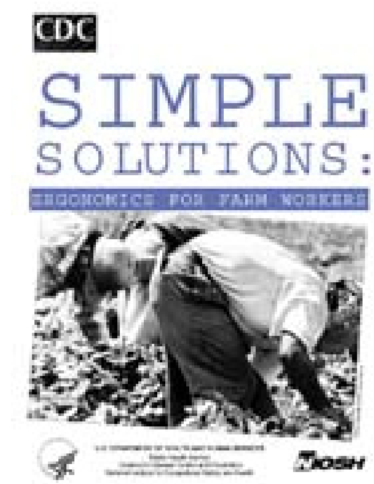
Since 2004, the California AFF Program researchers have worked with tree fruit harvesting workers and employers on multiple interventions to reduce ergonomic hazards. One is a specially designed platform machine previously used by apple growers in Washington State. The machine eliminates the need for a ladder and picking bags. Tests of the platform harvester showed no significant bruising of fruit, a critical factor.

AFF Program researchers at the University of Wisconsin developed social marketing hypotheses to research the adoption of ergonomic and other safety innovations in the dairy, berry, and nursery industries. Information materials were prepared for workers and employers about these innovations, but other information was prepared for targeted trade publications too. In addition, some farmers were recruited to talk with their peers about the innovations at trade shows. Extensive evaluation of these diffusion efforts was undertaken, measuring farmers' likelihood of adopting ergonomic changes after information campaigns, and comparison of measured rates with those of a control group. Those methods were presented by the principal investigator at the NORA symposium in April, 2006 in an invited presentation. Known as the Healthy Farmers/Healthy Profits project, it began in 1996 and is ongoing (http://bse.wisc.edu/hfhp).

In 1993, the AFF Program received a Health Hazard Evaluation request from the Maine Department of Human Services to investigate cases of "rakers tendonitis," which was reported among seasonal harvesters who raked wild blueberries in Maine. The AFF Program staff recommended a redesign of the rake to give it a long handle or to provide two handles. A report of this study was published in the New England Journal of Medicine (1994) and the American Industrial Hygiene Association Journal (1996).A fact sheet on the new rake was also published in *Simple Solutions: Ergonomics for Farmworkers* (2001). The Maine Agricultural Safety and Health Program developed a pamphlet about the rake that they distributed in schools and then evaluated the incidence of musculoskeletal disorders. Their report was published in the American Journal of Public Health (1996). The Maine Department of Human Services, the Maine Agricultural Safety and Health Program, and the C&D Corporation were partners on the rake project.

6.2c Selected Outputs

In 2001, intra- and extramural AFF Program researchers developed a booklet, *Simple Solutions: Ergonomics for Farm Workers* in collaboration with several stakeholders. Since many farmers are small employers with limited resources, the booklet focuses on low-cost solutions and includes diagrams for building them on the farm. AFF Program researchers developed 12 of the 16 interventions presented in the booklet. The booklet helps readers to develop their own solutions through guidelines, resources, and a "how to build ergonomic teams" section.



NIOSH Document: Simple Solutions: Ergonomics for Farm Workers

Simple Solutions takes research and puts it into the hands of those who can use it. Letitia Davis, Director of the Massachusetts Occupational Health Surveillance Program, wrote, "Congratulations! *Simple Solutions* is absolutely wonderful....we need them for all sectors."

Nitsa Allen-Barash, Ph.D., of the University of Washington wrote, "I have just reviewed [it]. I like it a lot—both content and format—and am planning to share it with people in eastern Washington. The examples seem comprehensive and very well presented, attractive, and nicely laid out. I also like the cost effectiveness information [Allen-Barash 2001]."

More than 80,000 copies of *Simple Solutions* have been disseminated (20,000 in Spanish). Because of continuing demand, the AFF Program will print additional copies in Fall 2006. It is available on the NIOSH Web site. Agriculture safety and health stakeholders such as the National Center for Farmworker Health have linked to this document from their Web sites.

Because of the good reception of this document, NIOSH has plans to develop similar documents for construction, mining, and maritime workers.

AFF Program researchers published information about ergonomics related to children in the document *Children and Agriculture: Opportunities for Safety and Health: A National Action Plan (NAP)* (Appendix A2-4).

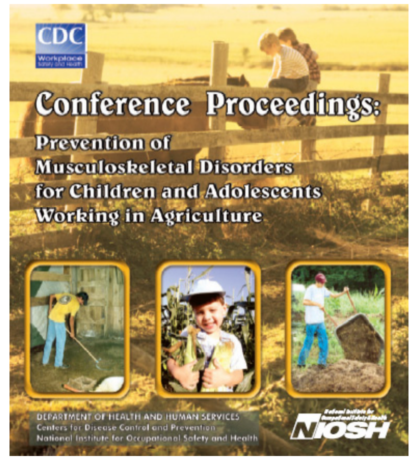
Strap-on stool improves ergonomics in tasks normally requiring bending and stooping

A publication related to the wine grape production tub project received the National Institute for Farm Safety's 2003 Research Award for its contribution toward preventing agricultural injury and illness [Meyers et al. 2001]. Further information and a research report on this project and other AFF Program-funded ergonomic work at the University of California, Davis can be found at http://ag-ergo.ucdavis.edu

The Healthy Farmers/Healthy Profits project created 24 tip sheets related to dairy direct-market farmers, berry growers, and nursery operations. The tip sheets are disseminated through a Web site (http://bse.wisc.edu/hfhp) and at trade shows. Recruited volunteer peer farmers staff exhibits at trade shows to share these tips. They do it in exchange for registration fees.

In 2006, the principal investigator on this project presented the results of the Healthy Farmers/Healthy Profits project at a plenary session of the NORA Symposium as a model for evaluating interventions. In addition, materials were included in other publications such as *Small-Scale Post-Harvest Handling Practices*, *a Manual for Horticultural Crops,* which was published in several languages [Newenhouse, 2002].

An AFF Program Health Hazard Evaluation report was prepared on blueberry harvesting. The document reported the first documentation of the musculoskeletal risk factors of harvesting blueberries. The report proposed new designs for the rake that is used to harvest blueberries. A New England Journal of Medicine report and another peer-reviewed journal article were prepared by AFF Program staff. This investigation was highlighted as a fact sheet in *Simple Solutions: Ergonomics for Farmworkers*.



In 2002, the AFF Program convened *Prevention of Musculoskeletal Disorders for Children and Adolescents Working in Agriculture.* This conference of multidisciplinary experts discussed the issues of preventing musculoskeletal disorders among children working in agriculture. The published proceedings helped describe the hazards faced by children and adolescents who work in agriculture (typically on family farms) and gave specific suggestions for how to assess high risk jobs, conduct surveillance, and implement interventions [Waters and Wilkins 2004]. In 2004, the AFF Program contributed to *Stooped and Squatting Postures in the Workplace,* a conference for assessing ergonomic problems and potential interventions of ergonomic problems in agriculture as well as in construction and other sectors. The proceedings were published [Fathallah et al. 2005].

A complete list of outputs can be found in section 6.3 at the end of this chapter.

6.2d Intermediate Outcomes

AFF extramural researchers in California redesigned nursery pot carriers to reduce ergonomic hazards for workers moving nursery pots. The nursery pot handles are now being sold through Gemplers, an agriculture products mail order catalog.

AFF Program researchers promoted six different safer, more profitable dairy farming practices among all dairy farmers in Wisconsin (~20,000) from 1997 to 2005. Questionnaires were used to measure the degree of adopting the new practices. Results showed that the likelihood of adopting barn lights, silo bags, and calf care feeding sites all increased significantly among northeast Wisconsin dairy farmers [Chapman et al. 2005]. Over this same period, there were also increases in the awareness of barn lights and the calf feed sites

The response to the *Simple Solutions* document has been positive.

- Matthew Keifer, MD of the Harborview Medical Center, Seattle reported on the Migrant Health Research Listserv, "For those of you who have not seen that pub yet, I encourage you to get a copy. It's a practical and very clearly written collection of recommendations. I found it very useful and thought provoking. It's a great handout for farmers, farm workers and farm managers." [Keifer 2001]
- East Carolina University systems engineering classes use it in their introductory class to applied technology as a guide for student projects and evaluation of those projects [Personal communication 2005].

- The North Carolina Labor Department praised the Spanish version of the document and indicated that they would use it for orientation of Mexican immigrant workers [North Carolina Dept. of Labor 2003].
- The USDA Coordinator of Agricultural Labor Affairs in the Office of the Chief Economist, USDA sent a three-paragraph article about the booklet to all their [?] Agricultural Health Centers, recommending that they get copies [Personal communication 2001].
- Gregorio Billikopf, of the University of California wrote the following to the Agricultural Health Listserv, "The manual is full of photographs and practical ideas. There is an excellent section on lifting, and a second example on lifting translated into Spanish as a sample [Billikopf 2003]."
- ErgoWeb and *CTD news* both wrote stories to make sure their readers knew about the booklet and directed their readership to download it from the Web site [Personal communication 2001]

As a result of the AFF Program research on ergonomic interventions for harvesting tree fruit, one major producer of pears has ordered two of the harvesters. In addition, in the 2006 harvest season, women were employed to do the pear harvesting from the platforms, a task reserved for men before. Women are probably being used because of a labor shortage and the fact that the platform system does not require carrying heavy bags up and down ladders.

6.2e End Outcomes

Management and workers in wine grape production adopted the smaller, lighter picking tubs (>3000 tubs in 2002 and 3400 in 2003) developed by AFF Program researchers. The only incentive for adoption was improved working conditions. Since the study, these smaller tubs have become the most common type used in the Napa and Sonoma counties' hand harvest. We presume that exposures have been reduced.

6.2f External Factors

Like other occupational safety and health issues, ergonomic research is affected by social, economic, and regulatory conditions that may help or hinder progress.

Social conditions include attitudes of workers and employers toward innovation in the workplace. They know the demands of their work, are creative about improving well-known processes, and have skills to adapt equipment and procedures. These factors help transfer ergonomic solutions to the workplace. However, workers and employers may lack knowledge of body systems that are affected by ergonomic risks—knowledge that would help them collaborate with researchers. Further, workers and employers may resist workplace changes when they have been doing things a certain way for a long time. Some workers are concerned that ergonomic changes will de-skill their work, reducing their potential income.

Good ergonomic interventions are often cost-effective and can enhance production. Workers and employers will often adopt interventions they perceive to be cost-effective, even in the absence of regulatory requirements. However, ergonomic changes can be expensive to adopt, with economic benefits uncertain for some time after adoption.

The ergonomic regulatory environment has been relatively inactive in the last decade. That has both stimulated and retarded ergonomic research and prevention efforts in the workplace.

Finally, evidence of outcomes from this research is limited by at least two factors. First, surveillance systems do not yet capture agricultural injuries in general and ergonomic-related musculoskeletal injuries in particular. Second, much of the population at risk is still unaware of their risk of experiencing work-related musculoskeletal problems.

6.2g Future Directions

Limited interventions are currently available to prevent the need to stoop and bend in many agricultural tasks, e.g. in the harvesting of berries. Research in this area is planned.

Plans are underway to further disseminate effective solutions to ergonomic hazards.

6.2h List of NIOSH projects that are included in this section

- DSHEFS-9278501-Community Partners for Healthy Farming (Appendix 3.1-04)

6.3 Outputs

6.3a Tractor Safety

Sponsored Workshops

Tractor Risk Abatement and Control Policy Conference, September 10–12, 1997, University of Iowa, Iowa City, IA.

Tractor-Related Injury and Death Meeting, February 13–14, 2003, Pittsburgh, PA.

Peer Reviewed Articles

Etherton JR, Cutlip RG, Harris JR, Ronaghi M, Means KH, Gillispie A [2002]. Static load test performance of a telescoping structure for an automatically deployable ROPS. J Ag Safety Health 8(1):119–126. (IS I Web of Science: Cited 1 time as of 11/20/06)

Etherton JR, Cutlip RG, Harris JR, Ronaghi M, Means KH, Howard S [2002]. Dynamic performance of the mechanism of an automatically deployable ROPS. J Ag Safety Health 8(1):113–118. (IS I Web of Science: Cited 1 time as of 11/20/06)

Etherton JR, McKenzie Jr EA, Lutz TJ, Cantis DM, Kau TY [2004]. An initial farmer evaluation of a NIOSH AutoROPS Prototype. Int J Ind Ergonomics 34:155–165

Harris JR, Ronaghi M, Snyder KA [1998]. Analyzing tractor rollovers using finite element modeling. Analysis Solutions *2*(4):24–25.

Hsiao H, Long D, Snyder K [2002]. Anthropometric differences among occupational groups. Ergonomics *45*(2):136–152. (IS I Web of Science: Cited 3 times as of 11/20/06)

Hsiao H, Whitestone J, Bradtmiller B, Zwiener J, Whistler R, Kau T, Gross M, Lafferty C. [2005]. Anthropometry criteria for the design of tractor cabs and protection frames. Ergonomics *48*(4):323–353.

Myers ML [1998]. NIOSH perspective on tractor-related hazards. J Ag Safety Health *4*(4):205–230.

Myers ML [2000]. Prevention effectiveness of roll-over protective structures. Part I: strategy evolution. J Ag Safety Health *6*(1):29–40. (IS I Web of Science: Cited 3 times as of 11/20/06)

Myers ML, Pana-Cryan R [2000]. Prevention effectiveness of roll-over protective structures. Part II: decision analysis. J Ag Safety Health *6*(1):41–55. (IS I Web of Science: Cited 1 time as of 11/20/06)

Myers JR, Snyder KA [1995]. Roll-over protective structure use and the cost of retrofitting tractors in the United States, 1993. J Ag Safety Health *1*(3):185–197. (IS I Web of Science: Cited 8 times as of 11/20/06)

Myers JR, Snyder KA, Hard DL, Casini VJ, Cianfrocco R, Fields J, Morton L [1998]. Statistical and epidemiology of tractor fatalities-a historical perspective. J Ag Safety Health *4*(2):95–108. (IS I Web of Science: Cited 5 times as of 11/20/06)

Pana-Cryan R, Myers ML [2002]. Cost effectiveness of roll-over protective structures. Am J Ind Med 42(S2):68–71.

Pana-Cryan R, Myers ML [2000]. Prevention effectiveness of Roll-Over Protective Structures-Part III: economic analysis. Journal of Agricultural Safety and Health 6(1):57-70.

Powers JR, Harris JR, Etherton JR, Snyder KA, Ronaghi M, Newbraugh BH [2001]. Performance of an automatically deploying ROPS on ASAE Tests. J Ag Safety Health 7(1):51–61. (IS I Web of Science: Cited 2 times as of 11/20/06)

Powers JR, Harris JR, Etherton JR, Ronaghi M, Snyder KA, Lutz TJ, Newbraugh BH [2001]. Preventing tractor rollover fatalities: performance of the NIOSH AutoROPS. Inj Prev 7(Suppl I):54–58. IS I Web of Science: Cited 1 time as of 11/20/06)

Conference Papers

Etherton JR, McKenzie EA Jr., Powers JR [2004]. Commercializing an automatically deployable rollover protective structure (AutoROPS) for a zero-turn riding mower: initial product safety assessment criteria. In: Proceedings of the ASME International Mechanical Engineering Congress and Exposition, Anaheim, CA, November 13–19.

