

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).

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.

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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 [Dzuga 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.

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.

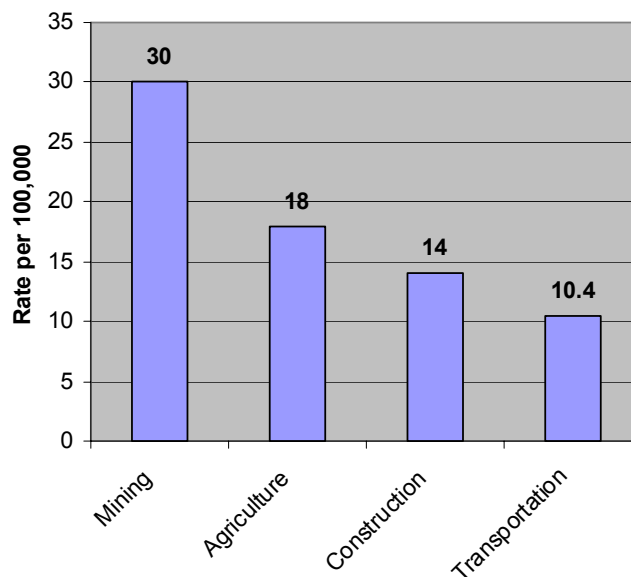


Figure 2-1: Occupational fatalities by four highest industry rates, 1990

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.

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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

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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].

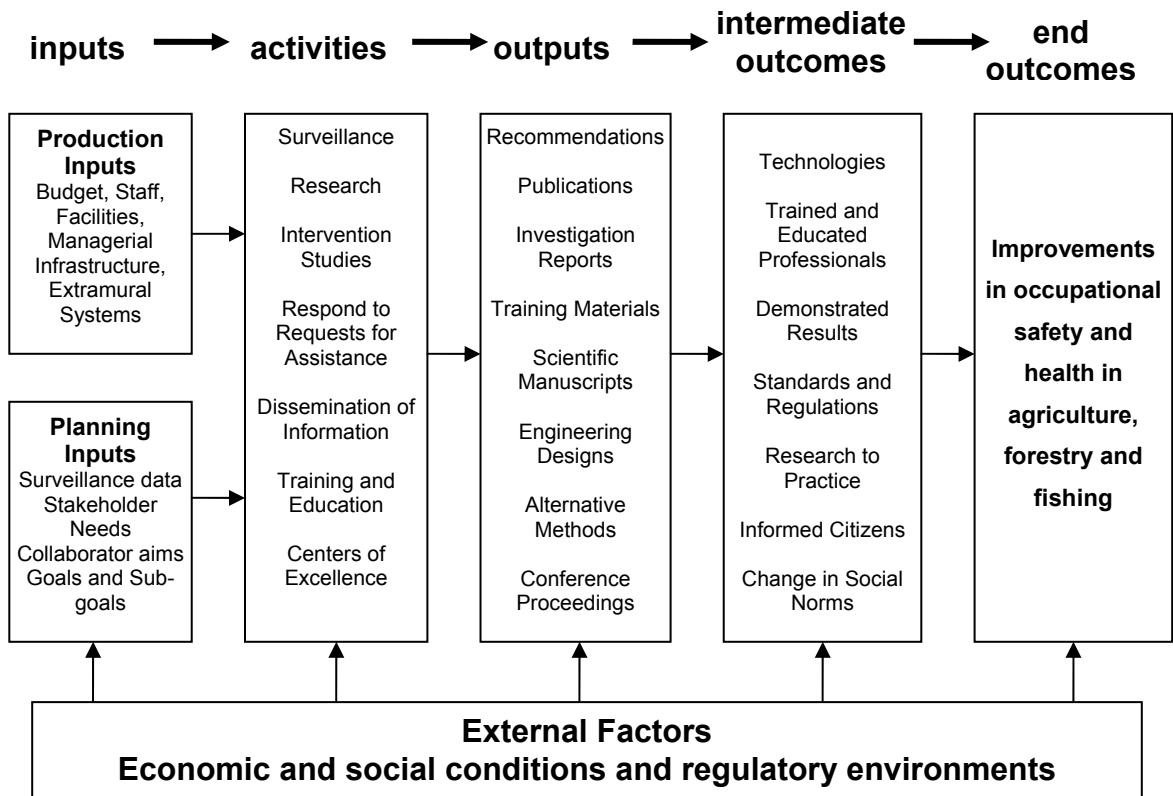
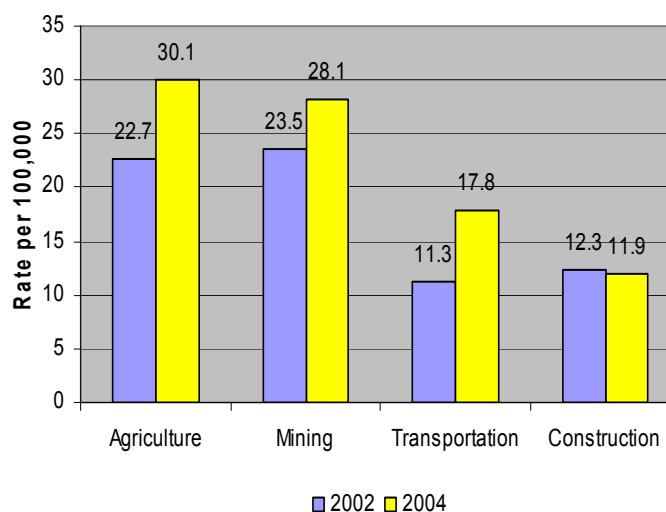


