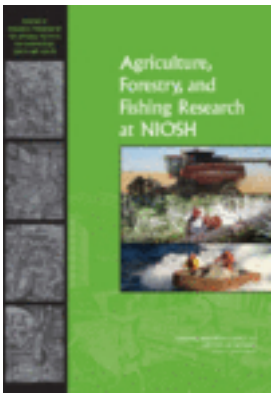

Agriculture, Forestry, and Fishing Research at NIOSH

Committee to Review the NIOSH Agriculture, Forestry, and Fishing Research Program, National Research Council

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Agriculture, Forestry, and Fishing Research at NIOSH

Reviews of Research Programs of the National Institute for Occupational Safety and Health

Committee to Review the NIOSH Agriculture, Forestry, and Fishing Research Program

Board on Agriculture and Natural Resources

NATIONAL RESEARCH COUNCIL *AND*
INSTITUTE OF MEDICINE
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COMMITTEE TO REVIEW THE NIOSH AGRICULTURE, FORESTRY, AND FISHING RESEARCH PROGRAM

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Preface

"Cultivators of the earth are the most valuable citizens. They are the most vigorous, the most independent, the most virtuous, and they are tied to their country, and wedded to its liberty and interests, by the most lasting bonds."
—Thomas Jefferson

Jefferson's perception has largely been replaced by other interpretations, but the perception remains unchanged that the agriculture, forestry, and fishing (AFF) workforce engages in noble activity that secures the nation's present and future fate. These populations deserve to work in environments that contribute to the production of safe consumer products and that protect their health. The National Institute for Occupational Safety and Health (NIOSH) is to be commended for its keen desire to respond to decades of evidence suggesting that the AFF workforce experiences some of the highest occupational disease and injury rates.

Congressional mandates regarding worker health and safety in agriculture, forestry, and fishing date back only 2 decades for agriculture and just over 3 decades for fishing. Yet, the interest of safety specialists, hygienists, engineers, public health professionals, clinicians, and policymakers dates back to the 1940s, when the war effort demanded an able, fit workforce to produce food and fiber for the allied armed forces. Drawing on that long tradition, NIOSH forged an agricultural occupational safety and health agenda in response to the 1990 congressional mandate. Using public health approaches, the NIOSH Agriculture, Forestry, and

Fishing Research Program (AFF Program) attempted to respond to worksites risks and hazards numbering more than 3 million, a complex collage of child and adult worker exposures, technological change unseen before in the history of human labor in extractive industries, unprecedented public policy gyrations, and emerging genomic capability. En route, it conducted surveillance, deployed an innovative regionalized system for the conduct of useful research and outreach activity, nourished a generation of scientists and occupational health clinicians, and developed useful linkages with organizations and entities that share a workforce safety and health agenda. Now, under the guidance of the National Research Council and the Institute of Medicine, it is time to pause, assemble results, analyze program outcomes, and reflect for the future.

The committee's composition was broad, reflecting both the diverse nature of the three industry sectors covered by the NIOSH AFF Program and the diversity of occupational exposures experienced by workers in the sectors (see Appendix D). Its professional skill set spanned from agricultural engineering to agricultural extension and education, from clinical medicine to epidemiology, from anthropology to physics, and from occupational hygiene to occupational safety. The committee is due a full measure of gratitude for its selfless pursuit of its charge and its review of published materials, other resources, and a large body of fugitive facts, publications, and other materials. It has been dogged in such activity, intent on securing that which would enable it to discharge its mandate. To each member: a generous measure of thanks is due for carrying this heavy load, all the while maintaining a helpful demeanor and a charitable sense of humor and continuing to discharge normal professional activity.

Not enough good can be said about staff assembled for this task by the Board on Agriculture and Natural Resources. Always attentive, yet working under intense time pressure, these professionals ably discharged both the exciting and the mundane, responded to the committee's numerous entreaties, patiently recruited experts capable of assisting the committee, assembled background materials, and maintained liaison with a large number of agencies and organizations. The committee would have been useless without their assistance, and to them an enormous amount of gratitude is due.

This program evaluation has been difficult. The worksite complexity and demographic makeup of the at-risk workforce is unprecedented, in terms of both NIOSH program evaluation and worker health and safety programming across North America. That NIOSH or other affected organizations or entities were not always able to produce documentation is made all the more understandable once the breadth of these combined sectors is grasped. Nevertheless, the committee was not timid in formulating useful recommendations for program improvement across future timeframes, and it believes that its present assessment reflects the best

evidence marshaled to date of AFF worker outcomes in response to an occupational safety and health program mandated by Congress.

The committee persevered in the belief that this nation's AFF workforce deserves the best protection from risk that the nation can provide. Its work was launched in the belief that that workforce is vitally important for the nation's future. To that workforce the committee dedicates its analyses reported herein.

Paul D. Gunderson
Committee Chair

Acknowledgments

This report is a product of the cooperation and contributions of many people. The committee would like to thank all the speakers who attended the first committee meeting on January 19, 2007, and the second committee meeting on March 28-29, 2007, and others who provided information and input (see committee meeting agendas in Appendix B).

The report has been reviewed in draft form by persons chosen for their diverse perspectives and technical expertise in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards of objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We thank the following for their review of this report:

John C. Bailar III, University of Chicago (*Emeritus*)
Dorianne Beyer, LMC Labor & Monitoring Consultants
Susan E. Cozzens, Georgia Institute of Technology
Vincent F. Garry, University of Minnesota (*Emeritus*)
James C. Helmkamp, West Virginia University
Anne Katten, California Rural Legal Assistance, Inc.
James A. Merchant, University of Iowa

Barbara Neis, Memorial University, Canada
Robert (Chip) Petrea, University of Illinois at Urbana-Champaign
Sam Steel, Pennsylvania State University
John R. Wheat, University of Alabama School of Medicine

Although the reviewers listed above have provided constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by Dr. Frederick A. Murphy, University of Texas Medical Branch at Galveston, and Dr. Harley W. Moon, Iowa State University (*Emeritus*). Appointed by the National Research Council, they were responsible for making certain that an independent examination of the report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the author committee and the institution.

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Tables, Figures, and Boxes

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Abbreviations and Acronyms

ACS	American Community Survey
AFF	agriculture, forestry, and fishing
AFS	Alaska Field Station
AgDARE	Agricultural Disability Awareness and Risk Education
AMSEA	Alaska Marine Safety Education Association
AOISS	Alaska Occupational Injury Surveillance System
APMP	Agricultural Personnel Management Program
ARC	agricultural research center
ASABE	American Society of Agricultural and Biological Engineers
ASAE	American Society of Agricultural Engineers
ASH-NET	Agriculture Safety and Health Network
ASPH	Association of Schools of Public Health
ATR	Alaska Trauma Registry
ATV	all-terrain vehicle
BLS	Bureau of Labor Statistics
CA EDD	California Employment Development Department
CAFO	concentrated animal feeding operation
CAIS	Child Agricultural Injury Survey
CalOSHA	California Occupational Safety and Health Administration
CARE	Children's Act for Responsible Employment

CDC	Centers for Disease Control and Prevention
CDPHE	Colorado Department of Public Health and Environment
CES	Cooperative Extension Service
CEW	Census of Employment and Wages
CFIVSA	Commercial Fishing Industry Vessel Safety Act
ChE	cholinesterase
CIRS	California Institute for Rural Studies
CoA	Census of Agriculture
CPS	Current Population Survey
CPSC	Consumer Product Safety Commission
CROPS	cost-effective rollover protective structure
CSF	Certified Safe Farm
DART	Division of Applied Research and Technology
DHHS	Department of Health and Human Services
DOL	Department of Labor
DRDS	Division of Respiratory Disease Studies
DSHEFS	Division of Surveillance, Hazard Evaluations, and Field Studies
DSR	Division of Safety Research
EEO	Equal Employment Opportunity
EID	Education and Information Division
EPA	U.S. Environmental Protection Agency
ERC	Education and Research Center
ERS	Economic Research Service
ESA	Employment Standards Administration
FACE	Fatality Assessment and Control Evaluation
FFA	Future Farmers of America
FFHHS	Farm Family Health and Hazard Surveillance
FISH	Fishing Industry Safety and Health
FLSA	Fair Labor Standards Act
FOPS	falling object protective structure
FTE	full-time equivalent
FY	fiscal year
GAO	Government Accountability Office
GLCASH	Great Lakes Center for Agricultural Safety and Health
GM	genetically modified
GMO	genetically modified organism