Harris JR, Cantis DM, McKenzie EA Jr., Etherton JR, Ronaghi M [2005]. Commercialization of cost-effective rollover protective structures (CROPS): research-in-progress. In: Proceedings of the National Institute for Farm Safety (NIFS) Annual Conference, Wintergreen, VA, June 26–30.

Harris JR, Etherton JR, Cantis DM, McKenzie EA Jr., Ronaghi M [2004]. Tractor overturns and ROPS performance—is the SAE standard tough enough? National Symposium on Agricultural Safety and Health, Keystone Resort, CO, June 20–24.

Harris JR, McKenzie EA Jr., Cantis DM, Etherton JR, Ronaghi M [2004]. Technology transfer— putting cost-effective rollover protective structures in the field. National Symposium on Agricultural Safety and Health, Keystone Resort, CO, June 20–24.

Harris JR, McKenzie EA Jr., Etherton JR, Cantis DM [2002]. Designing cost-effective rollover protective structures (CROPS) at NIOSH. In: Proceedings of the National Institute for Farm Safety (NIFS) Annual Conference, Ponte Vedra, FL, June 23–27.

Guan J, Hsiao H, Current RS, Powers JR, Ammons DE [2003]. Traumatic injury potential to seat belted operator during a rearward overturn of a ROPS equipped farm tractor. NORA Meeting, Arlington, VA, June 23–24, p. 51.

Guan J, Hsiao H, Zwiener J, Current RS, Newbraugh BH, Powers JR, Spahr J [2005]. Injury potential to a seat-belted operator during a rear and side overturn of a ROPS equipped farm tractor. In: Proceedings of the National Institute for Farm Safety Conference, Wintergreen, VA, June 28, p. 81. (ISI Web of Science: Cited 2 times as of 11/20/06)

Harris JR, Mucino V, Etherton JR, Snyder KA, Means KH [1997]. Computer simulation of ROPS testing in ASAE S519. National Occupational Injury Research Symposium (NOIRS), Morgantown, WV, October 15–17, p. 46.

Lutz TJ, McKenzie EA Jr. [2005]. Remote control on a zero-turn commercial lawn mower to conduct SAE J2194 rollover test. In: Proceedings of the 2005 American Society of Agricultural Engineers Annual International Meeting, Tampa, FL, July 17–20.

McKenzie EA Jr., Etherton JR, Harris JR, Cantis DM, Lutz TJ [2005]. NIOSH AutoROPS research to practice: zero turn commercial mowers. In: Proceedings of the 2005 American Society of Mechanical Engineers Congress and Exposition, Orlando, FL, November 8–11.

McKenzie EA Jr., Etherton JR, Harris JR, Cantis DM, Lutz TJ [2003]. NIOSH AutoROPS 3rd generation static testing and human interaction element. In: Proceedings of the 2003 American Society of Mechanical Engineers Congress and Exposition, Washington, DC, November 15–21.

Myers JR [2003]. Tractor occupational safety and health update. In: Record of tractor- related injury and death meeting. Pittsburgh, PA, February 13–14. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, pp. 5–23.

McKenzie EA Jr., Etherton JR [2002]. NIOSH AutoROPS latch and release mechanism: second generation. In: Proceedings of the 2002 American Society of Mechanical Engineers Congress and Exposition, New Orleans, LA November 17–22.

McKenzie EA Jr., Etherton JR [2002]. Novel latch and release mechanism for an automatically deployable ROPS. Agricultural Equipment Technology Conference, Kansas City, MO, February 20–23.

McKenzie EA Jr., Powers JR, Harris JR, Ronaghi M, Etherton JR, Current RS, Cantis DM, Newbraugh BH, Lutz TJ [2001]. Continuing developments at NIOSH on ROPS for agricultural tractors. In: Proceedings of the National Institute for Farm Safety Annual Conference, Pittsburgh, PA, June 24–27.

Powers JR, Harris JR, Etherton JR, Snyder KA, Ronaghi M, Newbraugh BH [2000]. Performance of a new ROPS on ASAE tests. In: Proceedings of the 93rd Annual International Meeting of ASAE, Paper No. 007005, Milwaukee, WI, July 9–12.

Powers JR, Harris JR, Snyder KA, Ronaghi M, Etherton JR, Newbraugh BH [2000]. Performance of the NIOSH AutoROPS. National Occupational Injury Research Symposium (NOIRS), Pittsburgh, PA, October 17–19, p.12.

Ronaghi M, Abukhadra SM, McKenzie EA Jr., Etherton JR, Means KH [2005]. Finite element modeling of a fiber reinforced plastics composite materials in automatically deployable rollover protective structure. In: Proceedings of the 2005 American

Society of Mechanical Engineers Congress and Exposition, Orlando, FL November 8–11.

Ronaghi M, Harris JR, Powers JR, Snyder KA [2000]. Dynamic nonlinear analysis of tractor rollovers. In: Proceedings of the 9th International ANSYS Conference and Exhibition, Pittsburgh, PA, August 28–30.

6.3b Ergonomic Interventions

Peer-reviewed articles

Allread WG, Wilkins JR III, Waters TR, Marras WS [2004]. Physical demands and low-back injury risk among children and adolescents working on farms. J Ag Safety Health *10*(4):255–272.

Bartels S, Niederman B, Waters TR [2000]. Job hazards for musculoskeletal disorders for youth working on farms. J Ag Safety Health 6(3):191–201. (IS I Web of Science: Cited 4 times as of 11/20/06)

Chapman LJ, Newenhouse AC, Meyer RH, Karsh B, Taveira AD, Miquelon M [2003]. Musculoskeletal discomfort, injuries and tasks accomplished by children and adolescents in fresh market vegetable work. J Ag Safety Health 9(2):91–105. (IS I Web of Science: Cited 1 time as of 11/20/06)

Chapman LJ, Meyers J [2001]. White paper: ergonomics and musculoskeletal injuries in agriculture: recognizing and preventing the industry's most widespread health and safety problem (paper and oral presentation). NN: 20022184.

Chapman LJ Meyers J [2001]. Proceedings of the Agricultural Safety and Health Conference: Using Past and Present to Map Future Actions. Baltimore, MD, March 2–3, 2001. Available at http://www.uic.edu/sph/glakes/agsafety2001/
Chapman L, Newenhouse A, Meyer R, Taveira A, Karsh B, Ehlers J, Palermo T [2004]. Evaluation of an intervention to reduce musculoskeletal hazards among fresh market vegetable growers. Applied Ergonomics *35*(1):57–66. NN: 20025596.

Chapman LJ, Newenhouse AC, Pereira KM, Karsh BT, Meyer RM, Brunette C, Ehlers JJ [in press]. Evaluation of a four year intervention to reduce musculoskeletal hazards among berry growers. Appl Ergonomics.

Ehlers J, Palermo T [2005]. Community partners for healthy farming intervention research. J Ag Safety Health *2*(11):193–203. NN: 20028889

Ehlers J, Palmero T [1999]. Community partners for health farming: involving communities in intervention planning, implementation, and evaluation. Am J Ind Med (Suppl1):107–109. NN: 20000843 (IS I Web of Science: Cited 2 times as of 11/20/06)

Estill CF, Tanaka S [1998]. Ergonomic considerations of manually harvesting Maine wild blueberries. J Ag Safety Health *4*(1):43–57.
NN:20025139 (ISI Web of Science: Cited 1 time as of 11/20/06)
[http://asae.frymulti.com/tocjournals.asp?volume=4&issue=1&conf=j&orgconf=j1998].

Estill C, Tanaka S, Wild D [1996]. Ergonomic considerations of manually harvesting Maine wild blueberries. Am Ind Hyg Assoc J *57*(10):946–948. NN: 00233944

Estill CF, Tanaka S, Wild DK [1996]. Ergonomic considerations of manually harvesting Maine wild blueberries (AIHCE extended abstract) Am Ind Hyg Assoc J *57*(10):946–948. NN: 00233944

Faucett J, Meyers J, Tejeda D, Janowitz I, Miles J, Kabashima J [2001]. An instrument to measure musculoskeletal symptoms among immigrant Hispanic farm workers: validation in the nursery industry. J Ag Safety Health *V7*(3):185–198 (IS I Web of Science: Cited 1 time as of 11/20/06)

Meyers J, Miles J, Faucett J, Janowitz I, Tejeda D, Weber E, Smith R, Garcia L [2001]. Priority risk factors for back injury in agricultural field work. J Agromed *8*(1):37–52. (Received the National Institute for Farm Safety's 2003 Research Award for its contribution toward prevention of agricultural injury and illness)

Millard PS, Shannon SC, Carvette B, Tanaka S, Halperin WE [1996]. Maine students' musculoskeletal injuries attributed to harvesting blueberries. Am J Public Health *86*(12): 1821–1822. (IS I Web of Science: Cited 1 time as of 11/20/06)

Newenhouse A, Meyer RH, Chapman LJ [2002]. Work efficiency tips for small scale growers. In: Kitinoja L, Kader A, eds. Small-Scale Post-Harvest Handling Practices, a Manual for Horticultural Crops. 4th ed. Davis, CA: University of California-Davis, Postharvest Technology Research and Information Center. (Translated into Spanish, Arabic, Bhasa Indonesia, Portuguese and several other languages).

Spielholz P, Silverstein B, Stuart M [1999]. Reproducibility a self-report questionnaire for upper extremity musculoskeletal disorder risk factors. Appl Ergonomics (30):429–433. (IS I Web of Science: Cited 5 times as of 11/20/06)

Spielholz P, Howard N [2000]. A critical evaluation the participatory ergonomics approach in industry. In: Advances in Occupational Ergonomics and Safety III: Proceedings of the Annual ISOES Conference, International Society for Occupational Ergonomics and Safety.

Book

Newenhouse, A. Meyer RH, Chapman LJ. Work efficiency tips for small-scale growers [2002]. In L. Kitinoja and A. Kader, Eds. Small-Scale Post-Harvest Handling Practices: A Manual for Horticultural Crops. 4th ed. Postharvest

Technology Research and Information Center: University of California-Davis, p 38-40. Translated into multiple languages.

Booklets

Baron S, Estill C, Steege A [2001]. Simple solutions: ergonomics for farm workers. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication Nos. 2001–111 (English) and 2001–111(*Sp2002*) (Spanish). Available at: http://www.cdc.gov/niosh/01-111pd.html (English) and http://www.cdc.gov/spanish/niosh/docs/01-111pd-sp.html (Spanish).

Booklets by Delahaut and Newenhouse below available through the University of Wisconsin publication at: http://cecommerce.uwex.edu/showcat.asp?id=18

Delahaut K, Newenhouse A [1997] Growing broccoli, cauliflower, cabbage, and other cole crops in Wisconsin: a guide for fresh-market growers. University of Wisconsin Extension Publication A3684. (Includes ergonomics information).

Delahaut K, Newenhouse A [1997]. Growing beans and peas in Wisconsin: a guide for fresh-market growers. University of Wisconsin Extension Publication A3685. (Includes ergonomics information).

Delahaut K, Newenhouse A [1997]. Growing tomatoes, peppers, and eggplants in Wisconsin: a guide for fresh-market growers. University of Wisconsin Extension Publication A3687. (Includes ergonomics information).

Delahaut K, Newenhouse A [1998] Growing carrots, beets, radishes, and other root crops in Wisconsin: a guide for fresh-market growers. University of Wisconsin Extension Publication A3686. (Includes ergonomics information).

Delahaut K, Newenhouse A [1998]. Growing pumpkins and other vine crops in Wisconsin: a guide for fresh-market growers. University of Wisconsin Extension Publication A3688. (Includes ergonomics information).

Delahaut K, Newenhouse A [2003]. Growing salad greens in Wisconsin: a guide for fresh-market growers. University of Wisconsin Extension Publication A3788. (Includes ergonomics information).

Delahaut K, Newenhouse A [2003]. Growing onions, garlic, leeks, and other alliums in Wisconsin: A Guide for Fresh-Market Growers. University of Wisconsin Extension Publication A3785. Includes ergonomic content.

Fact Sheets

Healthy Farmers/Healthy Profits Tip Sheets
University of Wisconsin at http://bse.wisc.edu/hfhp/
16 tip sheets related to Vegetable Production available at:
http://bse.wisc.edu/hfhp/TipVeggie.htm

10 tip sheets related to Berry Production available at:
http://bse.wisc.edu/hfhp/TipBerry.htm

11 tip sheets related to Nursery Production available at:
http://bse.wisc.edu/hfhp/TipNursery.htm

9 tip sheets related to Dairy Production available at:
http://bse.wisc.edu/hfhp/TipDairy.htm

Proceedings

Chapman LJ, Meyers J [2001]. Agricultural safety and health conference: using past and present to map future actions. Conference Proceedings. Baltimore, MD, March 2–3. Available at: http://www.uic.edu/sph/glakes/agsafety2001/

Fathallah FA, Meyers JM, Janowitz I [2005]. Stooped and squatting postures in the workplace. Conference Proceedings. Oakland, CA: University of California, Center for Occupational and Environmental Health; University of California, Berkeley. Davis, and Oakland, July 29–30. Available at: http://ag-ergo.ucdavis.edu/ .

Waters TR, Wilkins JR III [2004]. Prevention of musculoskeletal disorders for children and adolescents working in agriculture. Conference Proceedings. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2004–119.

Report (unpublished)

Kidd P, Draime J [1998]. Non-traumatic, work-related, musculoskeletal disorders in farm youth. Unpublished final report, NIOSH Contract No. 79278284.

Waters TR [2003]. Two-dimensional biomechanical modeling for estimating strength of youth and adolescents for manual material handling tasks. Poster presented at 2003 Challenges in Agricultural Health and Safety Conference, San Francisco, CA, September 7–9.

Thesis or Dissertation: Example

Spielholz P [1999]. A comparison of upper extremity physical risk factor measurement methods [dissertation]. Seattle, WA.: University of Washington.

Web Pages

Healthy Farmers/Healthy Profits Healthy Farmers-Healthy Profits. Tip sheets related to specific tools and work practices that reduce risks for musculoskeletal injury and are cost effective (Sources of tools provided). Available at: http://bse.wisc.edu/hfhp

NIOSH [2004]. Community Partners for Healthy Farming http://www.cdc.gov/niosh/pgms/commpart/default.html. Linked from the NIOSH Agricultural home page. Contains description of extramural projects funded 2000–2004 and links to extramural projects.