Figure 2-2. The AFF Program Logic Model

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].



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

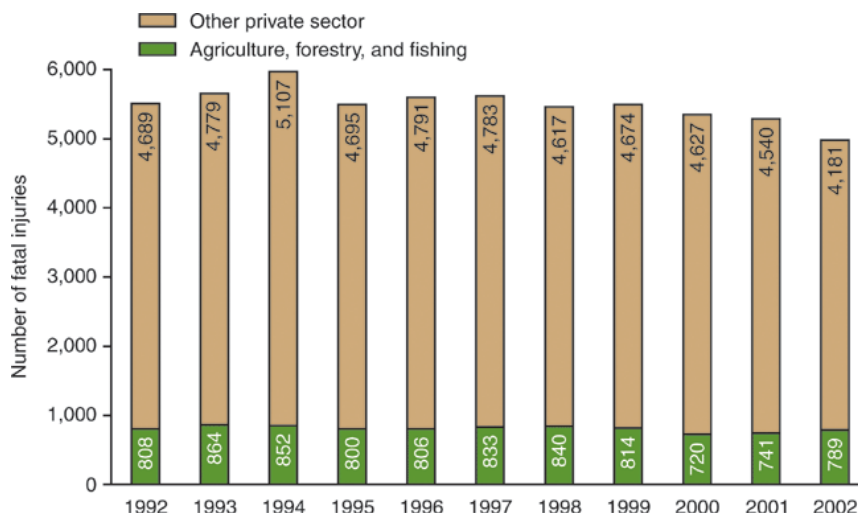


Figure 2-4. Fatal occupational injuries in agriculture, forestry, and fishing and the private sector, 1992–2002. Fatal occupational injuries in agriculture, forestry, and fishing industry ranged from 864 (16.2% of the total) in 1993 to 720 (13.5%) in 2000. Sources: [BLS 2003; Myers 2003].

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.