GPCAH	Great Plains Center for Agricultural Health
HAVS	hand-arm vibration syndrome
HELD	Health Effects Laboratory Division
HHE	Health Hazard Evaluation
HICAHS	High Plains Intermountan Center for Agricultural Health and Safety
HO	hazardous orders
HRSA	Health Resources and Services Administration
IFISH	International Fishing Industry Safety and Health
IFQ	individual fishing quotas
ILO	International Labour Organization
IOM	Institute of Medicine
IPM	integrated pest management
IRCA	Immigration Reform and Control Act
MAF	Master Address File
MMWR	*Morbidity and Mortality Weekly Report*
MSAWPA	Migrant and Seasonal Agricultural Worker Protection Act
MSD	musculoskeletal disorder
MSHA	Mine Safety and Health Administration
NAGCAT	North American Guidelines for Children's Agricultural Tasks
NAICS	North American Industry Classification System
NASC	NIOSH Agricultural Steering Committee
NASD	National Agriculture Safety Database
NASS	National Agricultural Statistics Service
NAWS	National Agricultural Workers Survey
NCASH	National Coalition for Agricultural Safety and Health
NCCRAHS	National Children's Center for Rural and Agricultural Health and Safety
NCHS	National Center for Health Statistics
NCI	National Cancer Institute
NEC	Northeast Center for Agricultural and Occupational Health
NEISS	National Electronic Injury Surveillance System
NFMC	National Farm Medicine Center
NGO	non-governmental organization
NHTSA	National Highway Traffic Safety Administration
NIEHS	National Institute of Environmental Health Sciences

NIFS	National Institute for Farm Safety
NIH	National Institutes of Health
NIOSH	National Institute for Occupational Safety and Health
NORA	National Occupational Research Agenda
NPFVOA	North Pacific Fishing Vessel Owners' Association
NPPTL	National Personal Protective Technology Laboratory
NLRA	National Labor Relations Act
NSC	National Safety Council
NTOF	National Traumatic Occupational Fatality
NYCAMH	New York Center for Agricultural Medicine and Health
OEP	Office of Extramural Programs
OHNAC	Occupational Health Nurses in Agricultural Communities
OMB	Office of Management and Budget
OSHA	Occupational Safety and Health Administration
PNASHC	Pacific Northwest Agricultural Safety and Health Center
PRL	Pittsburgh Research Laboratory
QALS	Quarterly Agricultural Labor Survey
r2p	research to practice
RAW	replenishment agricultural worker
RFA	request for application
RFP	request for proposal
ROPS	rollover protective structure
RR	relative risk
SAW	seasonal agricultural worker
SENSOR	Sentinel Event Notification of Occupational Risk
SMV	slow-moving vehicle
SOII	Survey of Occupational Injuries and Illnesses
SRL	Spokane Research Laboratory
SW Center	Southwest Center for Agricultural Health, Injury Prevention, and Education
TRAC-Safe	Tractor Risk Abatement and Control
UI	unemployment insurance
USCG	U.S. Coast Guard

USDA	U.S. Department of Agriculture
UTHCT	University of Texas Health Center at Tyler
WCAHS	Western Center for Agricultural Health and Safety
WCIRB	Workers' Compensation Insurance Rating Bureau
WHO	World Health Organization
WoRLD	Work-Related Lung Disease Surveillance Report

Summary

ABSTRACT *The agriculture, forestry, and fishing sectors are the cornerstone of industries that produce and market food, fiber, and fuel. Collectively, the three sectors make up a huge component of the U.S. economy and are a major employer in the United States. Annually, these industries generate more than $1 trillion and create exports exceeding $68 billion. The National Institute for Occupational Safety and Health (NIOSH) estimates that more than 5.5 million workers are employed in agriculture, forestry, and fishing. These sectors also consistently rank in the top six most hazardous occupations; fishermen and loggers have the highest fatality rates. Collectively, the three sectors consistently have the highest injury and fatality rates of any U.S. industries, so the overall effect on the safety and health of exposed populations in agricultural, forestry, and fishing worksites is enormous.*

In conjunction with planned reviews of up to 15 NIOSH research programs, the National Research Council convened a committee of experts to review the NIOSH Agriculture, Forestry, and Fishing Research Program (AFF Program) to evaluate the relevance of its work to improvements in occupational safety and health and the impact of NIOSH research in reducing workplace illnesses and injuries. Relevance was evaluated in terms of the priority of work carried out and its connection to improvements in workplace protection. Impact was evaluated in terms of its contributions to worker safety and health. The committee was also asked to assess the program's identification

and targeting of new research areas, to identify emerging research issues, and to provide advice on ways the program might be strengthened.

Although responsibility for controlling workplace exposure to agricultural, forestry, and fishing safety and health hazards lies with others, the AFF Program can be expected to contribute to efforts to reduce the effects of these workplace hazards through its research and information dissemination. Taking into account several important factors beyond the program's control, the committee found that from 1990-2006 (the period covered by this review), the AFF Program has made meaningful contributions to improving worker safety and health in agriculture, forestry, and fishing.

Using a five-point scoring scale (where 5 is highest), the committee converted its assessment of the relevance of AFF Program research into a score of 4 because research has been in high-priority and priority research areas, and research has resulted in some successful transfer activities. The committee arrived at this score after considerable deliberation: research carried out in some subprograms was more relevant than in others, and the program has been somewhat engaged in transfer activities, but not always the most appropriate. Had the committee been given the option of providing non-integer scores, the score for program relevance most likely would have been between 3 and 4. In addition, there was little evidence that the research activities, outputs, and intermediate outcomes contributed to the stated end outcomes of reducing workplace injury and illness. For this reason, the committee assigned the research program a score of 3 for impact, indicating that research program activities are ongoing and outputs are produced, which are likely to produce improvements in worker safety and health.

To enhance the relevance and impact of its work and fulfill its stated mission of providing national and world leadership to reduce workplace hazards through a focused program of research and prevention, the AFF Program should foster effective leadership to create a cohesive program, establish strategic goals, implement a comprehensive surveillance system that identifies and tracks worker populations at risk, engage stakeholders for input on research priorities, develop new approaches for technology and information dissemination, and incorporate current national developments in its targeting of new and emerging research areas.

STUDY PROCESS

The committee was charged with reviewing the AFF Program, evaluating the relevance of its work to improvements in occupational safety and health, and evaluating its impact on reducing workplace illnesses and injuries. As suggested in the statement of task, the committee's review was guided by the Framework Document

(Appendix A) that was developed by the National Academies' Committee for the Review of NIOSH Research Programs. The review of the AFF Program was based in large part on written materials provided by NIOSH (see Appendix C). Information gathering included presentations by NIOSH staff and other invited guests in open sessions of committee meetings in January and March (see Appendix B).

To evaluate the research program's work in its entirety, the committee chose to evaluate it from its inception in 1990 to the most current timeframe in 2006. In 1990, Congress directed NIOSH to develop an extensive agricultural safety and health program in surveillance, research, and intervention to address the high risks of injuries and illnesses in agricultural workers and their families. The Congressional Agricultural Occupational Safety and Health Initiative applies directly to activities in agriculture, but timber harvesting and commercial fishing-related activities are implicitly included.