UC Davis. Agricultural ergonomics. Davis, CA. Available at: http://ag-ergo.ucdavis.edu. Contains link to research article summarizing wine grape projects and other ergonomic work funded by NIOSH.

Presentations at National and International Conferences (Selected)

Aherin R, Hard D, Murphy D [1996]. Should ASAE be involved in safety practice standards? Invited panel participant in a panel presentation of the pros and cons of ASAE involvement in developing safety practice standards. Sponsored by T–15 Ergonomics, Safety and Health committee at the Annual International meeting of the American Society of Agricultural Engineers. Phoenix, AZ.

Chapman L, Meyers J [2001]. Ergonomics and musculoskeletal injuries in agriculture: recognizing and preventing the industry's most widespread health and safety problem. Invited white paper. Agricultural Safety and Health Conference: Using Past and Present to Map Future Actions (a major conference reviewing the prior 10 years of work nationally).

Chapman L, Pereira KM, Newenhouse, AC [2006]. A theory-driven, evidence-based intervention: seven years, 4,000 businesses, 3 safer ways to work. Invited plenary. NORA Symposium 2006: Research Makes a Difference, Washington, DC April 18–20.

Duraj V, Miles J, Meyers J [1999]. Development of a conveyor-based loading system for manual harvest of winegrapes. Presented at the ASAE conference, Toronto, Canada July 18–21.

Ehlers J, Palermo T [1998]. Community partners for healthy farming: involving communities in intervention planning, implementation, and evaluation. NIOSH-FIOH-NIWL Symposium, Pennsylvania. Symposium of selected NIOSH researchers and their counterparts from Finland and Sweden.

Ehlers J Palermo T [2006]. Community partners for healthy farming intervention research. NORA Symposium 2006: Research Makes a Difference, Washington, D.C. April 18–20. (poster and rapid oral presentation).

Faucett J, Miles J, Meyers J, Janowitz I [1998]. Cultural issues in the assessment of work-related pain. International Occupational Health and Environmental Health Nurses Conference, Eastbourne, UK: Royal College of Nursing and American Association of Occupational Health Nurses.

Faucett J, Miles J, Meyers J, Janowitz I [1998]. UE musculoskeletal symptoms in agricultural jobs. International Conference on Occupational Disorders of the Upper Extremities, San Francisco, CA. Sponsored by University of California at San Francisco, University of Michigan.

Meyers J, Miles J, Faucett J, Janowitz J, Tejeda D, Weber E, Smith R, Garcia L [1998]. Ergonomics risk factors for musculoskeletal disorder in wine grape vineyard work. Presented at National Institute for Farm Safety, Winnipeg, Canada.

Meyers J [1998]. The problem of musculoskeletal disorders in agricultural field work. Presented at the Research, Education and Extension Service Symposium, United States Department of Agriculture, Washington, DC.

Meyers J, Faucett J, Miles J, Janowitz I, Tejeda D, Duraj V, Smith R, Weber E [1999]. Effect of reduced load weights on musculoskeletal disorder symptoms in wine grape harvest work. Presented at the American Public Health Association: Celebrating a Century of Progress in Public Health, November 7–11, Chicago, IL.

Miles JA, Meyers JM, Faucett J, Janowitz I, Tejeda DG, Weber E, Smith R, Garcia L [1998]. Ergonomics risk factors in labor intensive agricultural work. Presented at the 4th International Symposium, Centre for Agricultural Medicine, University of Saskatchewan, Saskatoon, Canada.

Miles J [1999]. Research priorities for NORA from agricultural ergonomics. Presented at NIOSH/NORA Research Meeting, Houston, TX.

Waters T [1998]. Children in agriculture: ergonomic issues. Paper presented at the North American Guidelines for Children in Agriculture Symposium, New Orleans, LA., March 15–18.

6.4 References Cited

Allen-Barash N [2001]. Personal communication from Nitsa Allen-Barash, University of Washington, to the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, U.S. Department of Health and Human Services.

Arndt JF [1971]. Rollover protective structures for farm and construction tractors—a 50 year review. In: Society of Automotive Engineers Earthmoving Industry Conference, April 5–7, Peoria, IL.

Billikopf G [2003]. Comment from Gregorio Billikopf, Labor Management Farm Advisor, University of California to the Agricultural Health Listserv.

Bureau of Labor Statistics [1996]. Number of nonfatal occupational illnesses by industry division and illness category. Accessed at http://www.bls.gov/iif/

Bureau of Labor Statistics [2006]. Census of Fatal Occupational Injuries. Accessed at http://www.bls.gov/iff/oshfat1.htm.

Chapman, LJ, Newenhouse, AC, Pereira, KM, Karsh,BT, Meyer, RM, Brunette, C, and Ehlers, JJ [2005 accepted pending revisions]. Evaluation of a Four Year Intervention to Reduce Musculoskeletal Hazards Among Berry Growers. *Applied Ergonomics*.

Cole HP, Myers ML, Westneat S [2004]. Cost-effectiveness of promoting roll-over protective structures (ROPS) and seat belts on family farm tractors. Technical report to CDC/NIOSH. Lexington, KY: University of Kentucky, Southeast Center for Agricultural Health and Safety.

DHHS [1992]. Papers and Proceedings of the Surgeon General's Conference on Agricultural Safety and Health, PL 101–517. NIOSH, US Department of Health and Human Services, Centers for Disease Control, September, 1992. GPO number 017–033–00463–3 or NTIS number PB 93–114890

Donham K, Osterburg D, Myers M, Lehtola C [1998]. Tractor risk abatement and control: The policy conference, September 10-12. Final report. Iowa City: University of Iowa.

Fathallah FA, Meyers JM, Janowitz I [2005]. Conference proceedings: stooped and squatting postures in the workplace. July 29–30. Oakland, CA: University of California, Center for Occupational and Environmental Health; University of California, Berkeley. Davis, and Oakland. Available at: http://ag-ergo.ucdavis.edu/ .

Hsiao H, Whitestone J, Bradtmiller B, Zwiener J, Whistler R, Kau T, Gross M, Lafferty C. [2005]. Anthropometry criteria for the design of tractor cabs and protection frames. Ergonomics 48(4):323-353

Hullman EM [2005]. ROPS retrofitting: measuring effectiveness of incentives and uncovering inherent barriers to success. JASH 11(1):75-84.

Keifer M [2001]. Personal communication from Matthew Keifer, MD, of the Harborview Medical Center, Seattle, WA, to the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, U.S. Department of Health and Human Services.

Kelsey TW, Jenkins PL, May JJ. [1996]. Factors influencing tractor owners' potential demands for Rollover Protective Structures on farm tractors. JASH 2(2):35-42. TH

May JJ, Sorensen JA, Burdick PA, Earle-Richardosn GB, Jenkins PL [2006]. Rollover protection on New York tractors and farmers' readiness for change. JASH 12(3):199-213.

Mobed K, Gold EB, Schenker MB. Occupational health problems among migrant and seasonal farm workers. In Cross Cultural Medicine: A decade Later (Special Edition). West J Med 157:367-373, 192.

Myers JR, Snyder KA [1995]. Roll-over protective structure use and the cost of retrofitting tractors in the United States, 1993. J Ag Safety Health *1*(3):185–197.

Myers J, Miles J, Faucett J, Janowitz I, Tejeda D, Weber E, Smith R, Garcia L [2001]. Priority risk factors for back injury in agricultural field work. J Agromed *8*(1):37–52.

Myers JR [2003]. Tractor occupational safety and health update. In: Record of Tractor- Related Injury and Death Meeting. Pittsburgh, PA, February 13–14, 2003, pp. 5–23. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health.

Newenhouse A, Meyer RH, Chapman LJ [2002]. Work efficiency tips for small scale growers. In Small-Scale Post-Harvest Handling Practices, a manual for horticultural crops (38,40). 4th ed. L. Kitinoja and A. Kader, ed. Postharvest Technology Research and Information Center: University of California-Davis. Davis, CA. Translated into Spanish, Arabic, Bhasa Indonesia, Portuguese and several minor languages.

NIOSH [1996]. TRAC-Safe: a community-based program for reducing injuries and deaths due to tractor overturns. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 96–108.

NIOSH [1997]. Elements of Ergonomics Programs: A Primer Based on Workplace Evaluations of Musculoskeletal Disorders. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and

Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 97-117.

North Carolina Labor Department (personal communication 2003).

OTTC [2006]. Office of Technology Transfer and Commercialization. http: //ottc.csusb.edu/what_we_do.htm

Pana-Cryan R, Myers ML [2000]. Prevention effectiveness of roll-over protective structures. Part III: economic analysis. J Ag Safety Health *6*(1):57–70.

Pana-Cryan R, Myers ML [2002]. Cost effectiveness of roll-over protective structures. Am J Ind Med 42(S2):68–71.

Thelin A [1990]. Epilogue: agricultural occupational and environmental health policy strategies for the future. Am J Ind Med *18*:53.

Waters TR, Wilkins JR III [2004]. Conference proceedings: prevention of musculoskeletal disorders for children and adolescents working in agriculture. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2004–119.

Chapter 7: Goal 5: Reduce Injuries and Illnesses by informing and educating employers and employees about occupational safety and health hazards and control systems

[*N.B.*: Since the "Outreach" goal of the AFF Program often begins with the outputs of other portions of the program, the conceptual line between activities and outputs is somewhat blurred in the narrative that follows.]

7.1 Challenge or Issue

Agriculture is consistently ranked among the most hazardous industries. However, workers and employers have lacked knowledge about how to prevent occupational injuries and diseases, as well as the requisite skills to implement protective measures. In addition, prevention methods that are known to improve safety and reduce hazardous exposures are often not implemented in farming operations because of social, economic, and personal barriers such as the perceived need to accept greater risks when farming or perceived limitations of time or money to make changes. The influence of such barriers is not adequately understood. Also, occupational safety and health information and education interventions have been conducted in many communities, but their effectiveness was not often evaluated. Participatory research was needed to identify hazards that could be reduced by interventions and to develop, implement, and evaluate such interventions within the existing agriculture support structure. This type of research is challenging because of the large amount of time and resources needed to establish coalitions, conduct interventions, and then evaluate them. Other challenges include the seasonal nature of agricultural tasks and frequent changes in ownership of agricultural businesses.

7.2 Activities

Since 1990, the AFF Program has initiated several projects in response to the N-CASH report and Congressional funding directives discussed earlier. These projects implemented three components of a prevention approach: surveillance, research, and intervention.

7.2a Agricultural Health and Agricultural Safety Promotion Systems

The intervention component of the overall AFF Program approach was implemented in part by the AHPS cooperative agreement project. It used the existing network between the land-grant university, CES, and agricultural workers and employers. AHPS was directed toward expanding CES occupational safety and health programs by providing information dissemination, education, and referral services. Eighteen (18) cooperative agreements were funded in States that had a cooperative extension service State safety program (Arizona, California, Colorado, Florida, Iowa, Kansas, Michigan, Missouri, North Carolina, New Jersey, Ohio, Oklahoma, Pennsylvania, Tennessee, Virginia, Vermont, Washington, Wisconsin). The overall funding period was 1990 to 1993. The intention was to have an AHPS in each State by the end of three years. (Appendix 7-01)

Information dissemination was accomplished through pamphlets, brochures, cooperative extension fact sheets, radio and television programs, and print media (newspapers and magazines). Based on the viewing audience and circulation figures, it is estimated that 6,130,151 farmers/rural people were exposed to agricultural safety and health information through the AHPS programs. A total of 864 training programs and/or meetings were conducted with more than 48,000 people in attendance. In addition, 454 on-farm hazard assessments were completed, and 34 demonstration projects at the local level were funded by the various State AHPS programs. Thirty-one (31) agricultural safety videos were produced (10 bilingual), six agricultural computer safety programs (four targeted toward secondary students) were developed, and three States instituted or increased the level of effort for tractor and machinery safety training programs for youth. The AZ AHPS project proposed and developed "model safety programs" in agribusinesses and schools within; at the conclusion of the project, there were 37 such model programs in AZ. All 18 AHPS projects conducted or supported some form of rudimentary surveillance of agriculture deaths and injuries.

In addition to materials development and dissemination, Wisconsin's Agricultural Health Promotion Systems effort evaluated knowledge, attitudes and agricultural safety and health efforts by 58 of 69 county health departments (Chapman et al., 1996a), 88 of Wisconsin's 89 agriculture and agribusiness extension county faculty (Chapman et al., 1995a), 193 of the state's 284 school-based agricultural education instructors (Chapman et al., 1995b), and 268 dairy farmers (Chapman et al., 1996b). The results indicated that although a majority of all four groups reported making some efforts, permanent hazard correction usually received a lower priority than training to work more safely around hazards. Findings from all four groups were published in peer review journals.

In 1994, the AHPS evolved into the ASPS. The ASPS was a project designed to stimulate the development of new interventions and the implementation of both new and existing interventions to reduce traumatic injuries. Emphasis was placed on assessing intervention effectiveness. The project was intended to have intervention projects implemented quickly, and then to provide practitioners with information about their effectiveness. In ASPS, cooperative agreements were awarded to universities in six States (California, Missouri, North Carolina, New York, Ohio and Wisconsin). The cooperative agreements targeted 195,483 farmers, agricultural employees, and students in rural areas.

7.2b Occupational Health Nurses in Agricultural Communities

From 1990 through 1996, the AFF Program funded 31 public health nurses in rural communities in 10 States (California, Georgia, Iowa, Kentucky, Maine, Minnesota, New York, North Carolina, North Dakota and Ohio) to conduct case-based, and sometimes rate-based, surveillance through OHNAC. In 1995, the AFF Program funded continued surveillance work under the banner *Community Partners for Healthy Farming Surveillance*. States that were funded under the OHNAC project and subsequently funded by Community Partners for Healthy Farming Surveillance usually retained OHNAC in the titles of their programs. These surveillance projects addressed multiple agricultural subsectors. For simplicity, both surveillance projects will usually be referred to hereinafter as OHNAC. (Appendix 3.1-03)

The nurses identified cases of illness, fatalities, and serious injuries from emergency-room logs, newspaper clippings, and other sources identified by State and local health departments. Agricultural workers trusted the OHNAC nurses; allowed them to visit their farms, sometimes accompanied by other AFF Program staff; and provided them with important data about causes of incidents. Nurses used case findings to raise awareness of hazards and to encourage or implement interventions among stakeholders. The nurses developed strong partnerships in their communities with the CES, schools, agricultural organizations, migrant health clinics, hospitals, youth organizations, and equipment dealers. They disseminated materials created from their findings as well as materials created by other groups (e.g., the ASPS).

An OHNAC nurse in Maine collaborated with the State CES to collect injury data related to the annual potato harvest and to use the findings to revise safety training materials targeting youth. With the nurse's help, Maine included safety and health information in a statewide school curriculum called *Agr (agriculture) in the Classroom* for grades K-12.