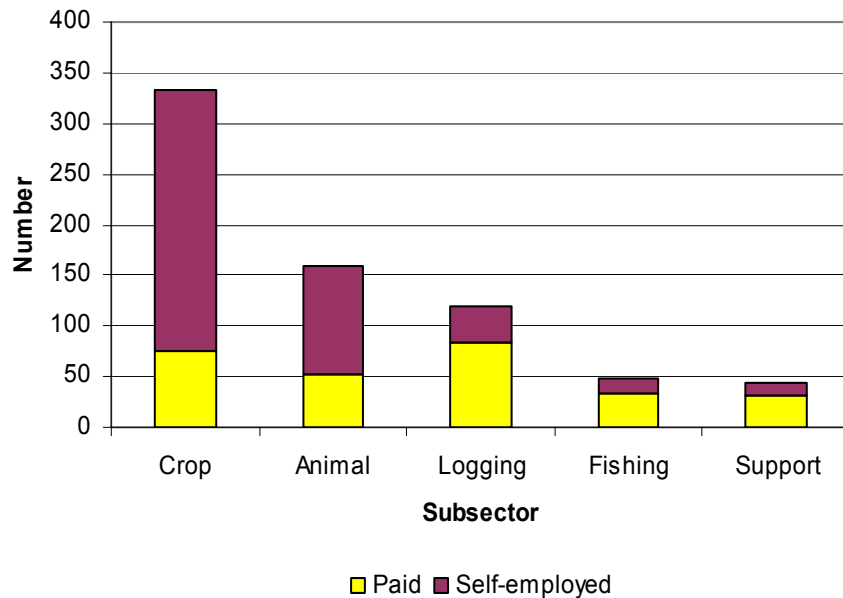


Figure 2-5. Number of agricultural fatalities, 2003

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.

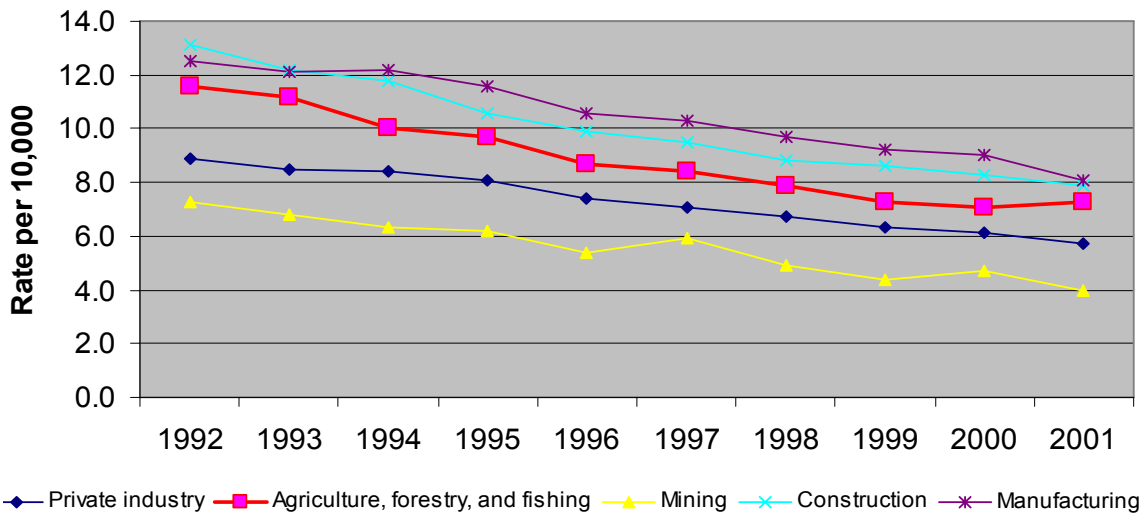


Figure 2-6. Trends of injury and illness rates by year

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].

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,

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]

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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.