CHARACTERISTICS OF AN IDEAL AFF RESEARCH PROGRAM

As its first step in evaluating the NIOSH AFF Program, the committee was directed by the Framework Document to independently identify the major program challenges for an occupational safety and health research program in agriculture, forestry, and fishing. When considering the ideal research program, the committee focused its efforts on identifying the following program components that would comprehensively and effectively address the safety and health issues that face workers in agriculture, forestry, and fishing:

- Identify and engage stakeholders,
- Identify populations at risk,
- Conduct surveillance,
- Conduct health effects research,
- Conduct intervention research,
- Conduct health services research and training,
- Conduct research on knowledge diffusion and technology transfer,
- Inform public policy and provide regulatory assistance,
- Conduct program evaluation initiatives.

The committee used the ideal program as a benchmark to measure the goals and activities of the existing NIOSH AFF Program.

AFF PROGRAM GOALS

The ideal NIOSH AFF Program would have adequate resources to set priorities among and accomplish the congressionally stated goals of surveillance, research,

and intervention through (1) identification and characterization of injuries and illness and detailed characterization of populations at risk through **surveillance**; (2) identification and characterization of **special populations** and the unique health and safety risks they face; (3) identification and characterization of **health effects** associated with chemical, physical, and biological agents encountered in agriculture, fishing, and forestry; (4) identification, development, evaluation, and implementation of **control systems** to reduce injury and illness; and (5) development of efficient and effective **outreach mechanisms** for dissemination and delivery of knowledge developed through research.

ASSESSMENT OF RELEVANCE AND IMPACT

On the basis of information provided by NIOSH and others and its own experience and expertise, the committee assessed the degree to which the AFF Program has led and carried out research most relevant to improvements in workplace protection in agriculture, forestry, and fishing. The Framework Document provides a scale for rating program relevance and impact (Box S-1). The committee also considered external factors in scoring for program relevance and program impact.

Resources have been inadequate for the AFF Program to carry out its congressional mandate in the area of agriculture, let alone in the additional areas of forestry and fishing. In contrast with other NIOSH programs that focus research on narrow sectors and well-defined problems, the AFF Program has the task of addressing manifold issues that affect the occupational safety and health of nearly all natural resource workers on land and sea. NIOSH non-sector based programs address extremely narrow topics and can focus good science on well-defined problems, whereas the AFF Program is expected to spread its resources to address broad issues, so it is difficult to conduct research on all of them. In agriculture, the AFF Program responded in a reasonably effective manner to the extreme diversity that characterizes agricultural production in the United States. The extensive sectoral, technical, and geographic diversity of the agricultural industry left NIOSH with no alternative but to focus on key subjects.

Despite those enormous challenges, the AFF Program has proved that it is able to conduct sound research on focused areas when given the opportunity. That is the case with the Alaska commercial fishing program, which is an exemplary research program with concentrated research topics, clear goals, and adequate resources. Work on agricultural risks to respiratory health conducted by AFF Program staff in collaboration with other researchers has included cutting-edge research that has moved the field forward. Several factors contributed to these successes: research that was focused and targeted, use of clear and consistent surveillance methods, involvement of key stakeholders, and motivated core staff to ensure project continuity.

BOX S-1
Scale for Rating Program Relevance and Impact

Rating of Relevance

5 = Research is in highest-priority subject areas and highly relevant to improvements in workplace protection; research results in, and NIOSH is engaged in, transfer activities at a significant level (highest rating).
4 = Research is in high-priority subject area and adequately connected to improvements in workplace protection; research results in, and NIOSH is engaged in, transfer activities.
3 = Research focuses on lesser priorities and is loosely or only indirectly connected to workplace protection; NIOSH is not significantly involved in transfer activities.
2 = Research program is not well integrated or well focused on priorities and is not clearly connected to workplace protection and inadequately connected to transfer activities.
1 = Research is an ad hoc collection of projects, is not integrated into a program, and is not likely to improve workplace safety or health.

Rating of Impact

5 = Research program has made a major contribution to worker health and safety on the basis of end outcomes or well-accepted intermediate outcomes.
4 = Research program has made a moderate contribution on the basis of end outcomes or well-accepted intermediate outcomes; research program generated important new knowledge and is engaged in transfer activities, but well-accepted intermediate outcomes or end outcomes have not been documented.
3 = Research program activities or outputs are going on and are likely to produce improvements in worker health and safety (with explanation of why not rated higher).
2 = Research program activities or outputs are going on and may result in new knowledge or technology, but only limited application is expected.
1 = Research activities and outputs are NOT likely to have any application.
NA = Impact cannot be assessed; program not mature enough.

The NIOSH Centers for Agricultural Disease and Injury Research, Education, and Prevention (Ag Centers) are an invaluable component of the AFF Program and have contributed to its successes. The Ag Centers serve as a national resource for addressing agricultural safety and health problems through research, education, prevention, and intervention. The regional nature of the centers allows research to be focused, targeted, and relevant to U.S. worker populations. The centers are based in university settings, enabling researchers to draw on university resources. Over-

all, the Ag Centers have methodically carried out and encompassed the necessary components of an occupational safety and health research program: surveillance, research in various subject areas, partnerships and collaborations with state and local stakeholders, and information dissemination. Nearly one-third of the research conducted by the AFF Program was conducted through the Ag Centers, and the centers have strategically addressed issues that affect various populations.

Relevance

The committee assigned the AFF Program a score of 4 for relevance because it found that research has been in high-priority and priority subject areas, and research has resulted in some successful transfer activities.

The AFF Program has engaged in some high-priority research areas and has done an adequate job of addressing major problems. A number of relevant, effective, and important research and intervention pieces have resulted from the program. As previously mentioned, the work on Alaska commercial fishing has focused on highly important issues and has had an impact. The Childhood Agricultural Injury Prevention Initiative is extremely relevant, and some evaluations of the North American Guidelines for Children's Agricultural Tasks have shown reduced injuries when the guidelines were applied. The National Agricultural Tractor Safety Initiative is another example of a focused research effort that has been extremely relevant. Research on musculoskeletal disorders that assessed simple and direct solutions for agricultural worker populations is an important issue that was addressed and that had a direct impact on workers. The research conducted on injuries and respiratory diseases is notable, even though efforts were somewhat disjointed at times. The AFF Program's current collaboration with other federal agencies on the Agricultural Health Study is a crucial endeavor that addresses the effects of environmental, occupational, dietary, and genetic factors on the health of the agricultural population.

Although the AFF Program has been engaged in some high-priority research, it has not balanced its research efforts to reflect areas that merit the highest priority. Forestry work remains one of the deadliest occupations in the United States, but the AFF Program has yet to demonstrate substantial effort in this area outside of Alaska and the Southeastern United States. The committee is concerned that the AFF Program is not in tune with modern agricultural and forestry practices, lacks the ability to review efforts and know when to move on to other emerging issues, and consequently NIOSH does not have an accurate grasp of issues most pressing to agriculture and forestry workers. As seen in information provided to the committee, the AFF Program has struggled to conduct surveillance to identify subjects that warrant the highest priority for attention and has not been able to accurately

define the populations that it serves. It has also struggled to effectively engage stakeholders to identify current issues and to disseminate its research findings to practice. Those are important matters that affect the kinds of research conducted; leaving them unaddressed will severely hinder the AFF Program's ability to conduct research relevant to worker safety and health.

The AFF Program is engaged in transfer activities, but it has not been entirely successful in developing integrated approaches to disseminating research findings so as to yield additional reductions in injuries and illnesses in the AFF sectors. The AFF Program does not appear to be as heavily involved in translational research activities as it should be. Where it is involved, it does not always appear to know how and to take credit for that involvement. The outreach approaches that do exist tended to have been developed in other industrial settings and have not been appropriate or effective in reaching most target AFF populations; industrial settings differ dramatically from AFF worksites and workforce, and different approaches are needed to reach worker populations in the AFF sectors. Many examples of such models have been used by the Ag Centers and are described in Chapter 8. As previously mentioned, some projects have been successful in outreach because they first and foremost successfully engaged stakeholders and target populations and understood how to translate research results into workplace practices.

The AFF Program has been ill equipped, even among university-based and clinical researchers, to address cultural and language barriers. Bench scientists cannot be expected to become instant experts in unfamiliar cultures, foreign languages, and rural lifestyles or practices. Several first-rate scientists have courageously and frankly admitted their lack of expertise and experience in community outreach and have asked for assistance in public conferences that involved the AFF Program.