In Minnesota, AFF Program collaborative efforts with operators of grain elevators and milk processors resulted in increased use of appropriate respiratory PPE from 25% to 88% by grain elevator workers. Seventy-percent (70%) of these workers reported that they personally encouraged farmers to also use appropriate PPE. The project increased local farmers' access to appropriate PPE by means of PPE sales at grain elevators and distribution by milk testers during routine visits to 1,300 dairy farmers.

In 1991, the New York OHNAC nurse received a report about a woman who had been scalped by inadequately guarded farm equipment. Investigation by the nurse and an agricultural engineer identified three similar incidents with female victims. The women were working with drivelines shielded from above by three-sided guards on hay-balling equipment. All of the women received extensive reconstructive surgery, but were left with permanent, sometimes disfiguring injuries. The nurse put them in contact with each other for support. Although OSHA standards for agriculture prohibit these limited guards, the bale throwers in these incidences were manufactured before the OSHA standard took effect. In addition, since these workers were on family farms, they would not be classified as full-time employees, so the OSHA standard could not be enforced. AFF Program staff published an MMWR article, a NIOSH Alert, and a NIOSH Update related to this problem to raise awareness and promote the use of retrofit guard equipment which is available from the manufacturer. (http://www.cdc.gov/mmwr/preview/mmwrhtml/00017187.htm).

7.2c Community Partners for Health Farming Intervention Research

The AFF Program created the Community Partners project in response to an external evaluation [Kennedy 1995]. The external review panel recommended that the AFF Program promote the development of community-based research and prevention projects that would link the traditionally supported research and surveillance projects directly to those engaged in prevention activities at the community level. Such partnerships between researchers and stakeholders produce sustainable community change, as well as products and models that can be used in other geographic locations, other agriculture subsectors, and other industrial sectors. (Appendix 3.1-04)

Teen trapped under rolled-over tractor but saved by ROPS on tractor from probable disabling injuries or death

The Community Partners project uses key elements of the USDA's Cooperative Extension Education Service model. The Cooperative Extension Service model involves local community based educators who are known and trusted in their communities as linkages between the community and subject matter specialists/researchers at land grant universities in every state. Key informants, end users of information, and other stakeholders are engaged in assessing needs, problems to be addressed and dissemination of new information. It also uses multiple surveillance data sources such as the FFHHS, OHNAC, workers' compensation data; health insurance claims data, and worksite injury records. AFF Program intra- and extramural investigators have collaborated to respond to emerging issues.

Between 1996 and 2003, AFF Program researchers at the University of Kentucky conducted projects to promote the use of ROPS on farm tractors and to discourage second riders on tractors. Focus groups and community-based advisory groups were used to learn how to raise awareness of the problem, identify barriers, and enable farmers to use ROPS. The AFF Program staff collected case reports of rollovers to use in developing realistic stories.

In collaboration with their partners, AFF staff produced and evaluated a ROPS Notebook for farmers. After piloting the notebook in two counties in Kentucky, the researchers partnered with other organizations to assess its effectiveness. They found that in two treatment counties, 81 ROPS retrofits were sold in 3.5 years, compared to four in the year before introduction of the notebook. Farmers who purchased ROPS said they did so to protect their families. Farmers in the intervention counties had significant increases in 1) positive attitudes about ROPS, 2) consideration of fitting

ROPS on tractors, and 3) efforts to do so [Cole 2002]. Partners worked with the Kentucky AFF Program staff to expand use of the materials and the intervention model. Simulation exercises and other materials are available in English and Spanish on the NIOSH Web site and as CD-ROMs.

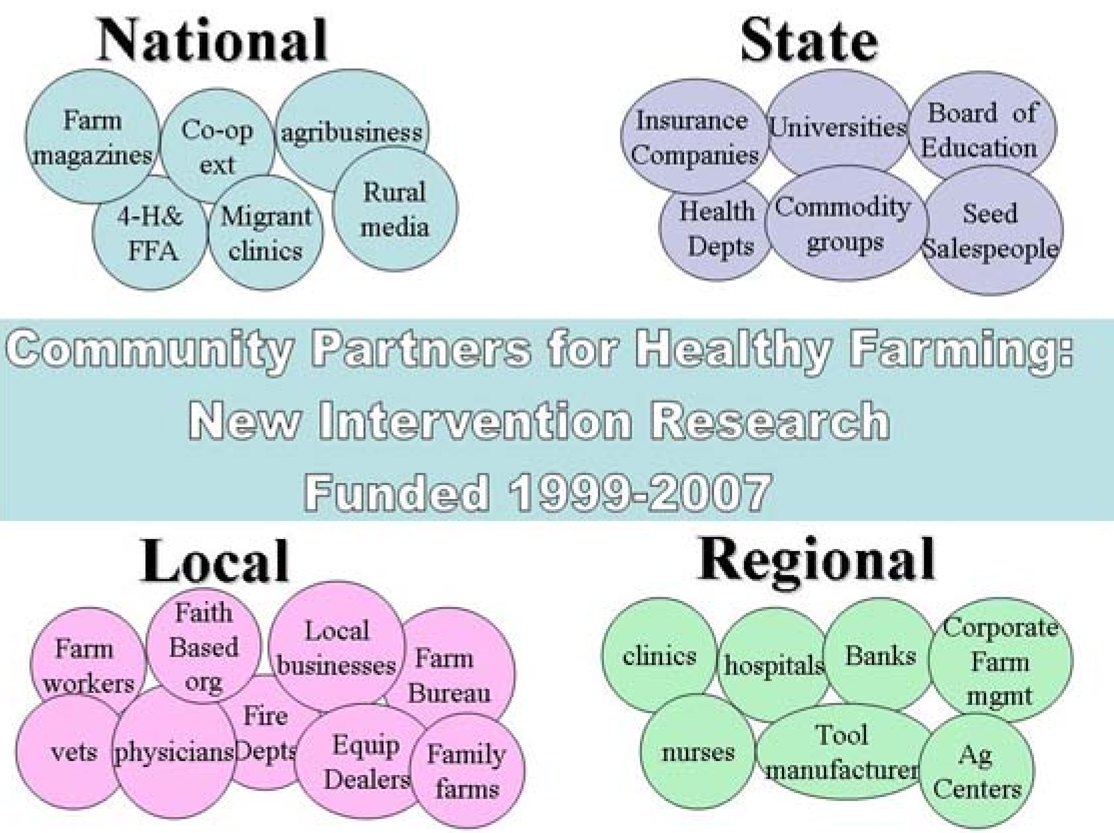


Figure 7-1. Examples of Partners in Project

Partners in this effort included Kentucky State University, South Carolina State University, Clemson University extension agents, Farm Bureau safety advocates in 23 States, and high school agriculture, social studies, and English teachers. More information is available at http://www.mc.uky.edu/scahip/rops.htm.

Green Tobacco Sickness (GTS) cases identified in Kentucky resulted in the development of training materials for health-care professionals and workers that were disseminated through the AFF Program. These materials included a self-administered educational module for physicians and a *foto-novela* for workers. Information about AFF Program work on GTS in Kentucky was also disseminated by national newspapers, the Agricultural Stabilization

Farmers said they purchased ROPS to protect their families and Conservation Service, publications related to migrant workers, a 14-minute segment on *Day One* (a national prime-time television news magazine), and the reprinting of an MMWR article in JAMA.

Promotores de Salud teaches farm workers about importance of eye protection

Between 1999 and 2003, AFF Program researchers at the University of Illinois at Chicago developed and evaluated an intervention to reduce the number and severity of eye injuries in Latino farm workers through collaboration with peer health advisors (*Promotores de Salud*) in Illinois and Michigan. The *Promotores de Salud* were trained in eye injury and first aid by AFF Program staff. Contacts with workers focused on distributing protective eyewear and training in the importance of wearing appropriate eyewear. Data were collected on the effectiveness of this intervention. "Preliminary results indicate use of protective eyewear increased among observed farm workers from less than 1% to between 29% and 77% for most task-specific risks they encountered while working" [Migrant Health Promotion 2005].

The research group established an eye health/safety Web site in collaboration with the Rural Women's Health Project to disseminate information about eye injury prevention and the project nationally. They demonstrated that use of appropriate protective eyewear among Hispanic farm workers can be increased by the training of lay health advisors (*Promotores(as) de Salud)* to select and custom fit protective eyewear acceptable to workers and by providing protective eyewear for distribution by *Promotores*.

The extramural AFF Program researchers formed a partnership with growers, the Community Health Partnership of Illinois, Migrant Health Promotion-Michigan, and the University of Illinois Urbana-Champaign to accomplish this work.

7.2d Diffusion of Safety Innovations

Dairy farming work is extremely hazardous with injury rates that exceed the average for production agriculture. From 1997 to 2005, AFF Program researchers at the University of Wisconsin focused their efforts on developing safety-enhancing products for dairy farm workers, diffusing information about those products, and measuring the results of the diffusion efforts.

Long day barn lighting, bag silos for cattle feed storage, and a site for distributing calf feed are practices that can improve operation profits as well as reduce exposures to injury hazards on dairy farms (see tip sheets on the practices at http://www.bse.wisc.edu/hfhp). The Wisconsin researchers investigated whether a planned diffusion effort that improved the information quality and flow to all 20,000 (1998) Wisconsin dairy farm producers about these innovations could persuade the producers to adopt them (as well as others). The diffusion effort extended for several

years and included industry print media journalists, selected farmers as opinion leaders, public events, university extension, dealers, suppliers, and internet.
To test the effects of the diffusion effort, we measured the treatment group at baseline and annually with a mail questionnaire. After the second through seventh years of the project, we added an "exposed control" group of Maryland or New York dairy farmers who were likely to be exposed to the same industry print and internet media but not other intervention components.

In comparisons after the intervention, significantly more Wisconsin managers reported getting barn lights and bag silo information from print media and from public events than at baseline. Significantly fewer New York managers reported getting information about barn lights or bag silos from public events than did the Wisconsin managers, even though they were probably exposed to the same mass media (but not the other diffusion efforts). In addition, compared to the Wisconsin dairy farmers, the odds of the New York controls adopting barn lights and bag silos were significantly less. For barn lights, the odds of adopting increased by more than ten times.

Similar interventions were conducted among other agricultural workers. In 1998-99, we conducted a one year long intervention that promoted two safer, more profitable practices (mesh bags for washing greens, standard containers for harvest and post harvest crop handling) to 450 fresh market vegetable growers in Wisconsin (see tip sheets at http://www.bse.wisc.edu/hfhp). We used information sources the growers were already known to use to learn about new practices, including other growers, print trade publications, grower public events, and university extension.

In 1999-2003, we evaluated another diffusion intervention among 2,250 fresh market vegetable growers Wisconsin, Minnesota, Michigan, and Iowa. In 2000-2004, we conducted another intervention that promoted five safer more profitable practices to an estimated 1,250 berry growers in seven Midwest States. We are currently conducting another intervention that is promoting eight safer more profitable practices to an estimated 6,750 producers of field-grown nursery crops in seven states (see tip sheets at http://www.bse.wisc.edu/hfhp). In most cases, measured awareness of the innovations increases after our communication efforts, and in many cases, so does adoption by the farmers.

7.2e Certified Safe Farm

From 1998 to the present, AFF Program researchers at the University of Iowa have conducted an investigation of the concept of the Certified Safe Farm (CSF). Willing farmers work with a nurse trained in farm safety and health. They receive occupational health screenings, health and wellness education, on-farm safety reviews, and incentives for adopting safer farming processes. Self-reported occupational injury and illness costs to the farmer and to their insurer were collected.

Peer farmer audits safety issues in Certified Safe Farm project.

Farmers reportedly liked the CSF project and were able to (a) reduce hazards on their farms, (b) report lower health care costs than controls, and (c) experience safety levels that correlated with these lower health care costs. In the pilot project (1998 to 2002), farmers made 1,292 safety improvements at an annual per farm value of $130; respiratory and noise exposure were reduced because of PPE usage [Hodne et al. 1999; Jaspersen et al. 1999; Rautiainen et al. 2004; Schneiders et al. 2001; Thu et al. 1999; von Essen et al. 1997]. Participation in the multifaceted program was shown to be cost-effective. Iowa farms receiving the intervention had lower costs for occupational injuries and illnesses than control farms [Donham et al. in press]. Annual occupational injury and illness costs were 27% lower for intervention farms than for control farms. For intervention farms, these annual occupational injury and illness costs were positively associated with level of safety in the on-farm safety reviews. The cost savings would more than cover the cost of providing CSF services. With strong encouragement from Iowa Farm Bureau, Wellmark (provider of Iowa Farm Bureau health insurance) allowed use of their health insurance data to evaluate the CSF project.

The CSF nurses participate in a 40-hour training program on agricultural occupational safety and health conducted by a sister project. The sister project received a $10,000 Rural Health grant for scholarships to nurses from other States to disseminate this expertise.

The AFF Program is pursuing expansion of the CSF system into other States and into larger operations with more employees. These larger operations are subject to more involvement with OSHA standards, e.g., required safety training, engineering controls, and hearing conservation programs. Larger operations also have more experience with workers' compensation insurance. The Iowa Farm Bureau has become a strong supporter of the Certified Safe Farm program. With the its support of, the bureau, the Certified Safe Farm program will have access to pre- and post-intervention medical claims data to use in evaluating the project. This is unique not only in agriculture, but has been in all of occupational safety and health. Data from the second round of funding indicated that medical insurance paid for a significant amount of farm-related injuries in Iowa.

Partners in the CSF project are the AgriSafe Network; the Farm Bureau of Iowa; Pioneer, a Dupont Company; Wellmark: BlueCross/Blue Shield; the Iowa Pork Producers Association; and the National Pork Producers Council. More information is available at http://www.certifiedsafefarm.com.

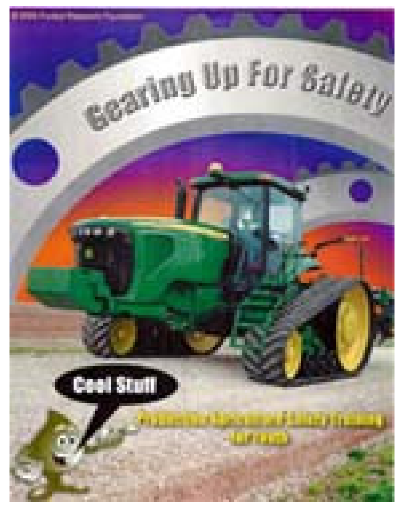
7.2f Safe Communities

From 1998–2000, AFF Program researchers at the National Farm Medicine Center in Wisconsin conducted an evaluation of a health and safety education initiative, Safe Communities, for rural high school students in 4,000 National FFA chapters across the United States. Data were collected from students and their FFA advisors. Community nurses provided injury data on participants following the intervention.

Evaluation of the Safe Communities model found minimal impact. Although students gained knowledge and leadership skills, the program did not demonstrate a strong likelihood of increasing sustainable community programs, as initially expected. On the basis of the evaluation, FFA phased out the newly-implemented project and redirected human resources and approximately $1,000,000 of private and public monies.