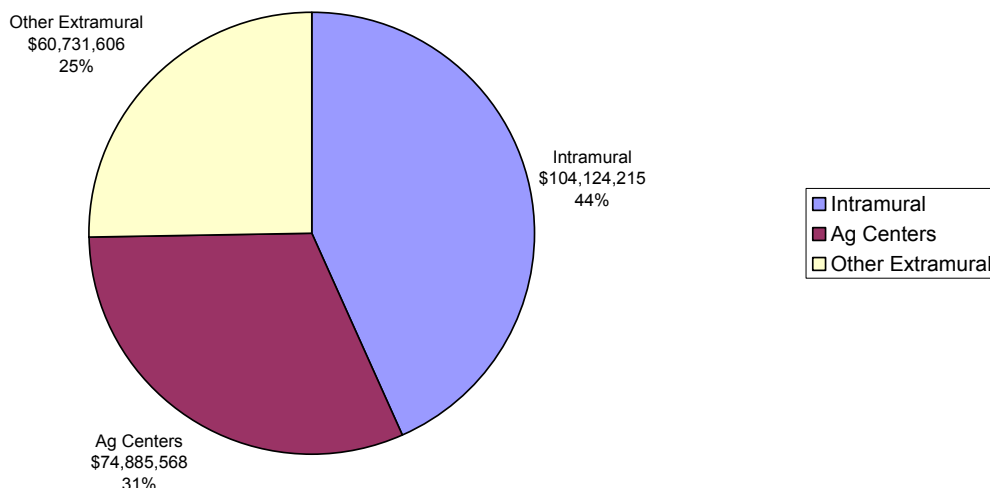


Figure 2-7: Intramural vs. Extramural total budget, 1997-2006

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

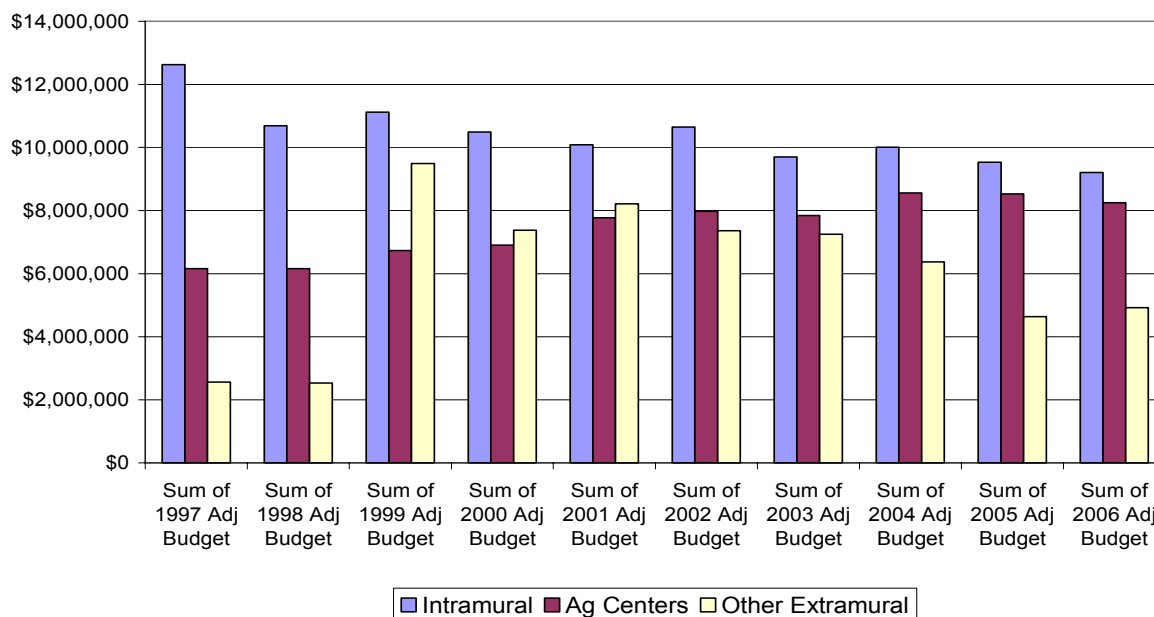


Figure 2-8: Annual agriculture budgets by intramural and extramural activities from 1997-2006

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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.