Impact

The committee concluded that AFF Program activities or outputs are going on and are likely to produce improvements in worker health and safety, and gave the AFF Program an impact score of 3. That score was merited by the fact that the program has made some contributions to worker safety and health, as seen in the success of projects that have affected children, commercial fishermen, and tractor operators. But the committee had a difficult time establishing a clear record of positive impacts because the AFF Program itself has not given much priority to documenting the impact of its efforts. In some instances, the committee was aware of impacts that could be attributed to the AFF Program for which the program itself did not take credit. In other cases, however, it is clear that the contributions of the program have not been accepted by stakeholders nor has the research program engaged sufficiently in transfer activities. The committee concluded that the

impact of the AFF Program's research has been hampered by a lack of leadership, stakeholder buy-in, and effective dissemination of knowledge and practices.

The committee finds that the NIOSH AFF Program has made important contributions that are likely to produce improvements in worker safety and health. The outputs of the AFF Program include a wealth of information that is still considered current and important by the scientific community. However, the information has not been organized in a manner that is understandable by or helpful to others and has not been accessible to its own researchers; the AFF Program holds great potential for impacting workers if it is able to organize information in an accessible, understandable, and helpful format. Research has informed public policy and regulatory initiatives at the federal level and in several states. It is vital that independent, scientifically based research continue to inform policy and regulatory discourse. Many in the AFF industries are well aware that safety and health are woven into the fabric of successful businesses. As illustrated by the tragic loss of life associated with the recent sinkings of fishing vessels off New Bedford, important gaps still allow extremely dangerous conditions to continue.

NIOSH has a unique role as the only federal agency capable of convening all players dedicated to preventing workplace injury and disease, and it has deployed itself credibly on this task and funded other partners to function in consensus-building roles. NIOSH-sponsored symposia and workshops have had a great impact on the work of many occupational safety and health professionals and probably on the lives of AFF workers, but it is difficult to measure the direct impact of these indispensable capacity-building activities on worker safety and health.

The AFF Program has made important contributions to occupational health services and training endeavors across the nation. The committee members themselves have benefited from NIOSH-sponsored meetings and symposia, which have sparked the interest of occupational safety and health practitioners and provided others with valuable avenues for professional growth that would otherwise not have been available. It remains vital that NIOSH continue such support because it has singular influence in convening clinicians, scientists, and training institutions; conducting clinical research that produces occupational training insight; prescribing appropriate content for occupational training; and providing scientific and clinical evidence that informs practice standards. But there is room for improvement. For example, there is a need for physicians to become more involved in preparing training materials and to enroll in training courses. In light of the growing numbers of schools of public health, there is a need to prepare appropriate education and training curriculum materials for health professionals.

The AFF Program evidence package and supplemental materials lacked substantial data demonstrating any substantial changes in the annual number of occupational fatalities or disabling injuries in hired farm workers and several other populations.

The lack of data may be attributed in part to the failure to conduct surveillance comprehensively and to poor data management and collection. There was also a lack of evidence of concerted efforts to address hazards, safety, and health in forestry workers and in fishermen outside of Alaska.

Worker populations have not been adequately defined or tracked; therefore injuries and illnesses and changes in these populations have not been documented. The AFF Program's unfamiliarity with standard sources of data on hired farmworker employment, including the long-established USDA quarterly *Farm Labor*, is an indication of its inability to obtain accurate denominator data for its separate populations. The program has not used state-level data and data from other sources, such as workers' compensation insurance coverage, that contain a rich body of information on hired farmworker morbidity and mortality that would be valuable in informing discussions of changes in rates of occupational injury or illness.

Key Program Limitations

Although on the whole the AFF Program demonstrated success in addressing some relevant issues and showed that it had impacted some populations, the committee identified limitations that affected the program's progress and effectiveness. The committee observed several issues that affected both the AFF Program's ability to conduct research on issues relevant to AFF workers and its ability to conduct research that would have an impact on worker safety and health.

Leadership and Strategic Planning

The overarching concern about the AFF Program is the lack of a single cohesive vision to drive the research agenda. The lack of consistent leadership, long-term strategic planning, and periodic review of that course has led to a piecemeal approach to the research program, and the program appears disjointed more often than not. However, the patchwork approach has produced some successful efforts because of the efforts of talented and dedicated researchers.

Surveillance

The AFF Program appears to have had considerable difficulty in applying the principles of and engaging in surveillance. Constraints to successfully implementing comprehensive surveillance may be due to external factors and funding. Basic demographic and health effects surveillance of each human population at risk of worksite exposure is essential because without it no effective targeting of

other programmatic elements can occur, nor can one know when an intervention has been effective and move on to address other priorities. Surveillance must be broad-based in its population targets inasmuch as the sector is diverse in settings and employment practices and places that put populations at risk, such as children, wives, and the elderly.

Stakeholders

On the basis of the information provided by the AFF Program, remarks provided by stakeholders, and comments submitted by the public, the committee understands that the AFF Program has not fully engaged its stakeholders. It has had some remarkable partnerships to reach stakeholders, such as those with the commercial fishing industry in Alaska, but it has struggled to engage other stakeholders. The program has met the most success when it has understood stakeholder needs by asking for direct feedback from farm workers, loggers, and fishermen. It has also garnered the most credibility when researchers have demonstrated that they are sensitive to stakeholder needs, which vary greatly among the three sectors.

Without a strong buy-in from its targeted populations, the program may appear to be out of touch with its stakeholders and unresponsive to the realities of the workplace environment, and its work may therefore not be credible among farm workers, loggers, and fishermen. Stakeholders have also at times confused NIOSH with the Occupational Safety and Health Administration (OSHA); most workers are more familiar with OSHA's role in the workplace than with NIOSH's research.

Populations at Risk

The AFF Program targeted specific populations that it deemed at higher risk than others but omitted certain other populations and fell short in defining the entire population of AFF workers at risk of injury and illness. There has yet to be a program-wide endeavor to characterize the numbers and types of workers involved in agriculture, forestry, and fishing. Some populations, such as hired farm workers, have also been poorly defined or miscategorized, and others, such as ranchers, have been largely unaddressed.

IDENTIFYING EMERGING ISSUES AND RESEARCH AREAS

The committee was charged with assessing the program's targeting of new research in occupational safety and health most relevant to future improvements in workplace protection. It was also asked to identify emerging issues important

for NIOSH and the program. In keeping with the guidance of the Framework Document, the committee provided suggestions on the basis of the expertise of individual members rather than as a product of a formal process to explore and synthesize recommendations that could be developed through a comprehensive review of the field.

AFF Program's Identification of New Research Areas and Emerging Issues

The AFF worksite of tomorrow clearly will be different from the worksite of today, given trends in agriculture that will affect forestry and fishing. The changes, both predicted and unpredicted, will fuel the need for surveillance of such human factors as worksite organization and management, climate, technology, and policy change and of economics. On the basis of information provided by NIOSH, the committee concludes that the AFF Program has not developed a consistent process for identifying new research issues and developing a way to address emerging issues. The success of a public health research program is marked by its ability to recognize and address the needs of a targeted population. Because the AFF Program on the whole has struggled to conduct surveillance to understand the current needs of its worker populations, it is unable to forecast future needs.

In light of the fact that the program lacks an established procedure for assessing emerging issues in agriculture, forestry, and fishing, the committee furthermore concludes that the AFF Program has fallen behind in understanding current practices and how these practices can create new hazards for workers. The program has instead focused resources on issues that have already been resolved by changes in work practices and environments. Thus, the AFF Program has not kept up with emerging issues and has lost the capability to gain useful knowledge and to respond with appropriate new technologies.

A few projects, however, have more successfully identified emerging issues and conducted research to address them. The fishing projects in Alaska and the farm-resident child-injury initiatives, for example, have consistently carried out sound research practices to affect fishermen and children, respectively, and have been able to identify new and emerging issues for these populations.