7.2g Other Outreach Efforts

Extramural AFF Program researchers at Purdue University worked on tractor and machinery safety training materials for youth during 2000-2003. An advisory panel guided the identification of 149 critical tasks. The Purdue evaluation of these materials included their impact on knowledge, attitude, and behavior 12 months post-intervention. The advisory panel included representatives from the NSC, equipment manufacturers, USDA, State extension safety specialists, and Hobart, a major publisher of agricultural training materials. Local school districts and their high school agricultural teachers were involved in testing the materials. Students who used the materials demonstrated improved safety attitudes and behaviors [Ortega et al. 2003].



Tractor and Machinery Safety training CD-ROM targets youth. It is being marketed by distributed by Hobart Publishing

Hispanic workers with limited education .use cTRAIN, an interactive, computer-based instruction format.

Extramural AFF Program researchers at the Oregon Health and Sciences University are studying the effectiveness of computer-based training for workers that is reinforced by supervisors. They worked with ¡Salud! of Tuality Healthcare Foundation, a community organization of vineyard employers, and workers, to identify training topics. Topics selected were hazard communication, heat exposure protection, personal protective gear for specific tasks, winter and wet weather slips and falls, post-pounding, tractor and forklift safety, confined spaces, pesticide safety, applicator training, and supervisor training. They used cTRAIN, an interactive, computer-based instruction format that was used in a prior project among Hispanic nursery workers with limited education. The format uses a nine-button input device in place of a computer keyboard. The partners decided to integrate the safety training with job skills training to develop a top-to-bottom training program for the vineyards. Data collection instruments were field-tested for work practices and supervisor-employee interactions. Safety culture measures were used for different levels of the organization (employee, supervisor, manager, and owner). This intervention is expected to allow small companies to also provide training without the added expense of stopping production for classes or hiring trainers. We expect the training to be marketable.

In California, the AFF Program's Social Marketing Farm Safety Diffusion Tool project conducted a TV, radio, and newspaper media campaign to deliver safety information to farm workers and employers. As another part of the campaign, 300 copies of a multi-media tractor safety and field sanitation training package, *Loteria del Manejo Seguro,* have been sold in California. These training materials have been recognized in California and Arizona as effective training tools for non-English-speaking agriculture workers.

Extramural AFF Program staff worked with the Colorado Corn Growers Association to make a safety training video that featured an enactment of an operator entrapment in a corn harvester. The video also recognized the costs associated with such incidents.

7.3 Selected Outputs

Peer-reviewed Publications

In 1993, an issue of the *Journal of the Occupational Health Nurses Association* focused on agricultural health and safety. Intra- and extramural AFF Program staff wrote all of the articles and editorials for the issue. The journal issued 2,800 copies of the program staff-authored articles for distribution by OHNAC nurses.

AFF Program researchers in the Community Partners program have published 31 papers in 9 different peer-reviewed journals. Every project has disseminated its work at international, national, and regional conferences. Staff members have also disseminated their educational materials to farmers, farm managers, and farm families. They have also disseminated materials to rural media, USDA CES personnel, Farm Bureau personnel, rural youth organizations, agribusinesses, and advocates for Hispanic farm workers. Most have made such information available through their own Web sites and the NASD.

The GTS work in Kentucky resulted in an MMWR article in 1992 (reprinted in JAMA) [CDC 1993]. It was also published in the Archives of Environmental Health [Ballard et al. 1995] and as a NIOSH [1993] Update. There have been at least 23 citations of the journal and MMWR articles in peer-reviewed journals within two years, and reprints of one publication were requested from at least 5 countries.

The most important peer-reviewed publications from the AFF Program outreach activities include the following:

Cole et al.'s 1997 article, *Difficult decisions: A simulation that illustrates cost effectiveness of farm safety behaviors*, which appeared in Agricultural Health and Safety: Recent Advances. This tool addresses one of the root causes of farm injuries: having too much time-sensitive work at specific times due to the seasonal nature of agriculture.

Forst et al.'s 2004 article, *Effectiveness of community health workers for promoting use of safety eyewear by Latino farm workers*, which appeared in the American Journal of Industrial Medicine. Forst and colleagues published a second article on the eyewear project in 2006, *Barriers and benefits of protective eyewear use by Latino farm workers*, which appeared in the Journal of Agromedicine. These two publications relate to a Web site and curriculum listed below.

Kidd and colleagues at the University of Kentucky published *An economic motivator for safe farming: changing perceptions through learning* in the Journal of Agricultural Safety and Health in 1998. The study reported in the article provided valuable information for guiding the ROPS Notebook project.

Morgan and Cole published *Stories or statistics? Farmers' attitudes toward messages in an agricultural safety campaign,* in 2002 in the Journal of Agricultural Safety and Health. This article was based on data from the ROPS Notebook project and is useful for guiding tractor safety and other intervention programs.

Rautiainen and colleagues published *Injuries in the Iowa certified safe farm study*, in the Journal of Agricultural Safety and Health in 2004. The report is useful to guide interventions in agriculture.

Training Curricula

Farm tractors, safety, and economics, an interactive multimedia CD-ROM, was produced by AFF Program researchers at the University of Kentucky in 2004. The curriculum includes the electronic version of The Kayles' Difficult Decisions, a farm safety and economics simulation exercise (http://www.mc.uky.edu/scahip/rops.htm).

The University of Illinois and farm worker advocacy organizations are disseminating their eye protection training materials nationally among the *Promotores de Salud* (Camp Health Aides) programs and have modified those materials to address skin cancer as well. Training materials developed for preventing eye injuries among Hispanic farm workers have become a chapter in the *Camp Health Aid Manual*, used across the Nation in training *Promotores de Salud's*, peer lay health advisors. The eye safety and health Web site (http://www.FENet.org), established in collaboration with

Rural Women's Health Project, continues to develop. Gempler's Newsletter, a trade publication, solicited multiple articles from project staff.

Training materials developed by the project team at Purdue University are being marketed by Hobart Publishing, a recognized publisher of agricultural educational materials.

Booklets, Factsheets, and Web Sites

The Florida AHPS project was key to developing the NASD (Appendix 4.2-02). It started out as a project to garner all of the new agricultural safety and health information products produced by the AFF Program (fact sheets, videos, etc.). It was originally produced on a CD-ROM. At the end of the Florida AHPS project, the database was updated, became the NASD, and has a peer-review board. It is currently available on the NIOSH Web site: www.cdc.gov/niosh/nasd.html.

The AFF Program disseminated OHNAC findings and recommended interventions through 34 fact sheets that were developed by the OHNAC project in California. Known as *NURSE Reports*, they are available on the NASD Web site. In addition, the overall OHNAC project developed at least 38 peer-reviewed journal articles; 10 MMWR articles; 9 NIOSH Updates (targeted to media, agricultural organizations, equipment manufacturers, and health departments); 1 multi-agency Alert; and 4 other NIOSH publications.

The Kentucky researchers who were part of the Community Partners project prepared The Kentucky community partners for health farming ROPS project: A program of materials and activities to preserve farmers' health, way of life, and money in 2002. It is available in both English and Spanish at: www.cdc.gov/nasd/docs/d00901-d001000/d000997/10.html.

The Wisconsin dairy farm researchers issued a number of tip sheets and other media for farmers, dealers, suppliers, and others that can be accessed at http://www.bse.wisc.edu/hfhp/index.htm.

The CSF Project researchers developed a Web site about the project: http://www.public-health.uiowa.edu/icash/csf/.

Sponsored Conferences and Workshops

The AFF Program researchers in Iowa presented *The AgriSafe Network and the Certified Safe Farm: Sustainable Interventions for Agriculture* in 2006 at the International Association of Agricultural Medicine and Rural Health in Lodi, Italy.

Presentations and papers on the AHPS/ASPS projects were delivered at the Third National Injury Control Conference (1991), Third International Symposium: Issues in Health, Safety and Agriculture (1992), NIOSH Symposium on Agricultural Safety and Health: Detection, Prevention and Intervention (1994), the NIFS Conference

(1990, 1991, 1992, 1993, 1999), the Fifth U.S.–Finnish Joint Symposium on Occupational Safety and Health (1992), the NIOSH Agricultural Health and Safety Conference (1997), 7th Joint Science Symposium on Occupational Safety and Health (1998), the National Safety Council-Agriculture Division (1994), and the ASAE Conference (1996).

A complete list of outputs can be found in **section 7.7** **at the end of this chapter.**

7.4 Intermediate Outcomes

7.4a National Agricultural Safety Database (NASD)

The AFF program's National Agricultural Safety Database (NASD) is the only extensive, publicly accessible database of agricultural safety and health information available. The AFF program created the NASD at the request of the NIOSH agricultural cooperative agreement participants to provide a national information resource for the purposes of dissemination, leveraging resources, and avoiding duplication of efforts. It is widely recognized and heavily used by the diverse community involved in agriculture, e.g. farmers, large agribusinesses, universities and government agencies. It contains over 3000 publications, has linkages from other organizations, e.g. The National Institute for Farm Safety, and utilizes an Editorial Review Board and continuous user input to improve quality. The website has typically received over 500,000 hits per month representing more than 75,000 unique users.

7.4b Agricultural Health Promotion System

AFF Program funding for the AHPS projects was instrumental in securing State funding for a State level agricultural safety center and a director to run it ($200,000/year) starting in 1995. The AHPS projects provided important requested information that was used during debate in the State legislature on Wisconsin Act 455 (1996). That act, now law, prohibits children under age 16 from driving farm tractors on public roads until they complete a tractor and machinery certification course.

Since the beginning of AHPS activity in Pennsylvania, the Pennsylvania State legislature allocated State funds for agricultural safety. The Pennsylvania State farm safety program has received about $50,000 annually through the Pennsylvania Department of Agriculture since 1996.

7.4c Agricultural Safety Promotion System

The AFF Program project in Missouri, *Missouri Training of Agricultural Safety to Kids*, became the basis for a national program later adopted by the National FFA for their Partners for Safer Communities. It was a million-dollar program, funded by private agribusiness, and was implemented across the United States by National FFA chapters.

The Cornell University project, *New York Agricultural Hazard Assessment Tool*, demonstrated that farmers will voluntarily correct workplace hazards if it reduces workers' compensation costs. This program is still running in New York and has been adopted by the State workers' compensation board.

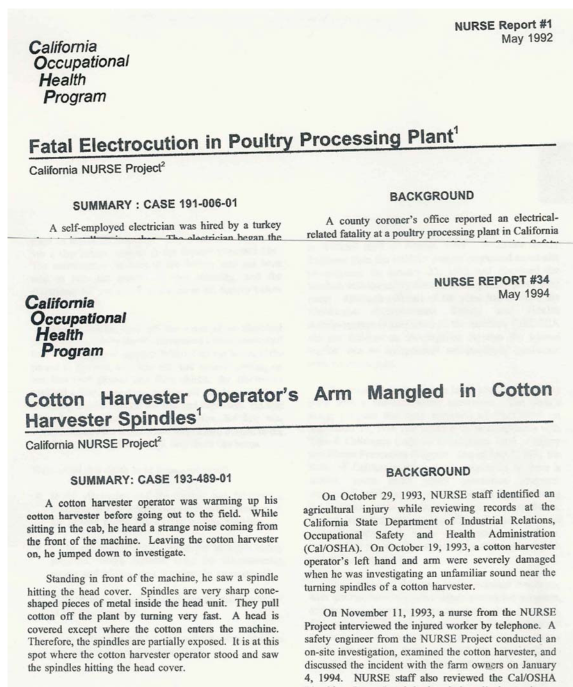
The AFF Program safety training project at the Ohio State University still exists as educational training for farmers and workers. It is used for reducing workers' compensation costs in the State.

7.4d Occupational Health Nurses in Agricultural Communities

The use of AFF Program reports by others to disseminate information about hazards and known interventions is an intermediate outcome. Below are examples from the OHNAC project.

For more than 12 years, insurance companies' risk managers have used the *NURSE Reports* developed by the California project to train farm workers, crew leaders, and managers in Department of Labor-mandated training. These reports are also used by university professors of agricultural education in their classrooms.

In response to the Kentucky GTS findings, researchers in North Carolina conducted further surveillance, developed additional educational materials targeting paid farm workers and health care providers, conducted outreach activities, published their findings, and subsequently were awarded a 2006 NORA award for their work. Mary Fleming, OHNAC nurse and Ohio dairy farmer, continues to have an impact on farm safety and health 7 years after AFF Program funding for OHNAC finished.



NURSE Report #1
May 1992

California Occupational Health Program

Fatal Electrocution in Poultry Processing Plant[1]

California NURSE Project[2]

SUMMARY : CASE 191-006-01

A self-employed electrician was hired by a turkey

BACKGROUND

A county coroner's office reported an electrical-related fatality at a poultry processing plant in California

NURSE REPORT #34
May 1994

California Occupational Health Program

Cotton Harvester Operator's Arm Mangled in Cotton Harvester Spindles[1]

California NURSE Project[2]

SUMMARY: CASE 193-489-01

A cotton harvester operator was warming up his cotton harvester before going out to the field. While sitting in the cab, he heard a strange noise coming from the front of the machine. Leaving the cotton harvester on, he jumped down to investigate.

Standing in front of the machine, he saw a spindle hitting the head cover. Spindles are very sharp cone-shaped pieces of metal inside the head unit. They pull cotton off the plant by turning very fast. A head is covered except where the cotton enters the machine. Therefore, the spindles are partially exposed. It is at this spot where the cotton harvester operator stood and saw the spindles hitting the head cover.

BACKGROUND

On October 29, 1993, NURSE staff identified an agricultural injury while reviewing records at the California State Department of Industrial Relations, Occupational Safety and Health Administration (Cal/OSHA). On October 19, 1993, a cotton harvester operator's left hand and arm were severely damaged when he was investigating an unfamiliar sound near the turning spindles of a cotton harvester.

On November 11, 1993, a nurse from the NURSE Project interviewed the injured worker by telephone. A safety engineer from the NURSE Project conducted an on-site investigation, examined the cotton harvester, and discussed the incident with the farm owners on January 4, 1994. NURSE staff also reviewed the Cal/OSHA

NURSE Reports in English and Spanish are case investigations with recommendations for prevention.