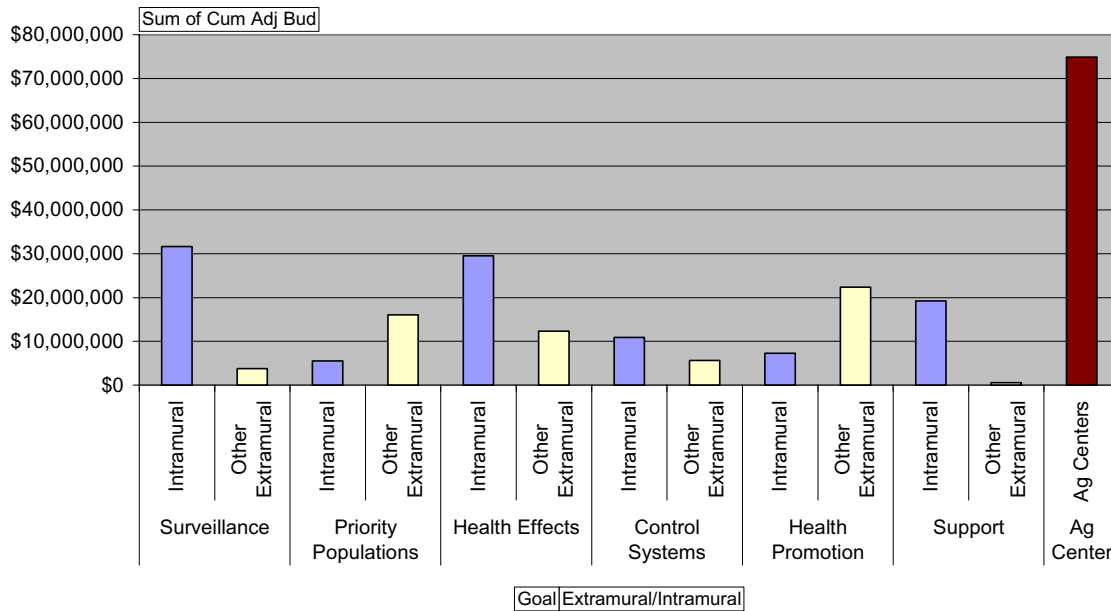


Figure 2-9: Intramural and extramural project budgets by five goals and support activities, as well as ag centers, 1997-2006