Emerging Research Needs Identified by Evaluation Committee

In evaluating the AFF Program's research, the committee identified several kinds of research missing in health effects, health services, intervention, and regulatory policies (Chapter 11). Some research issues that have not been investigated are of great relevance to improvement of AFF worker safety and health and could substantially affect safety and health with help from NIOSH.

BOX S-2
Recommendations for Program Improvement

Establish Strategic Goals for Improvement in Administration and Evaluation

Recommendation 1: The AFF Program should establish strategic goals for the overall program and for separate subpopulations to provide a basis for improving program leadership, administrative oversight, and program evaluation.
1.a: The AFF Program lacks a concerted effort and should focus its administrative efforts on improving program leadership, administrative oversight, and program documentation.
1.b: The AFF Program should develop a comprehensive program evaluation mechanism to assess and set priorities among its research and transfer activities.

Develop a Cohesive Program

Recommendation 2: The AFF Program should provide national leadership and coordination of research and transfer activities in agricultural, forestry, and fishing safety and health.

Implement a Comprehensive Surveillance System

Recommendation 3: The AFF Program should implement a comprehensive surveillance system.

Identify and Track AFF Populations at Risk

Recommendation 4: The AFF Program should clearly identify and track its target populations.
4.a: A clear definition of worker populations "at risk" is needed.
4.b: The AFF Program should conduct comparative studies across agriculture, forestry, and fishing to better set priorities and to respond to dynamic workforce and workplace conditions.

Conduct Research on Knowledge Diffusion Processes

Recommendation 5: NIOSH should conduct research on the science of knowledge diffusion to identify effective methods for AFF research-to-practice programs.

RECOMMENDATIONS FOR PROGRAM IMPROVEMENT

The AFF Program is the sole federal research program dedicated to enhancing the safety and health of workers in agriculture, forestry, and fishing. As such, the AFF Program should be the definitive leader and source of expertise in occupational safety and health in agriculture, forestry, and fishing. From its evaluation of

5.a: The AFF Program should incorporate broader social science expertise into the research diffusion process.
5.b: The AFF Program should explore communication tools capable of reaching the AFF workforce.

Improve Stakeholder Engagement and Partnerships

Recommendation 6: The AFF Program should establish a new model to involve stakeholders throughout the research process, and should also establish an effective multipartite stakeholder mechanism that includes at-risk workers and other organizations to focus on occupational safety and health.
6.a: The AFF Program should develop a new model for targeting all key stakeholders as full participants in its research program design and execution.
6.b: The AFF Program should establish a coordinating council that would serve as a public advisory committee and would assume lead responsibility for informing public discourse on occupational safety and health issues.
6.c: The AFF Program should continue to partner with appropriate federal and state agencies and establish additional interagency partnerships to increase the capacity for carrying out research and transfer activities.
6.d: The AFF Program should establish public-private partnerships to work more closely with equipment, facility, and pesticide manufacturers in design and development processes.

Implement Integrative and Interdisciplinary Approaches

Recommendation 7: The AFF Program should implement integrative and interdisciplinary approaches in its research practices.
7.a: Researchers that receive funding from the AFF Program should visit worksites regularly so that they can acquire understanding of the workplace environment and thus develop and integrate culturally appropriate and sensitive approaches.
7.b: The AFF Program should increase the use of interdisciplinary teams to address the environmental, social, cultural, and psychological complexities of issues that face AFF workers.

Enhance Awareness of National Policy

Recommendation 8: The AFF Program staff should develop greater awareness of national policy activities because they can have a substantial impact on AFF worker populations and risk factors.

the relevance and impact of the program (Chapter 10) and its assessment of new and emerging research (Chapter 11), the committee identified several potential opportunities to improve the relevance of the program's work and strengthen its impact on reducing injuries and illness in the AFF sectors. The committee's recommendations are aimed at improving the program as a whole (summarized in Box S-2):

- Establish Strategic Goals for Improvement in Administration and Evaluation
- Develop a Cohesive Program
- Implement a Comprehensive Surveillance System
- Identify and Track AFF Populations at Risk
- Conduct Research on Knowledge Diffusion Processes
- Improve Stakeholder Engagement and Partnerships
- Implement Integrative and Interdisciplinary Approaches
- Enhance Awareness of National Policy

The AFF Program plays a positive and crucial role in providing information and tools to promote a safer and healthier work environment in agriculture, forestry, and fishing. The committee hopes that its recommendations will help refocus and redirect program efforts to have a greater impact on the safety and health of all populations at occupational risk in agriculture, forestry, and fishing.

1

Introduction

The National Institute for Occupational Safety and Health (NIOSH) was established by the Occupational Safety and Health Act of 1970 (U.S. Congress, 1970). Today, the agency is part of the Centers for Disease Control and Prevention (CDC) of the U.S. Department of Health and Human Services. NIOSH is charged with the responsibility to "conduct . . . research, experiments, and demonstrations relating to occupational safety and health" and to develop "innovative methods, techniques, and approaches for dealing with [those] problems" (U.S. Congress, 1970). Its research targets include identifying criteria for use in setting worker exposure standards and exploring new problems that may arise in the workplace. NIOSH does not have the authority to establish or enforce regulations for workplace safety and health. Regulatory and enforcement authority rests with such agencies as the Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA).

STUDY CHARGE AND EVALUATION COMMITTEE

NIOSH asked the National Academies to conduct reviews of as many as 15 of its research programs with respect to their impact on and relevance to reducing workplace injury and illness and to identify directions for future research. The NIOSH Agriculture, Forestry, and Fishing Research Program (the AFF Program) is the third to undergo such evaluation: the Hearing Loss Research Program and the Mining Safety and Health Research Program were the first two programs evalu-

ated, respectively, and used evaluation criteria and scoring mechanisms provided by the Committee for the Review of NIOSH Research Programs (IOM and NRC, 2006; NRC and IOM, 2007).

The Committee to Review the NIOSH Agriculture, Forestry, and Fishing Research Program was convened by the National Research Council in late 2006 under the auspices of the Board on Agriculture and Natural Resources (see Appendix G). Committee members were chosen because of their expertise in epidemiology, agricultural engineering, industrial hygiene, respiratory diseases, zoonotic diseases, mental health, rural health, exposure assessment, child and adolescent safety, ergonomics, farmworker safety and health, and fishing safety and health. Committee members have varied experience in such settings as academe, industry, and labor organizations. The statement of task for the committee is in Box 1-1.

EVALUATION APPROACH

The committee was charged with reviewing the AFF Program, evaluating the relevance of its work to improvements in occupational safety and health, and evaluating its impact on reducing workplace illnesses and injuries. As suggested in the statement of task, the committee's review was guided by the Framework Document (Appendix A) that was developed by the National Academies' Committee for the Review of NIOSH Research Programs.

The Framework Document

The Framework Document directs that relevance be evaluated in terms of the significance of research and connection to improvements in workplace protection. It identifies factors to take into account, including the frequency and severity of health outcomes and the number of people at risk, the structure of the program, and the degree of consideration of stakeholder input. The impact of the program's research is to be evaluated in terms of its contributions to worker safety and health. The evaluation is to take the form of qualitative assessments and the assignment of integer scores of 1-5 for the relevance and impact of the AFF Program's research and other activities.

The guidance in the Framework Document reflects the terminology and organization of a logic model adopted by NIOSH to characterize the steps in its work. The logic model used by the AFF Program appears as Figure 1-1. To assess the relevance of the program's research, the committee examined goals, inputs, activities, and outputs; to evaluate the impact of the program's research, it focused principally on intermediate and end outcomes. External factors were taken into consideration in the evaluation. The committee separately envisioned what an ideal AFF research

BOX 1-1
Statement of Task

In response to a request from the National Institute for Occupational Safety and Health (NIOSH), the Institute of Medicine and the Division of Earth and Life Studies of the National Academies are conducting a series of evaluations of NIOSH research programs. Each evaluation will be conducted by an ad hoc committee, using a methodology and framework developed by the Committee for the Review of NIOSH Research Programs (framework committee).