She received a 1-year award (2001) of $100,000 from the Robert Wood Johnson Foundation. In addition, Grady Memorial Hospital and the community she served continued to employ her after OHNAC. She continues to conduct agriculture injury surveillance using emergency room reports, hospital discharge data, news media, etc. She investigates cases, maintains a database, and then uses findings to enhance community awareness about injury prevention. Examples of her continued work include the following:

- In cooperation with Ohio Farm Bureau, she has chaired the Agricultural Producers and Industries Committee for the All Ohio Safety Congress of the Ohio Bureau of Worker's Compensation in 1995, 2003, and 2006 and presents annually at the Congress. She trains EMS workers in farm injury prevention and rescue methods.
- She spearheaded a coalition of EMS providers, community agency representatives, and individual farmers who conduct safety day camps that reach 800 Delaware, Ohio 5th graders annually. Evaluations of such day camp programs have found them to be effective in raising safety awareness and behavior change in children, and in disseminating hazard awareness information to parents by the participating children.
- Partly because of her efforts, inexpensive first aid kits are now available to farmers in more than 44 Ohio counties and surrounding States.
- She has helped develop committees of stakeholders to deliver agricultural safety and health programs to 29 counties in central Ohio.

7.4e Community Partners for Healthy Farming Intervention Research

Researchers and farmers collaborated in the developing tools to promote ROPS and seatbelts use.

- Tractor safety campaigns by Kentucky State University, South Carolina State University, Clemson University extension agents, and Farm Bureau safety leaders in 23 States
- In South Carolina, the installation of SMV emblems on tractors used in school agricultural programs and on 8-10 farms, a 4-H Camp upgrading to a tractor with an ROPS, and repair of broken lighting on at least one tractor.
- Fulfilling new requirements relating to the use of electronic media in the classroom in rural Kentucky high schools.
- In six rural Kentucky high schools, interactive narratives in social studies and English classes in conjunction with social issues such as the plight of farmers, social, technology, and economic changes.
- Simulation exercise in rural high schools. The materials were well accepted, more relevant, and of interest to rural youth than traditional textbooks. In

addition, according to telephone interviews conducted by the Kentucky Agricultural Statistics Service, after using the ROPS Notebook materials, high school students increased farmers' awareness of the cost effectiveness of farm planning and safety practices [Cole et al. 2004a].

- University of Kentucky agricultural economics courses demonstrating the importance of investing in safety as a method of loss control for profitable farming
- Collaboration with the Virginia Farm Bureau and the University of Kentucky to evaluate the Virginia Farm Bureau's safety program. The Virginia Farm Bureau's safety program has the potential for adoption by Farm Bureaus and farm insurance businesses in other States as a means to reduce injuries and to lower costs for insurance companies, farmers, and farm communities. Additional information about this collaboration can be found at: http://www.mc.uky.edu/scahip/vafb.htm. A link to the Virginia Farm Bureau's safety activities can be found at http://www.vafb.com.
- Inclusion in two texts as an exemplary, community-based intervention program [Cole 1997; Cole et al. 2004b]. Researchers and educators in Kentucky and elsewhere are adapting the ROPS Notebook model for use in other sectors, for example, for training health care workers about compliance with bloodborne pathogen precautions and to prevent adolescent pregnancy.

The following trade publications and media are examples of electronic links to the Kentucky ROPS promotional materials:

- Kentucky Living (January 2002): http://www.kentuckyliving.com/article.asp?articleid=520&issueid=93\
- Kentucky EMS Connection (September 2000) http://www.hultgren.org/news/00-3/n0-0242.html
- Successful Farmer (February 2002) http://www.findarticles.com/cf_dls/m1204/2_100/82743155/p3/article.jhtml?term
- Wallingford News link to dealers carrying ROPS for tractors http://www.citylinkz.com/Kentucky/Wallingford.html

Collaborations with the Rural Women's Health project, farm owners, migrant clinics, and advocacy groups are likely to sustain the activities of Eye Safety among Hispanic Farm Workers project beyond the end of AFF Program funding.

The CDC-funded Prevention Research Center at the University of South Florida collaborated with Florida A&M University, the Farm worker Association, and the largest citrus grower in Florida, the United States Sugar Corporation, to replicate the eye injury prevention program developed and piloted at the University of Illinois. Without AFF Program funding, the coalition's efforts reduced eye injuries 75% among 500 workers, between 2003 and the present. They found that the acceptance rate of using safety glasses increased to between 65% and 75% post-intervention, compared with 5% pre-intervention [NIOSH Agricultural Health and Safety Centers

2004; Lopez 2004; Lay Health Promoters 2004; Monaghan et al. (in review)]. The project intends to develop best practices for reducing eye injuries in citrus groves, to disseminate to other workers and employers. The CDC-funded Prevention Center (not NIOSH) received $20,000 in Healthy Vision grants, for Camp Health Aide stipends, to expand this program to reach 300 farm workers in 2006.

One objective of the Florida effort was for developing public health capacity in a traditionally black college for occupational safety and health, agriculture, and migrant farm worker issues. Florida A&M University had started a new Institute of Public Health with a small faculty in environmental and occupational health sciences. Although it was already conducting community-based participatory research, the college was not working in the area of agricultural health and safety before starting this project. It now has networks and trusted partnerships with both growers and worker organizations to facilitate further work in that area.

7.5 External Factors

We are unable to causally link the intermediate outcomes described above with occupational injury, illness, fatality, or hazard exposure data. However, the dairy farm intervention executed by the Wisconsin AFF Program researchers (see section 7.2d) did achieve measured hazard reductions among the population of Wisconsin dairy farmers (~ 50,000). This group represents around 15-18% of the U.S. dairy farm workforce.

7.6 Future Directions

Social and economic conditions and the regulatory environment affected these studies. External factors included the following:

The seasonal nature of agricultural tasks often provides only short windows of time for data collection. Therefore, multiple years are needed for studies. Crop production variations, due to weather and other conditions, can also affect studies.

Partners were helpful to the research. For example, the Iowa Farm Bureau and an insurance provider were instrumental to the success of the CSF project by assuring the availability of medical claim information.

Farmers' attitudes toward workplace safety and health issues affected our ability to do research. Among some, the perceived need to accept greater risks when farming was a deterrent to participation. In other cases, lack of awareness of the preventability of injuries, illnesses, and fatalities may also have been a deterrent.

Communities, volunteer organizations, and workers often have strong desires to implement interventions to prevent injuries and illnesses. These groups have access to target populations for assessing needs, innovations, and dissemination. However, they lack many of the resources of academic organizations, especially the ability to evaluate programs to guide the best use of limited resources. The participatory research methods used by some AFF Program staff facilitate meeting the needs of both researchers and nonresearchers. Those methods also build trust between groups who do not commonly work together, sometimes facilitating other projects.

7.6 List of NIOSH projects included in this chapter

- DSHEFS-9278501-Community Partners for Healthy Farming (Appendix 3.1-04)
- EID-9278040-National Agriculture Safety Database (Appendix 4.2-02)
- DSR-VLE883-Agricultural Safety Promotion System (Appendix 7-01)

7.7 Outputs

7.7a Agricultural Health and Agricultural Safety Promotion Systems

Bobick T, Myers J, Hard D, Parker J [1991]. Musculoskeletal injuries in the major agricultural industries. Proceedings of the Human Factors Society, 35th Annual Meeting, Vol. 1, pp. 867–871. (ISI Web of Science: Cited 1 time as of 11/20/06)

Chapman LJ, Schuler RT, Wilkinson TL, Skjolaas CA [1996a]. Agricultural work safety efforts by Wisconsin county public health departments. *Public Health Reports* 11:437-443.

Chapman LJ, Schuler RT, Wilkinson TL, Skjolaas CA [1996b]. Work hazard control efforts by Wisconsin dairy farmers. *Journal of Agricultural Safety and Health* 2(2):7-13.

Chapman LJ, Schuler RT, Wilkinson TL, Skjolaas CA [1995a]. Agricultural work safety efforts by Wisconsin Extension agricultural agents. *Journal of Rural Health* 11:295-304.

Chapman LJ, Schuler RT, Wilkinson TL, Skjolaas CA [1995b]. Farm work hazard prevention efforts by school-based agricultural education instructors. *American Journal of Industrial Medicine* 28:565-577.

Chapman LJ, Taveira AD, Newenhouse AC, Meyer RH, Josefsson KG [1998]. Causal factors in production agriculture injuries: working children and youth versus adults. In S. Kumar (Ed.) Advances in Occupational Ergonomics and Safety. Washington DC:IOS Press, 73-76.

Hard D [1992]. Status of the NIOSH agricultural health promotion systems. National Institute for Farm Safety, Summer Conference, June 14–18.

Hard DL, Myers JR [forthcoming]. Fatal work-related injuries in the agriculture production sector among youth in the United States, 1992–2002. J Agromedicine, May 30, 2006.

Hard DL, Myers JR, Fosbroke DE, Jenkins EL, Bender TR [1994]. The agricultural health promotion system: its use in building state-based agricultural safety and health infrastructures for developing a national model. Supplement to agricultural health and safety: workplace, environment, sustainability. Chelsea, MI: Lewis Publishers, pp. 243–247

Hard DL, Myers JR, Snyder KA, Casini VJ, Morton LL, Cianfrocco R, Fields J [1999]. Identifying work-related fatalities in the agricultural production sector using two national occupational fatality surveillance systems, 1990–1995. J Ag Saf Health *5*(2):155–169.

Hard DL, Myers JR, Stout NS, Pizatella TJ [1992]. A model agricultural health promotion systems program for building state-based agricultural safety and health infrastructures. Scand J Work, Environ, Health *18(*2):46–48. (ISI Web of Science: Cited 7 times as of 11/20/06)

Hard DL, Olenchock S, Bender TR, Fraizer T, Myers J [1990]. The agricultural safety and health initiative—What is it? Las Vegas, Nevada: The National Institute for Farm Safety.

Hard D, Wilkinson T, Knobloch M, Lancaster M [1998]. Rural health: farm watch. National Edition Health Scene: J Wellness Good Health Care, Jan/Feb, p. 4.

Jenkins EL, Hard DL [1992]. Implications for the use of E codes of the International Classification of Diseases and narrative data in identifying tractor-related deaths in agriculture, United States, 1980—1986. Scand J Work, Environ, Health *18*(2):49–50. (ISI Web of Science: Cited 7 times as of 11/20/06)

Joesefsson KG, Chapman LJ, Taveira AD, Holmes BJ, Hard DL [2001]. A hazard analysis of three silage storage methods for dairy cattle. Human Ecologic Risk Assess *7*(7):1895–1908.

Landsittel D, Hard DL, Murphy DJ, Kiernan NE [1998]. The Pennsylvania Central Region Farm Safety Pilot project: Part II—Baseline data associations between approach-to-safety and hazard conditions. J Ag Saf Health, Special Issue *1*:21–28. (ISI Web of Science: Cited 3 times as of 11/20/06)

Landsittel D, Murphy DJ, Kiernan NE, Hard DL, Kassab,C [2001]. An evaluation of the effectiveness of educational interventions in the Pennsylvania Central Region farm safety pilot project. Am J Ind Med *40*(2):145–152. (ISI Web of Science: Cited 7 times as of 11/20/06)

Murphy DJ, Kiernan NE, Hard DL, Landsittel D [1998]. The Pennsylvania Central Region farm safety pilot project: Part I—Rationale and baseline results. J Ag Saf Health *4*(1):25–41. (ISI Web of Science: Cited 2 times as of 11/20/06)

Myers J R, Hard DL [1995]. Work-Related fatalities in the agricultural production and services sectors, 1980–1989. Am J Ind Med *27*(1):51–63. (ISI Web of Science: Cited 33 times as of 11/20/06)

Myers JR, Hard DL, Snyder KA, Casini VJ, Morton LL, Cianfrocco R, Fields J [1999]. Risks of fatal injuries to farm workers 55-years of age and older. Am J Ind Med *36*(Suppl 1):29–30. (ISI Web of Science: Cited 3 times as of 11/20/06)

Myers ML, Herrick RF, Olenchock SA, Myers JR, Parker JE, Hard DL, Wilson K, eds. [1992]. Papers and Proceedings of the Surgeon General's Conference on Agricultural Safety and Health, PL 101-517. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control, National Institute for Occupational Safety and Health. GPO number 017-033-00463-3 or NTIS number PB 93-114890.

Myers J, Snyder K, Hard D, Casini V, Cianfrocco R, Fields J, Morton L [1998]. Statistics and epidemiology of tractor fatalities—A historical perspective. J Ag Saf Health *4*(2):95–108. ISI Web of Science: Cited 5 times as of 11/20/06)

Pratt SG, Hard DL. 1998. Risk factors associated with agricultural workplace fatalities. J Ag Saf Health, Special Issue 1:29–38.

Abstracts

Aherin R, Hard D, Murphy D [1996]. Should ASAE be involved in safety practice standards? Presentation of the pro's and con's of ASAE involvement in developing safety practice standards. Sponsored by T-15 Ergonomics, Safety and Health committee at the Annual International meeting of the American Society of Agricultural Engineers. Phoenix, AZ.

Chapman LJ, Pereira KM, Newenhouse AC [2006]. A theory-driven, evidence-based intervention: Seven years, four thousand businesses, three safer ways to work (abstract and oral presentation). Presented at the NIOSH "NORA at Ten" Symposium, April 19, 2006, Washington, DC.

Chapman LJ, Purschwitz MA, Joesefsson KG, Taveira AD, Arndt RH, Schuler RT, Holmes BJ, Reinemann DJ, Smith TR, Hard DL [1997]. Higher Profitability and a Better Place to Work on Wisconsin Dairy Farms. Poster presentation at the NIOSH Agricultural Health and Safety Conference, July 15-17, Morgantown, WV.

Hard DL [1992]. The Agricultural Health Promotion System: Its use in building state-based agricultural safety and health infrastructures for developing a national model.

Third International Symposium: Issues in Health, Safety, and Agriculture, Saskatoon, Saskatchewan, Canada.

Hard D [1993]. Intervention. NIOSH Symposium on Efforts to Prevent Injury and Disease among Agricultural Workers, August 25/27, Lexington, KY.

Hard D [1994]. Agricultural injuries in the United States. Presentation at the conference on Dangers in Agriculture: Injuries and Pesticide Exposure, February 4, Oregon Health Sciences University, Center for Research on Occupational and Environmental Toxicology.

Hard D [1994]. State-based education programs in agricultural safety and health. Presentation at the NIOSH Symposium on Agricultural Safety and Health: Detection, Prevention and Intervention, Columbus, OH, August 24/26.

Hard D [1994]. Education as a Prevention Strategy. NIOSH Symposium on Agricultural Safety and Health: Detection, Prevention and Intervention, Columbus, OH, August 24/26.

Hard DL [1997]. The Agricultural Safety Promotion System (ASPS). Poster presentation at the NIOSH Agricultural Health and Safety Conference, July 15–17, Morgantown, WV.

Hard D [1999]. Safety and health on the farm: A NIOSH perspective. Presentation for the annual West Virginia Agromedicine Conference, May 13, Flatwoods, WV.

Hard DL [2001]. Traumatic Injuries in Agricultural Production. International Injury Prevention and Control 2001: Partnerships and Practice. Edmonton, Alberta, Canada.