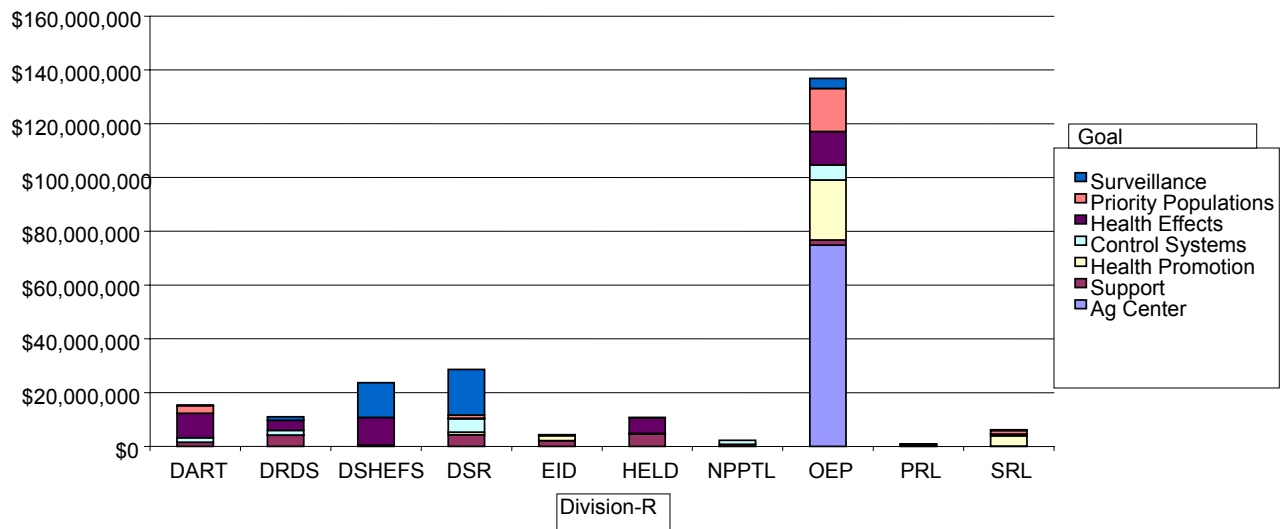


Figure 2-10: Division/Lab/Office composite budgets, 1997-2006. Stacked by goal

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

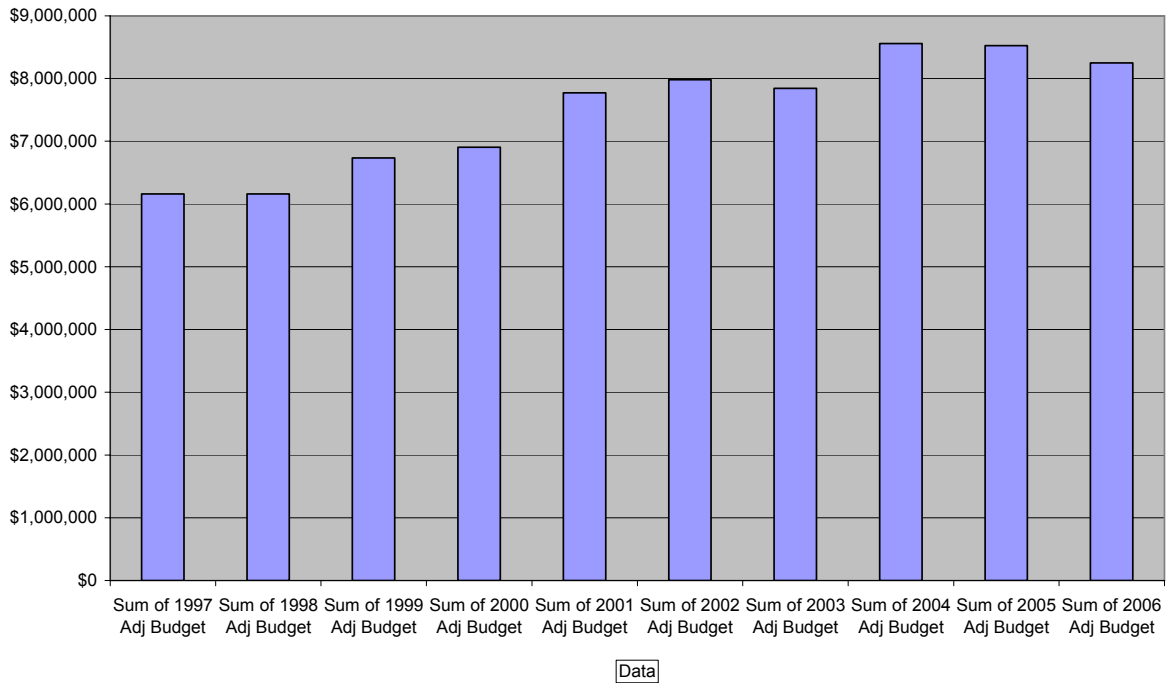


Figure 2-11: Total agricultural centers annual budgets from 1997-2006

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.

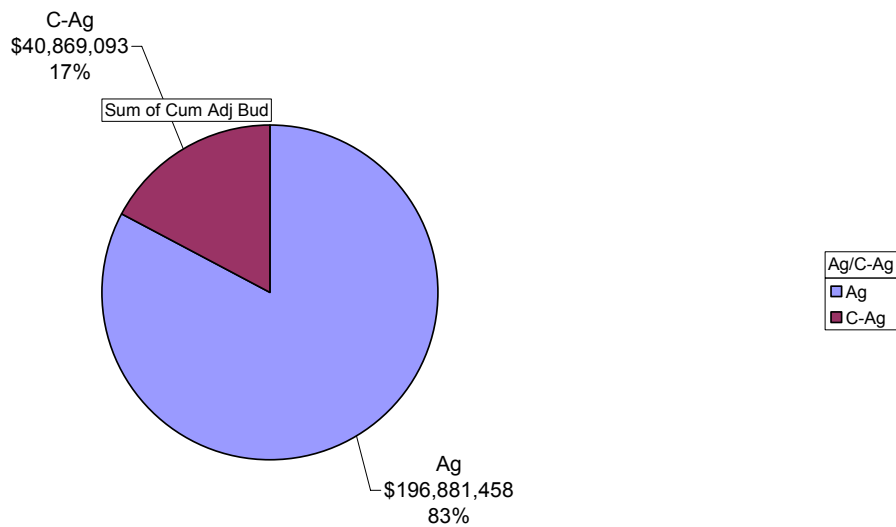


Figure 2-12: Ag Expenditures vs. Child Ag Expenditures, 1997-2006

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.