Each evaluation committee will review the program's impact, relevance, and future directions. The evaluation committee will evaluate not only what the NIOSH research program is producing, but will also determine whether it is appropriate to credit NIOSH research with changes in workplace practices, hazardous exposures, and/or occupational illnesses and injuries, or whether the changes are the result of other factors unrelated to NIOSH.

The program reviews should focus on evaluating the program's impact and relevance to health and safety issues in the workplace and make recommendations for improvement. In conducting the review, the evaluation committee will address the following elements:

1. Assessment of the program's contribution through occupational safety and health research to reductions in workplace hazardous exposures, illnesses, or injuries through
   a. an assessment of the relevance of the program's activities to the improvement of occupational safety and health, and
   b. an evaluation of the impact that the program's research has had in reducing work-related hazardous exposures, illnesses, and injuries.

The evaluation committee will rate the performance of the program for its relevance and impact using an integer score of 1 to 5. Impact may be assessed directly (e.g., reductions in illnesses or injuries) or, as necessary, using intermediate outcomes to estimate impact. Qualitative narrative evaluations should be included to explain the numerical ratings.

2. Assessment of the program's effectiveness in targeting new research areas and identifying emerging issues in occupational safety and health most relevant to future improvements in workplace protection. The committee will provide a qualitative narrative assessment of the program's efforts and suggestions about emerging issues that the program should be prepared to address.

program would entail (Chapter 2) and used the components of an ideal program as a benchmark with which to compare the existing program. The terms used and the details of the committee's evaluation are presented in Chapters 3 and 4.

The study charge also directed the committee to review the progress that the AFF Program has made in identifying new research and provided the committee with the opportunity to identify emerging research relevant to the program's mis-

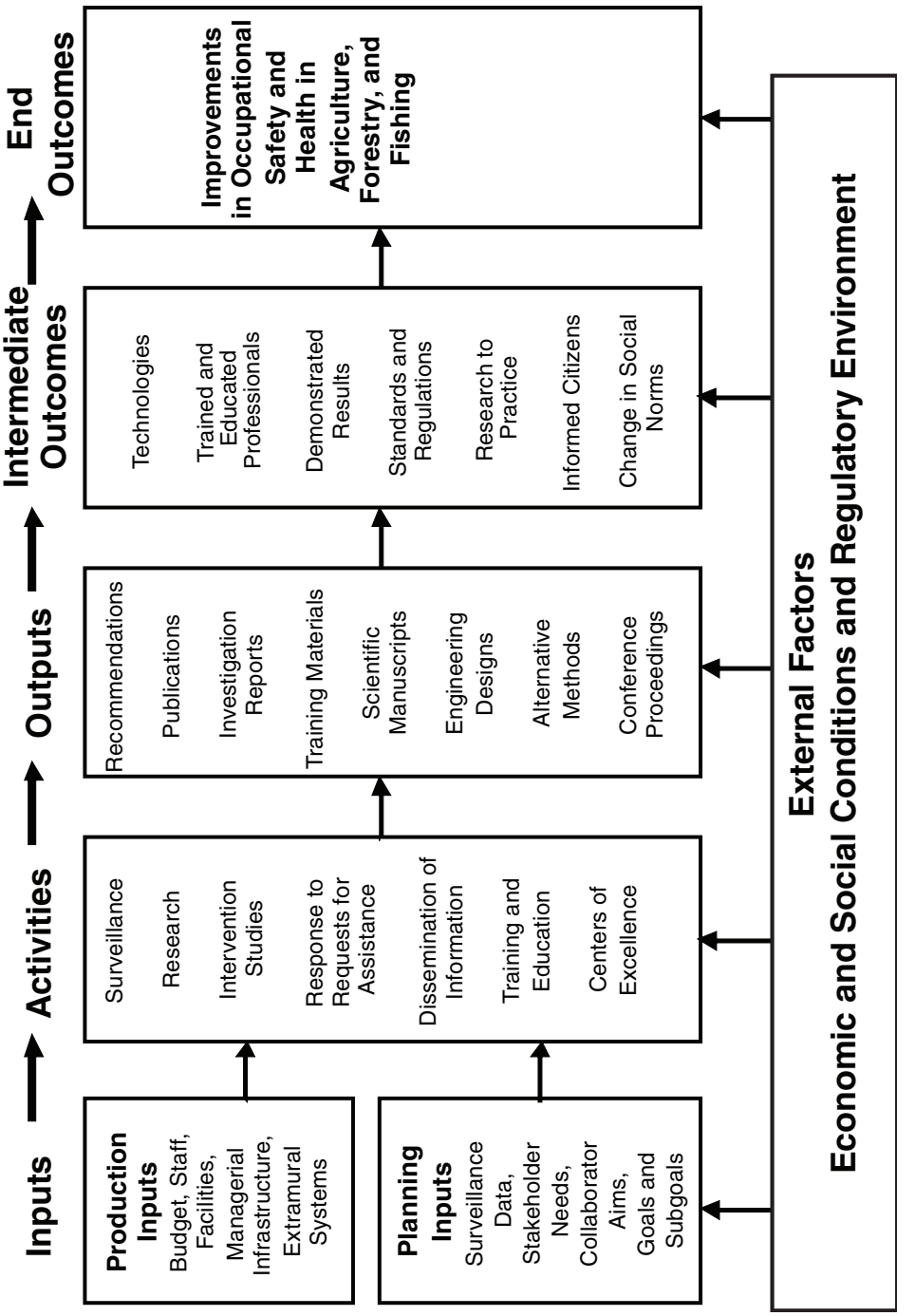

FIGURE 1-1 The AFF Program logic model.
SOURCE: NIOSH, 2006a.

sion. According to the Framework Document, the committee's identification of emerging research areas is to be based on members' expert judgment rather than a formal research-needs identification effort.

Program Period Evaluated

The committee was given the discretion to determine the period to be covered by its review. To evaluate the research program's work in its entirety, the committee chose to evaluate it from its inception in 1990 to the most current timeframe in 2006. In 1990, Congress directed NIOSH to develop an extensive agricultural safety and health program in surveillance, research, and intervention to address the high risks of injuries and illnesses in agricultural workers and their families (U.S. Congress, 1990b). The Congressional Agricultural Occupational Safety and Health Initiative applies directly to activities in agriculture, but timber harvesting and commercial fishing-related activities are implicitly included.

Information Gathering

The review of the AFF Program was based in large part on written materials provided by NIOSH (see Appendix C). The AFF Program gave the committee a 350-page evidence package and a CD containing more than 3000 pages of appendixes (NIOSH, 2006a). The committee also submitted written requests to NIOSH for additional information on the AFF Program. The committee met three times from January 2007 through May 2007 and conducted additional deliberations through conference calls and e-mail. Information gathering included presentations by NIOSH staff and other invited guests in open sessions of committee meetings in January and March (see Appendix B).

The committee also invited comments from stakeholders, that is, organizations and individuals with a potential interest in the AFF Program. Given that the research program is related to an enormous and disparate portfolio of sectors—agriculture, forestry, and fishing—the population of potential stakeholders is diverse and not easily defined. As a result, the committee made an effort to reach a varied national and international audience in federal and state agencies, industry, labor, and academe but did not attempt to make its information-gathering effort a comprehensive or systematic survey of the program's stakeholders, because of the short timeframe for its work. (Additional details on committee methods and a list of stakeholders who provided information to the committee are available in Appendix B.)

The committee chose not to visit facilities used by the AFF Program staff, inasmuch as most members had a working knowledge of the facilities based on visits in

their professional activities. Furthermore, relative to the AFF Program's extramural portfolio, the committee was confident that they had received sufficient input from a few directors of the extramurally funded NIOSH Agricultural Centers (Ag Centers): The director of the National Children's Center for Rural and Agricultural Health and Safety presented information at the first committee meeting in January 2007, four Ag Center directors were invited to speak at the second committee meeting in March 2007, the other five directors were queried by the committee for additional information.