Hard DL [2003]. Agricultural injury surveillance conducted by NIOSH. 5th International Dosman Symposium: Future of Rural People—Rural Economy Health People, Environment, and Rural Communities, Saskatoon, Saskatchewan, Canada, October 19–22.

Hard DL [2003]. NIFS Efforts in Preventing Tractor Fatalities and Opportunities for Collaboration. Presentation at the NIOSH Agricultural Centers Tractor-Related Injury and Death Workshop, February 14, Pittsburgh, PA.

Hard DL [2003]. Agriculture Injury Data. Presentation to the West Virginia University Occupational Health Program and WV Agromedicine Program. October 3, Morgantown, WV.

Hard D, Green K [1992]. Rural Health Promotion. Third International Symposium: Issues in Health, Safety, and Agriculture, May 10–15, Saskatoon, Saskatchewan, Canada.

Hard DL, Myers JR [2005]. Fatal work-related injuries in the agriculture production sector among youth in the United States, 1992-2002. National Institute for Farm Safety Annual Conference, June 26–30, Wintergreen, VA.

Hard D, Cutlip P, Stout N, Jenkins L, Kisner S, Cianfrocco R [1991]. Worker Fatalities Identified by Irrigation Key-Word Searches of the NTOF Data Base. Poster presentation at the Surgeon General's Conference on Agricultural Safety and Health, Des Moines, IO.

Hard DL, Myers JR, Gerberich SG [2001]. Using Past and Present to Map Future Actions. Presentation of the Agricultural Safety and Health Network: Using Past and Present to Map Future Actions, Baltimore, MD.

Hard DL, Myers J, Stout N, Pizatella T [1991]. Building State-Based Agricultural Safety and Health Infrastructures: A Model Agriculture Health Promotions System Program. Poster presentation at the Surgeon General's Conference on Agricultural Safety and Health, Des Moines, IO.

Hard DL, Myers J, Stout N, Pizatella T [1991]. State-Based Agriculture Health Promotion System Programs. Poster presentation at the Third National Injury Control Conference, Denver, CO.

Hard DL, Myers JR, Stout NS, Pizatella TJ [1992]. A model agricultural health promotion systems program for building state-based agricultural safety and health infrastructures. Presentation at the Fifth U.S.–Finnish Joint Symposium on Occupational Safety and Health. June 9–12, Cincinnati, OH.

Hard DL, Pizatella T, Stout N, Linn H [1997]. The NIOSH Agriculture Research Program in the Division of Safety Research. Poster presentation at the NIOSH Agricultural Health and Safety Conference, July 15–17, Morgantown, WV.

Morton LL, Snyder KA, Hard DL, Bean TL, Lawrence TJ, Jepsen SD [1994]. A Method of Partnering for Evaluating Educational Materials. Poster presentation at the Agricultural Safety and Health: Detection, Prevention & Intervention symposium, August 24–26, Columbus, OH.

Morton LL, Myers JR, Hard DL, Fields J, Snyder KA, Casini VJ, Cianfrocco R [1999]. Risks of Fatal Injuries to Farm Workers 55 Years of Age and Older. Poster presentation at the National Institute for Farm Safety Annual Meeting and Conference, June 20–25, Ocean City, MD.

Murphy DJ, Kiernan NE, Hard DL, Landsittel D [1997]. Pennsylvania Central Region Farm Safety Pilot Project: Audit Form Development. Poster presentation at the NIOSH Agricultural Health and Safety Conference, July 15–17, Morgantown, WV.

Myers JR, Hard DL, Snyder KA, Casini VJ,Morton LL, Cianfrocco R, Fields J[1998]. Risks of fatal injuries to farm workers 55-years of age and older. 7th Joint Science Symposium on Occupational Safety and Health, October 26-29, Hidden Valley, PA.

7.7b Community Partners for Healthy Farming Intervention Research

Articles Publications, Professional (juried publication) Articles Publications, Professional (juried publication)

Brandt, VA, Struttmann, TW, Morgan, SE, Piercy, LR [2001]. Delivering health and safety education messages for part-time farmers through local businesses and employers. J Agromedicin*e 7*(3):23–30.

Chapman LJ, Newenhouse AC, Meyer RH, Karsh B, Taveira AD, Miquelon M [2003]. Musculoskeletal discomfort, injuries and tasks accomplished by children and adolescents in fresh market vegetable work. J Agric Saf Health *9*(2):91–105. (ISI Web of Science: Cited 1 time as of 11/20/06)

Chapman LJ, Meyers J [2001]. White paper: Ergonomics and musculoskeletal injuries in agriculture: recognizing and preventing the industry's most widespread health and safety problem (paper and oral presentation). NN: 20022184

Chapman LJ, Meyers J [2001]. Proceedings: Agricultural Safety and Health Conference: Using Past and Present to Map Future Actions. March 2–3, Baltimore MD, Available at http://www.uic.edu/sph/glakes/agsafety2001/

Chapman L, Newenhouse A, Meyer R, Taveira A, Karsh B, Ehlers J, Palermo T [2004]. Evaluation of an intervention to reduce musculoskeletal hazards among fresh market vegetable growers. Appl Ergonomics *35*(1):57–66. NN: 20025596

Chapman LJ, Newenhouse AC, Meyer RH, Taveira AD, Karsh B, Ehlers J, Palermo T. [2004]. Evaluation of an intervention to reduce musculoskeletal hazards among fresh market vegetable growers. Applied Ergonomics ; 35:57-66.

Chapman LJ, Taveria AD, Josefsson KG, Hard DL [2003]. Evaluation of an occupational injury intervention among Wisconsin dairy farmers. J Ag Saf Health *9*(3):197–209.

Cole HP [2002]. Cognitive-behavioral approaches to farm community safety education: A conceptual analysis. J Ag Saf Health *8*(2):145–159. (ISI Web of Science: Cited 2 times as of 11/20/06)

Cole HP [2000]. Knowledge is not enough. J Ag Saf Health *6*(4):245–247.

Cole HP, Westneat SC, Browning SR, Piercy LR, Struttmann TW [2000]. Sex differences in principal farm operators' tractor driving safety beliefs and behaviors. J

Am Med Women Assoc *55*(2):93–95. (ISI Web of Science: Cited 1 time as of 11/20/06)

Cole HP, Kidd PS, Isaacs SG, Parshall M, Scharf T [1997]. Difficult decisions: A simulation that illustrates cost effectiveness of farm safety behaviors. Ag Health Saf: Recent Advances; Part I, 117–124. NN: 00241665

Donham KJ, Thelin A, eds. [2006]. Agricultural Medicine. Occupational and Environmental Health for the Health Professions. Blackwell Publishing.

Donham KJ, Rautiainen R, Lange JL, Schneiders S [forthcoming]. Injury and illnesses costs in the certified safe farm study. J Rural Health.

Ehlers J, PalermoT [1998]. Community partners for healthy farming: involving communities in intervention planning, implementation, and evaluation. NIOSH-FIOH-NIWL Symposium, Pennsylvania. Symposium of selected NIOSH researchers and their counterparts from Finland and Sweden.

Ehlers J, Palmero T [1999]. Community partners for health farming: Involving communities in intervention planning, implementation, and evaluation. Am J Ind Med (Suppl.1):107–109. NN: 20000843 (ISI Web of Science: Cited 2 times as of 11/20/06)

Ehlers J, Palermo T [2005]. Community partners for healthy farming intervention research. J Ag Saf Health *2*(11):193–203. NN: 20028889

Faucett J, Meyers J, Tejeda D, Janowitz I, Miles J, Kabashima J [2001]. An instrument to measure musculoskeletal symptoms among immigrant Hispanic farm workers: validation in the nursery industry. J Ag Saf Health. V7(3):185–198. (ISI Web of Science: Cited 1 time as of 11/20/06)

Forst L, Lacey S, Chen HY, Jimenex R, Bauer S, Skinner S, Alvarado R, Nickels L, Zanoni J, Petrea R, Conroy, L [2004]. Effectiveness of community health workers for promoting use of safety eyewear by Latino farm workers. Am J Ind Med *46*:607–613. (ISI Web of Science: Cited 1 time as of 11/20/06)

Forst L, Noth I, Lacey S, Bauer S, Skinner S, Petrea R, Zanoni J [2006]. Barriers and benefits of protective eyewear use by Latino farm workers. J Agromed *11*(2):11–17

Hodne CJ K, Thu K, Donham KJ, Watson D, Roy N [1999]. Development of the farm safety and health beliefs scale. J Ag Saf Health *5*(4):395–406. NN: 20024562 (ISI Web of Science: Cited 3 times as of 11/20/06)

Howard NL, Spielholz P, Bao B [2000]. A comparative evaluation of job techniques in the tree nursery industry. In: Ergonomics for the New Millennium. Proceedings of the International Ergonomics Association 14th Triennial Congress and Human Factors and Ergonomics Society 44th Annual Meeting

Howard NL, Spielholz,P, Cohen,MA, Silvertein B [2005]. Self-reported musculoskeletal symptoms and observed risk factors in bareroot tree nurseries. J Ag Saf Health *11*(1):19–33.

Jaspersen J, List P, Howard L, Morgan D,Von Essen S [1999]. The certified safe farm project in Nebraska: The first year. J Ag Saf Health *5*(3):301–307. NN: 20024563 (ISI Web of Science: Cited 1 time as of 11/20/06)

Kidd P, Isaacs S, Cole H, Parshall M, Scarf T, Struttmann T [1998]. An economic motivator for safe farming: changing perceptions through learning. J of Ag Saf Health *4*:205–212. (Special Issue 1) NN: 20024976 (ISI Web of Science: Cited 2 times as of 11/20/06)

Lee BC, Westaby JD, Berg RL [2004]. Impact of a national rural youth health and safety initiative: Results from a randomized controlled trial. Am J Public Health *94*:1743–1749.
(ISI Web of Science: Cited 1 time as of 11/20/06)

Mazur JM, Cole H., Reed,D, Clauch D [2005]. Instructional practices at Farm Safety 4-Just Kids Safety Day Camps. J Ag Saf Health *11*(2):257–264 NN: 20028871

McKnight R, Levine E, Rodgers G [1994]. Detection of green tobacco sickness by a regional poison center. Vet Human Toxicol *36*(6):505–510. (ISI Web of Science: Cited 13 times as of 11/20/06)

Meyers J, Faucett J, Miles J, Janowitz I, Tejeda D, Duraj V, Smith R, Weber E [1999]. Effect of reduced load weights on musculoskeletal disorder symptoms in wine grape harvest work. Presented at the American Public Health Association: Celebrating a Century of Progress in Public Health, November 7–1, Chicago, IL.

Meyers J, Miles J, Faucett J, Janowitz I, Tejeda D, Weber E, Smith R, Garcia L [2001]. Priority risk factors for back injury in agricultural field work. J Agromed *8*(1):37–52.

Monaghan P, Forst L, Harris C, Luque J, Bryant C [in review]. Evaluating a community health worker program among Hispanic migrant farm workers. J Immigrant Hlth

Morgan SE, Cole HP [2002]. Stories or statistics? Farmers' attitudes toward messages in agricultural safety campaign. J Agric Saf Health *8*(2):225–239. (ISI Web of Science: Cited 2 times as of 11/20/06)

Myers ML, Westneat, SC [2004]. Cost-effectiveness of a ROPS retrofit education campaign. J Ag Saf Health *10*(2):77–90. NN: 20029308 (ISI Web of Science: Cited 2 times as of 11/20/06)

Nonnenman MW, Donham, KJ, Rautiainen RH, O'Shaughnessy PT, Burmeiste LF, Reynolds SJ [2004]. Vegetable oil sprinkling as a dust reduction method in swine confinement. J Ag Saf Health *10*(1):7–15. NN 20029781

Palermo T, Ehlers J [2002]. Coalitions: partnerships to promote agricultural health and safety. J Ag Saf Health *8*(2):161–174. NN: 20023033. http://www.asae.org/pubs/journals.html

Privette CF, Cole HP [2003]. Tractor safety using the South Carolina ROPS program. J Extension *41*(6). http://www.joe.org/joe/2003december/tt5.shtml

Rautiainen RH, Lange JL, Hodne CJ, Schneiders S, Donham KJ [2004]. Injuries in the Iowa certified safe farm study. J Ag Saf Health 10(1):51–63S. NN 20024561 (ISI Web of Science: Cited 1 time as of 11/20/06)

Scharf T, Kidd P, Cole H, Bean T, Chapman L. Donham K, Baker D [1998]. Intervention tools for farmers-Safe and productive work practices in a safer work environment. J Ag Saf Health *4*(Special issue 1):193–203. NN: 20024975 (ISI Web of Science: Cited 1 time as of 11/20/06) http://asae.frymulti.com/toc_journals.asp?volume=4&issue=5&conf=j&orgconf=j1998

Schneiders S, Donham KJ, Hilsenrath P, Roy N, Thu K [2001]. Certified safe farm: Using health insurance incentives to promote agricultural safety and health. J Agromed *8*(1):25–36. NN 20024697 (ISI Web of Science: Cited 1 time as of 11/20/06)

Spielholz P [1999]. A comparison of upper extremity physical risk factor measurement methods. [Dissertation]. Seattle, WA: University of Washington.

Spielholz P, Silverstein B, Stuart, M [1999]. Reproducibility a self-report questionnaire for upper extremity musculoskeletal disorder risk factors. Appl Ergonomics (30):429-433. (ISI Web of Science: Cited 5 times as of 11/20/06)

Spielholz P, Howard N [2000]. A critical evaluation the participatory ergonomics approach in industry. In: Advances in Occupational Ergonomics and Safety III: Proc. Annual ISOES Conferenc*e*, International Society for Occupational Ergonomics and Safety.

Struttman TW, Brandt VA, Morgan SE, Piercy LR, Cole HP [2001]. Equipment dealers' perceptions of community-based ROPS campaign. J Rural Health *17*(2):131–140.

Thu K, Pies B, Roy N, Von Essen S, Donham K [1999]. A qualitative assessment of farmer responses to the certified safe farm concept in Iowa and Nebraska. J Ag Saf Health *4*(3):161–171. NN 20024564
Von Essen S, Thu K, Donham K [1997]. Insurance incentives for safe farms. J Agromed *4*(1/2):125–127. NN 20024565. http://dx.doi.org/10.1300/J096v04n01_15

CD ROM

Cole H P [2004]. Farm tractors, safety, and economics. An interactive multimedia CD- ROM. Lexington, Ky: University of Kentucky, Southeast Center for Agricultural Health and Injury Prevention. Includes the electronic version of Kayles' Difficult Decisions, a farm safety and economics simulation exercise.

Cole HP [2004]. Farm tractors, safety and economics. An interactive multimedia CD-ROM. Lexington, KY: University of Kentucky, Southeast Center for Agricultural Health and Injury Prevention Includes the electronic version of the Kayles' Difficult Decisions farm safety, and economics simulation exercise case.