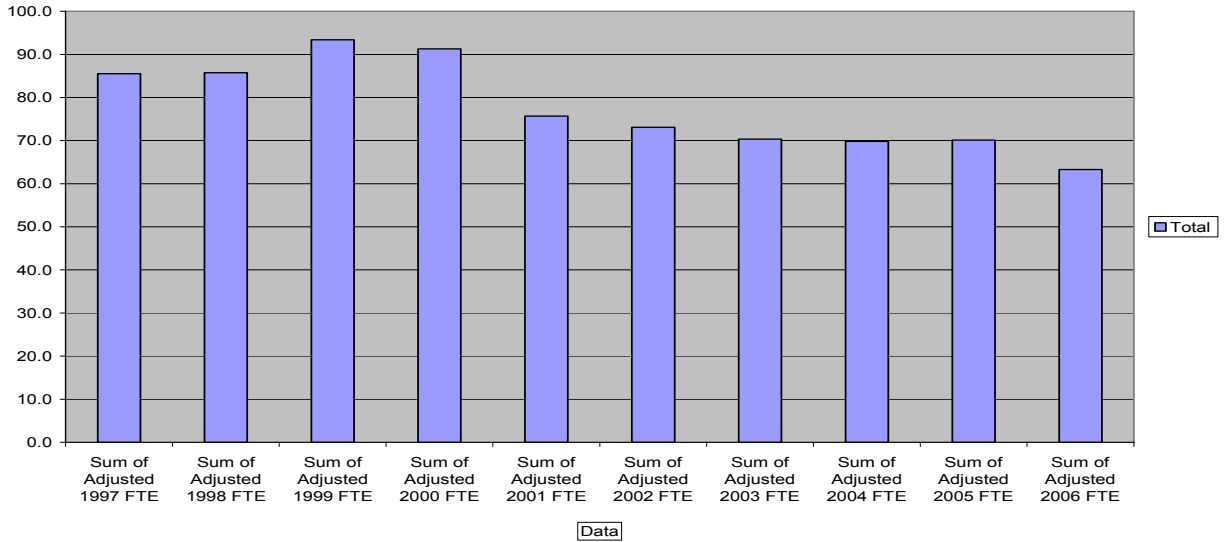


Figure 2-13: Number of NIOSH FTEs working on agriculture, 1997-2006

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

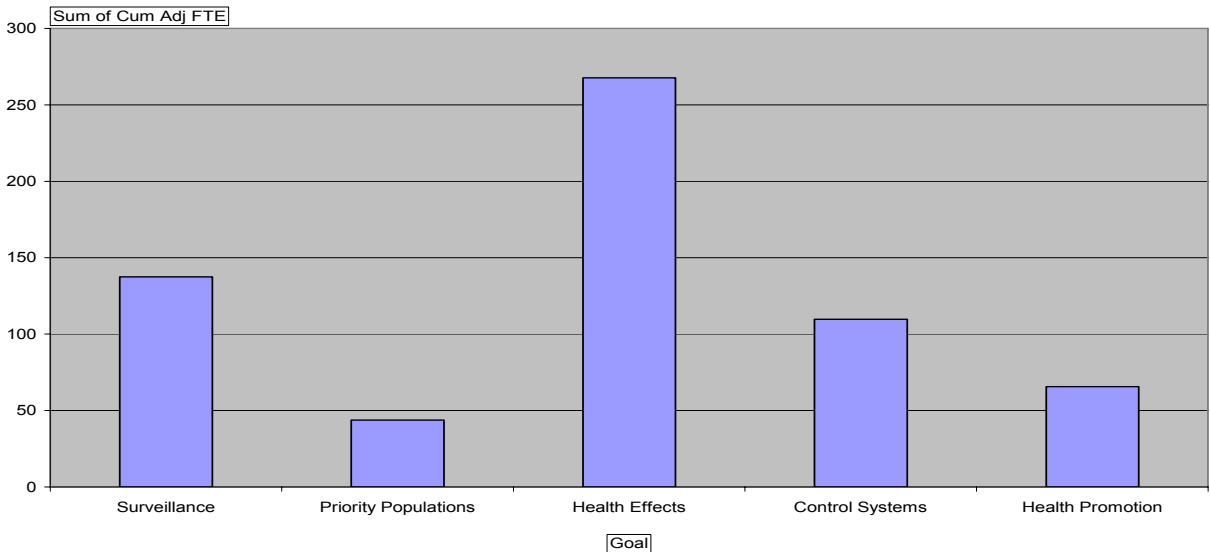


Figure 2-14: Total FTEs by AFF program goals, 1997-2006

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.

Surveillance

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

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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 HO's 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 CFR¹ 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

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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 combustion 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

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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

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- 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

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- 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

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