Evaluation Data Limitations

In the 9 months given to conduct the program evaluation, the committee based its assessment of the AFF Program on the "evidence package" (NIOSH, 2006a) and supplemental information (Appendix C) provided by NIOSH, and also consulted with experts and conducted information searches. The committee found that the materials provided by NIOSH were neither a comprehensive nor an accurate reflection of work that has been done by the AFF Program; rather it was a mere snapshot of the program that poorly cataloged basic information about the program's work. The committee knows of seminal publications and substantial data that were not included in the evidence package or in the supplemental materials. In addition, several committee members who had worked with the AFF Program in the past noted that there were several insightful internal publications (such as NIOSH, 1992b) that should have been publicly released years ago, which would have been helpful for the evaluation. The committee is concerned that the AFF Program is unaware of its own work.

THE U.S. AGRICULTURE, FORESTRY, AND FISHING INDUSTRIES

The agriculture, forestry, and fishing sectors are the cornerstone of industries that produce and market food, fiber, and fuel. Collectively, the three sectors make up a huge component of the U.S. economy and are a major employer in the United States (GAO, 2007). Annually, these industries generate more than $1 trillion and create exports exceeding $68 billion. NIOSH estimates that more than 5.5 million workers are employed in agriculture, forestry, and fishing (2007). These sectors also consistently rank in the top six most hazardous occupations; fishermen and loggers have the highest fatality rates (BLS, 2007a). Collectively, the three sectors consistently have the highest injury and fatality rates of any U.S. industries, so the overall effect on the safety and health of exposed populations in agricultural, forestry, and fishing worksites is enormous (Hard et al., 2002; Frank et al., 2004; BLS, 2007a).

Agriculture Sector

The agriculture sector, which the 1990 enabling legislation targeted, is composed of about 2.1 million farms (Hoppe and Banker, 2006). Its structure is bifurcated: large capital-intensive operations rely on scale to survive economically, and smaller operations rely on niche production of high-value commodities (Midwest Center for Agricultural Research, Education, and Disease & Injury Prevention, 2002). The former constitute about 7 percent of all farms in the United States; these farms typically each have agricultural product sales of $1 million or more per year and generate 75 percent of farm cash receipts from the sale of agricultural commodities (USDA, 2004; Hoppe and Banker, 2006). They operate enterprises on 44 percent of all U.S. harvested cropland and account for a large majority of farm cash receipts in every category of agricultural commodity except tobacco and specialty livestock, such as sheep, goats, and horses (USDA, 2004). In 1987, a ranking of farms by value of commodities marketed demonstrated that the largest 13 percent accounted for 75 percent of total sales (USDA, 1987). Thus, from 1987 to 2002, the size concentration in the U.S. agricultural sector doubled (USDA, 1987, 2004).

At the other extreme are agricultural enterprises that operate on 56 percent of U.S. cropland and generate 25 percent of total farm cash receipts (USDA, 2004; Hoppe and Banker, 2006). Some are limited-resource farms, which report gross product sales of less than $100,000 in 2003 dollar equivalents and low (below the poverty level) operator household income; others are retirement farms (run by retirees who are also farm operators), residential or lifestyle farms (smaller enterprises whose operators report a major occupation other than farming), or conventional farming-occupation farms (such as family farms whose operators report farming as their major occupation) (Hoppe and Banker, 2006). The committee recognizes that congressional testimony surrounding NIOSH's 1990 agricultural health and safety mandate used findings from midwestern and northeastern (largely New York) family operations, and public and congressional debate relative to the role of family farm operations in the agriculture sector has been spirited. However, the committee believes that in the context of NIOSH's agricultural health and safety initiatives the most useful definition of a "family farm" is the one used by Congress in the 1985 Food Security Act: any farm that is organized as a sole proprietorship, partnership, or family corporation and uses less than 1.5 person-years of hired labor per year (U.S. Congress, 1985). This definition has the advantage of including the notion that family owners are responsible for providing the major share of labor required to operate the farm—an important dimension in allocating federal resources to surveillance and intervention among different agricultural settings in the sector.

Of all farms in the United States, 61 percent do not participate in any federal farm program (Hoppe and Banker, 2006) and so have no incentive to respond to agricultural subsidies, federally subsidized conservation programs, or acreage set-asides. That occurs because of absentee ownership (for example, over 50 percent of the land in Iowa); targeting of national agricultural policy, which excludes many agricultural commodities; and individual owner, operator, or corporate decisions to remain out of program spheres (Duffy, 2004; Hoppe and Banker, 2006).

Since Congress passed NIOSH's enabling legislation in 1990, the role of farm management companies, agricultural labor contractors, and other types of non-owner operation has substantially increased in importance. In part, that has occurred because of shifts in the demographic profile of those who own land and facilities, technological changes in production practices, capitalization requirements, and incentives embedded in federal agricultural policy (Stofferhan, 2006). The result has been a large change in who is exposed to worksite risk: custom farmers and other employees who are under contract to agricultural management companies are typically as important as farm owner-operators in large sections of the Midwest and Southwest where row crops (corn, potatoes, sorghum, soybeans, and sugar beets) predominate and the West Coast where vineyards are present and other specialty crops are grown (CIRS, 2006). The trend could intensify as a "bioeconomy" based on agricultural biomass emerges in portions of the nation's cropland, spurring both monocultures of annual and perennial crops and semi-natural plant communities and the intensive industrialization of cropping activity (Hunt, 2006; Jordan et al., 2007). Other exposed populations have also increased in importance, including hired workers, many of whom are immigrants—probably the majority of employees in the agriculture workforce.

The agriculture workforce is estimated to number about 5,296,000 people, including self-employed workers and working youth (see Table 1-1). U.S. agriculture

TABLE 1-1 Size of Agriculture, Forestry, and Fishing Workforce Populations

Workforce Sector	Number of Persons at Risk
Agriculture	3,167,000[a]-5,296,000[b]
Logging and forestry	88,000[c]-202,000[d]
Fishing and hunting	55,000[d]-160,000[e]
TOTAL	3,314,000-5,658,000

[a]Source: Farm Labor, NASS, USDA, November 2001, p. 13.

[b]Source: Occupational Injury Survey of Production, Response to Committee Question #4, NIOSH, February 16, 2007.

[c]Source: Occupational Outlook Handbook, Bureau of Labor Statistics, 2008.

[d]Source: Current Population Survey, Bureau of Labor Statistics, 2007c.

[e]Source: U.S. Fishing Industry, NIOSH, 2007b.

has typically employed proportionally more people 16-19 years old and 55 years old and above than have other economic sectors (BLS, 2001a). Of the total workforce in 2001, about 993,000 were 15 years old and younger and reported to be working on U.S. farms and ranches (NIOSH, 2006b). The injury and occupational disease experience of the agriculture workforce has varied with age, gender, cohort, and calendar interval. Fatal injury rates are proportionately lower than in the other two AFF sectors (see below), but nonfatal injuries occur in as many as 10 percent of exposed workers (NIOSH, 2006a). Other nonfatal occupational hazards result in eye injury, cumulative hearing loss, low-back and other musculoskeletal injury, cumulative trauma disorders, some cancers, and respiratory disease. Most of those conditions, excluding cancer, were known to occur among working agricultural populations when Congress established the AFF Program in NIOSH.

Forestry Sector

The forestry sector has played a pivotal role in the economic, social, and cultural development of the United States. It comprises an array of lands managed for an evolving constellation of objectives: timber and other commodity production, recreation, maintenance of wildlife habitat, water-quality protection, wilderness and open-space preservation, and more recently as a buffer against climate change and an effective carbon sink (Holmgren and Thuresson, 1998; Peterson et al., 1999). The total U.S. forest land area has remained relatively unchanged since the 1920s (Peterson et al., 1999). Currently, about one-third of the nation's overall land base, 737 million acres, is forested (Peterson et al., 1999). The federal government controls about 35 percent (249 million acres) of all forest land, and about 10 million private owners control over 60 percent of it (Rand, 1990; Garland, 2007). In the East, most forested land is under state and private control; however the federal government is the principal owner of forestland in the West (Powell et al., 1993).