Booklets, Pamphlets, and Fact Sheets (Community Partners)

Baron S, Estill C, Steege A [2001]. Simple solutions: ergonomics for farm workers. English and Spanish (NIOSH Publication No. 2001–11). http://www.cdc.gov/niosh/01-111pd.html)

Cole HP, Piercy L, Struttman T, Morgan S, Brandt V, Muehbauer J [2002]. The Kentucky community partners for health farming ROPS project: A program of materials and activities to preserve farmers' health, way of life, and money. Available in English and Spanish at: www.cdc.gov/nasd/docs/d00901-d001000/d000997/10.html.

Delahaut K, Newenhouse A [1997]. Growing broccoli, cauliflower, cabbage, and other cole crops in Wisconsin: a guide for fresh-market growers. University of Wisconsin Extension Publication A3684. Includes ergonomic content.

Growing beans and peas in Wisconsin: a guide for fresh-market growers. University of Wisconsin Extension Publication A3685. Includes ergonomic content.

Delahaut K, Newenhouse A [1997]. Growing tomatoes, peppers, and eggplants in Wisconsin: a guide for fresh-market growers. University of Wisconsin Extension Publication A3687. Includes ergonomic content.

Delahaut K, Newenhouse A [1998]. Growing carrots, beets, radishes, and other root crops in Wisconsin: a guide for fresh-market growers. University of Wisconsin Extension Publication A3686. Includes ergonomic content.

Delahaut K, Newenhouse A [1998[. Growing pumpkins and other vine crops in Wisconsin: a guide for fresh-market growers. University of Wisconsin Extension Publication A3688. Includes ergonomic content.

Delahaut K, Newenhouse A [2003]. Growing salad greens in Wisconsin: a guide for fresh-market growers. University of Wisconsin Extension Publication A3788. Includes ergonomic content.

Delahaut K, Newenhouse A [2003]. Growing onions, garlic, leeks, and other alliums in Wisconsin: a guide for fresh-market growers. University of Wisconsin Extension Publication A3785. Includes ergonomic content.

Curriculum (training)

Migrant Health Network in collaboration with Community Health Partnership of Illinois (IL), Great Lakes Center for Environmental and Occupational Health Migrant Health Network and Camp Health Aids in MI and IL 2002. Chapter 14: Eye Health Training Kit in *Camp Health Aid Manual*. (Eye Health Training Kit and teaching aids available electronically at: FENet.org See resources/curriculum)

Eye Health Training Kit. The training materials are available in both electronic and print format. *Electronic is through the Migrant Health Promotion web site, http://www.migranthealth.org. Go to "Materials and Tools," then "Download Materials", and then scroll down -- the "Eye Health Training Kit" is listed under Videos & Activity Guides (http://migranthealth.org/materials_and_tools/view_material.php?id=83).

Books

Cole HP [1997]. Stories to live by: A narrative approach to health behavior research and injury prevention. In: Gochman DS, ed. Handbook of health behavior research IV: Relevance for professionals and issues for the future. New York: Plenum, pp. 325–349. (ISI Web of Science: Cited 8 times as of 11/20/06)

Cole HP, Kidd PS, Isaacs SG, Parshall M, Scharf T [1997]. Difficult decisions: A simulation that illustrates cost effectiveness of safety behaviors. In: Donham KJ, ed. Agricultural health and safety research: Recent advances. Binghamton, NY: Haworth Press, pp. 117–124. NN: 00241665

Cole HP, et al. [2002]. The Kentucky community partners for health farming ROPS project: a program of materials and activities to preserve farmers' health, way of life and money. National Agricultural Safety Database. Available in English and Spanish.

Cole HP, Westneat SC, Myers ML [2004]. Effectiveness of a ROPS retrofit program in Kentucky. In: Volpe R, ed. Casebook for Evidenced Based Neurotrauma Prevention. Toronto, ON, Canada: Laidlaw Research Centre (Department of Human

Development and Applied Psychology, University of Toronto) Institute of Child Study.

Newenhouse A, Meyer RH, Chapman LJ [2002]. Work efficiency tips for small scale growers. In: Kitinoja L, Kader A, ed. Small-Scale Post-Harvest Handling Practices, a manual for horticultural crops (38,40). 4th ed. Davis, CA: Postharvest Technology Research and Information Center: University of California-Davis. Translated into Spanish, Arabic, Bhasa Indonesia, Portuguese, and several minor languages.

Web sites

Healthy Farmers/Healthy Profits Healthy Farmers-Healthy Profits: Tip sheets related to specific tools and work practices that reduce risks for musculoskeletal injury and are cost effective. Sources of tools provided. http://bse.wisc.edu/hfhp

Farm Worker Eye Network. Established by the Eye injury program led by the University of Illinois in collaboration with the Women's Health Network. http://www.fenet.org
Certified Safe Farm http://www.public-health.uiowa.edu/icash/csf/. Part of the Iowa's Center for Agricultural Safety and Health. http://www.public-health.uiowa.edu/icash/

Community Partners for Healthy Farming. http://www.cdc.gov/niosh/pgms/commpart/default.html
Linked from NIOSH's Agricultural home page. Contains description of extramural projects funded 2000-2004 and links to extramural projects.

KY ROPS Notebook project. http://www.mc.uky.edu/scahip/rops.htm
Linked from the SE Center for Agricultural Health and Injury Prevention Agricultural Ergonomics, UC, Davis. http://ag-ergo.ucdavis.edu
Contains link to research article summarizing wine grape projects and other ergonomic work funded by NIOSH.

Presentations (Examples of National and International)

Chapman L, Pereira KM, Newenhouse AC [2006]. A theory-driven, evidence-based intervention: seven years, 4,000 businesses, 3 safer ways to work. Invited plenary. NORA Symposium 2006: Research Makes a Difference. April 18-20, Washington, DC.

Chapman L, Meyers J [2001]. Ergonomics and musculoskeletal injuries in agriculture: recognizing and preventing the industry's most widespread health and safety problem. Invited white paper. Agricultural Safety and Health Conference: Using Past and Present to Map Future Actions, a major conference reviewing the prior ten years of work nationally.

Donham K, Schneiders S, Roy N, Rautiainen R, Grafft L, Sheridan C, Fisher K, Lange J [2006]. The agrisafe network and the certified safe farm: sustainable

interventions for agriculture. Lodi, Italy: International Association of Agricultural Medicine and Rural Health*.* June 18–21.

Donham K, Rautiainen R, Lange J, Schneiders S, Grafft L. (2006). Economic Benefits in Health Care Costs for Farmers Participating in the Certified Safe Farm Intervention Program. *International Commission on Occupational Health*. June 11-16. Milan, Italy.

DurajV, Miles J, Meyers J [1999] Development of a conveyor-based loading System for manual harvest of winegrapes. Presented ASAE, July 18–20, Toronto, Canada.

Ehlers, J. and Palermo, T. (October 1998). Community partners for healthy farming: involving communities in intervention planning, implementation, and evaluation. *NIOSH-FIOH-NIWL Symposium*, Pennsylvania. Symposium of selected NIOSH researchers and their counterparts from Finland and Sweden.

Ehlers J, Palermo T [2006]. Community partners for healthy farming intervention research. Poster, NORA Symposium 2006: Research Makes a Difference, April 18–20, Washington, DC.

Faucett J, Miles J, Meyers J, Janowitz I [1998]. Cultural issues in the assessment of work-related pain. International Occupational Health and Environmental Health Nurses Conference, Eastbourne, UK: Royal College of Nursing and American Association of Occupational Health Nurses.

Faucett J, Miles J, Meyers J, Janowitz I [1998] UE Musculoskeletal Symptoms in Agricultural Jobs. International Conference on Occupational Disorders of the Upper Extremities. San Francisco, CA (Sponsors: UCSF/University of Michigan).

Meyers J, Miles J, Faucett J, Janowitz J, Tejeda D, Weber E, Smith R, Garcia L [1998]. Ergonomics risk factors for musculoskeletal disorder in wine grape vineyard work. Presented at National Institute for Farm Safety, Winnipeg, Canada.

Miles JA, Meyers JM, Faucett J, Janowitz I, Tejeda DG, Weber E, Smith R, Garcia L [1998]. Ergonomics risk factors in labor intensive agricultural work. Presented at 4th International Symposium, Centre for Agricultural Medicine, University of Saskatchewan, Saskatoon, Canada

7.8 References Cited

Ballard T, Freund E, Ehlers J, Brandt B, Boyland B, Halperin J [1995]. Green tobacco sickness: occupational nicotine poisoning in tobacco workers. Arch Environ Health. 50(5):384–389.

Centers for Disease Control and Prevention [1993]. Green tobacco sickness in tobacco harvesters. Kentucky, 1992. MMWR 42(13):237–239. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/00020119

Chapman LJ, Newenhouse AC, Meyer RH, Taveira AD, Karsh B, Ehlers JJ, Palermo T [2004]. Evaluation of an intervention to reduce musculoskeletal hazards among fresh market vegetable growers. Appl Ergonomics 35:57–66.

Cole HP [1997]. Stories to live by: a narrative approach to health behavior research and injury prevention: In: Gochman DS, ed. Handbook of health behavior research IV: relevance for professionals and issues for the future. New York: Plenum Press, pp. 325–349.

Cole HP [2002]. Cognitive-behavioral approaches to farm community safety education: a conceptual analysis. J Ag Safety Health 8(2):145–159.

Cole H, Westneat S, Mazur J, Myers M, Piercy L [2004a]. Final report: community partners for healthy farming intervention project: further dissemination and evaluation of the Kentucky ROPS project. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, CDC/NIOSH Cooperative Agreement U06/CCU417554.

Cole HP, Westneat SC, Myers ML [2004b]. Effectiveness of a ROPS retrofit program in Kentucky. In: Volpe R, ed. Casebook for evidenced based neurotrama prevention. Toronto, Canada: University of Toronto, Department of Human Development and Applied Psychology, Laidlaw Research Centre.

Donham KJ, Rautiainen R, Lange JL, Schneiders S [in press]. Injury and illnesses costs in the certified sale farm study J Rural Health.

Hodne CJ, Thu K, Donham KJ, Watson D, Roy N [1999]. Development of the farm safety and health beliefs scale. J Ag Safety Health 5(4):395–406.

Janowitz I, Meyers JM, Tejeda DG, Miles JA, Duraj V, Faucett J, Kabashima JN [1998]. Reducing risk factors for the development of work-related musculoskeletal problem in nursery work. Appl Occup Environ Hyg 13(1):9–14.

Jaspersen J, List P, Howard L, Morgan D, Von Essen S [1999]. The certified safe farm project in Nebraska: the first year. J Ag Safety Health. 5(3):301–307.

Kennedy S [1995]. Recommendations from the report of an extramural committee to review the extramural cooperative agreement programs. National Occupational Safety and Health Program in Agriculture.

Lay Health Promoters Improving Eye Safety on Florida Citrus Crews [2004]. 17th Annual East Coast Migrant Stream Forum, St. Petersburg, FL: October 21–23.

Lopez D (CPI Citrus) [2004]. New methods for reducing injuries and cutting costs. Training for the 30th Annual Agricultural Labor Relations Forum, Orlando, FL, September 23–24.

Meyers JM, Miles JA, Faucett J, Fathallah F, Janowitz I, Smith R, Weber EA [2006]. Smaller loads reduce risk of back injuries during wine grape harvest. California Ag (March):25–26.

Migrant Health Promotion [2005]. Annual report 2003–2004. Saline, MI: Migrant Health Promotion.

Monaghan P, Forst L, Harris C, Luque J, Bryant C [in review]. Evaluating a community health worker program among Hispanic migrant farm workers. J Immigrant Health.

NIOSH [1993]. NIOSH Update: NIOSH issues warning to tobacco harvesters. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, July 8. Available at: http://www.cdc.gov/nasd/docs/d001001-d001100/d001025/d001025.html

NIOSH [2001a]. Guide to evaluating the effectiveness of strategies for preventing work injuries: how to show whether a safety intervention really works. Cincinnati, OH: Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2001–119.

NIOSH [2001b]. Simple solutions: ergonomics for farm workers. Cincinnati, OH: Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2001–111.

NIOSH [2004]. Does it really work? Evaluating safety and health changes in the workplace. Cincinnati, OH: Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2004–135.

NIOSH Agricultural Health and Safety Centers, North American Agromedicine Consortium, National Institute for Farm Safety [2004]. The farm worker eye injury project in Florida: combining camp health aides and social marketing to improve agricultural safety. National Symposium on Agricultural Health and Safety presented by NIOSH Agricultural Health and Safety Centers, North American Agromedicine Consortium, and the National Institute for Farm Safety, Keystone, CO, June 20–24.

Ortega RR, Tormoehlen RL, Field WE, Balschweid MA [2003]. Analysis and evaluation of the effectiveness of a computer assisted instruction/multimedia farm tractor and machinery safety curriculum. Presented at the ASAE Annual International Meeting. Las Vegas, NV.

Rautiainen RH, Lange JL, Hodne CJ, Schneiders S, Donham KJ [2004]. Injuries in the Iowa certified safe farm study. J Ag Safety Health. 10(1):51S–63S.

Rogers E [2003]. Diffusion of innovations. 5th ed. New York: Free Press.

Schneiders S, Donham KJ, Hilsenrath P, Roy N, Thu K [2001]. Certified safe farm: using health insurance incentives to promote agricultural safety and health. J Agromed 8(1):25–36.

Thu K, Pies B, Roy N, Von Essen S, Donham K [1999]. A qualitative assessment of farmer responses to the certified safe farm concept in Iowa and Nebraska. J Ag Safety Health 4(3):161–171.

Von Essen S, Thu K, Donham K [1997]. Insurance incentives for safe farms. J Agromed 4(1/2):125–127.

List of Appendices

The following Appendices are referenced in this document.

Chapter 1

Appendix 1-01	OSHAct
Appendix 1-02	Program Assessment Rating Tool
Appendix 1-03	NIOSH Worker Chartbook

Chapter 2

Appendix 2-01	National Coalition for Agriculture Safety and Health Report
Appendix 2-02	Appropriations Language for the NIOSH Agriculture Program
Appendix 2-03	Surgeon General's Conference Proceedings
Appendix 2-04	Children and Agriculture: Opportunities for Safety and Health - A National Action Plan
Appendix 2-05	Kennedy Evaluation Report
Appendix 2-06	NIOSH Board of Scientific Counselors 2000 Evaluation
Appendix 2-07	NIOSH Intramural Investigators' Biosketches
Appendix 2-08	Extramural Announcements for Funding Opportunities
Appendix 2-09	Agriculture Centers - Highlights Reports
Appendix 2-10	Agriculture Centers - Comprehensive Reports
Appendix 2-11	Individual Grant Summary Reports

Chapter 3	NIOSH Project Reports
Chapter 4	NIOSH Project Reports
Chapter 5	NIOSH Project Reports
Chapter 6	NIOSH Project Reports
Chapter 7	NIOSH Project Reports