The forestry workforce is composed of all who harvest forest and forest-related products and those who provide other support services for the maintenance and sustaining of the nation's forests. It includes owners and managers of forested acreage, timber harvesters (loggers and fellers), caretakers (involved in silvicultural activities and fire control), harvesters of non-wood forest products (such as nuts, cones, other greenery, and mushrooms), transport drivers and road-building and -maintenance crews, and others in support functions, such as machinery manufacturers, logging-rigging outlets, recreation managers and guides, and state and federal natural resources employees. The size of the workforce has been estimated to range from 88,000 to 202,000 workers (BLS, 2007b, 2008). This workforce has been described as relatively isolated geographically and possessing a unique subculture (Myers and Fosbroke, 1994; Garland, 2007). Historically, the workforce has

had little labor organization; however, with the advent of offsite management firms that specialize in providing workers during times of high need, such as for fire suppression or mandated vegetative removal, the population exposed to forestry risk has changed to include numerous newly immigrant workers of Hispanic, Asian, and eastern European origin.

The workforce, particularly that involved in felling and logging, has experienced some of the highest injury rates in the AFF sector. In 1955, the fatality rate was 214 per 100,000 workers, and the nonfatal injury rate was 16 events per 100 full-time workers (NIOSH, 2006a). By the late 1980s, deaths attributed to injury had dropped to 161 per 100,000 workers (NIOSH, 2006a); but nonfatal injuries had increased to almost 20 events per 100 full-time workers (BLS, 1990). By 1996, the fatality rates had dropped even further, to 128 per 100,000 workers (NIOSH, 2006a). More recent reliable injury-related data are unavailable, and numerous types of worker categories have not been included in published analyses because of reliance on "official" numerator (event) and denominator (population-at-risk) data. The prevalence of occupational diseases is unknown.

Fishing Sector

The fishing portion of AFF comprise several fisheries, which are identified by region: the Northeast, the mid-Atlantic, the Southeast, the Gulf Coast, the West, and the Alaskan shelf. Fishing is conducted in both the open ocean and adjoining states' internal waters by vessels that vary in size and fitting, totaling approximately 82,000 operating units in 2006 (U.S. Coast Guard, 2007). Operations can range from technologically sophisticated with expensive gear and advanced electronics to those with simple gear and modest electronics. Most fishing vessels along the Northeast, mid-Atlantic, and Gulf Coast are small owner-operated, whereas many vessels in the West and Alaska are in larger multi-vessel enterprises. At-risk workers can range from one, two, or three per boat to upwards of 150 (U.S. Coast Guard, 2007). The U.S. Coast Guard regulates most aspects of the industry; its Commercial Fishing Industry Vessel Safety Advisory Committee is charged with developing workable recommendations for the health and safety of vessel employees.

The workforce is composed of both native-born and immigrant populations, including workers from several African nations. Of the estimated 55,000-160,000 workers exposed to occupational risk while engaged in maritime fishing activity (BLS, 2007b; NIOSH, 2007b), more than half are self-employed. The workforce experienced the nation's highest occupational fatality rate due to occupational exposures in 2006: 141.7 per 100,000, nearly 30 times higher than the rate in the overall workforce (BLS, 2007a). Its overall nonfatal injury rate is unknown, but the Alaska fishery had 410 injury hospitalizations per 100,000 full-time fishermen

(NIOSH, 2007b). Fishermen go out to sea in poor weather, especially in heavy New England seas and Aleutian Island storms, and a fall overboard often results in drowning. Fishermen also work with dangerous power tools, such as huge winches and hoists, and heavy nets and cages, all of which can turn into lethal missiles on slippery wet or icy decks in heavy seas. The prevalence of occupational diseases is unknown.

LEGISLATIVE HISTORY AND HISTORICAL PERSPECTIVE

The U.S. Census Bureau's North American Industry Classification System (NAICS) classifies economic units that have similar production processes in the same industry (BLS, 2001b), and categorizes agriculture, forestry, and fishing in the same industry classification because the three sectors are involved in the harvesting of food, fiber, and fuel. NIOSH is obligated to address all three sectors under the NAICS while the original congressional mandate only specifies funds for agriculture (U.S. Congress, 1990a; BLS, 2001b). However, as early as March 1992, NIOSH included loggers, fishermen, children, unpaid workers, and racial minorities when developing goals to carry out the new NIOSH research program in agricultural safety and health (NIOSH, 1992b). In 1991, 1992, and 1996, congressional appropriations language continued to specify funds for agriculture, and NIOSH has continued to carry out plans according to the original mandate. Perhaps future appropriations language may specify funding allocation among the three sectors, but as it stands agriculture will continue to dominate the program's portfolio unless AFF Program leadership directs otherwise. Because the AFF Program only addresses occupational issues related to harvesting of food, fiber, and fuel, it does not address processing concerns related to food processing, lumber mills, or fish processing.

Agriculture

Attention to injury and disease prevalence among farmers and ranchers took a long time to take root in the last century. Though the farm injury toll was recognized from the introduction of the steam traction engine in 1908 (Avery Machine Corporation, 1912), it was not until 1938 that the farm injury problem attracted national attention at the annual National Safety Congress sponsored by the National Safety Council (Rasmussen, 1989). The mentality emerged that "The careless farmer who gets injured in an accident this year not only hurts himself and his family, but he curtails the nation's 'Food for Freedom program'" (Wickard, 1943). A few years later, the wartime labor shortage allowed the safety community to create a national consensus focusing efforts on improving worker safety (Hall,

1943; Anon, 1944; Oden, 2005), and resulted in President Franklin D. Roosevelt instituting policy (USDA, 1942), which would be used decades later as the basis of the 1990 congressional appropriations language to establish the NIOSH AFF Program.

In 1944, the first farm safety week was jointly sponsored by Cooperative Extension across the nation, the U.S. Department of Agriculture (USDA), and the National Safety Council (NSC, 1954), and was a sentinel development because it paved the way for key players to closely cooperate over the next 3 decades. The NSC, an organization dedicated to protecting life and promoting health, convened annual conferences from the late 1940s onward to highlight intentional and unintentional injuries at agricultural worksites and provided a training and networking venue for state-level agricultural safety specialists and others engaged in agricultural safety. In the 1950s, the National Institute for Farm Safety (NIFS) was formed by agricultural safety and health leaders. NIFS formed single-purpose committees—such as those on tractor and safety, fire and electricity, emergency preparedness, home and farmstead, rural traffic, and farm chemicals—to identify unique agricultural worksite and home-site risks and dangers, and explore ways of reducing injuries for farmers and ranchers. The NSC provided needed national leadership until 1972 and aided in the continual development of engineering safety standards by the American Society of Agricultural Engineers. By the mid-1970s, however, controversy emerged that was fueled by the passage of the Occupational Health and Safety Act and alarmed many in agricultural production, as professionals involved in agricultural safety and health desired greater autonomy for its educational and other professional venues (Oden, 2005).

Numerous technological and other workforce developments in production agriculture galvanized professionals and others around the injury experience of the nation's farmers and ranchers. As early as 1915, California enacted provisions regulating agricultural labor camps (Parker, 1915; California Department of Housing and Community Development, 2007). The adoption of corn picker technology on American farms quickened by 1950 because it yielded enormous labor savings, but the injury toll mounted: in Iowa alone in 1951, 299 fingers, 32 thumbs, and 32 hands were severed by the corn picker technology (Wallaces' Farmer, 1952; Scranton, 1952). California was an early leader with its enactment of legislation in the 1970s limiting the use of short-handled hoes to reduce cumulative trauma (Jourdane, 2004). As the overall agricultural health and safety movement came of age, professional perspectives diverged from time to time, including controversy about which federal entity should be charged with overall programmatic responsibility (Burke, 1968).

In 1972, the Congress appropriated $1 million to fund state-level safety efforts in the 50 agricultural extension services (Murphy, 2003) that functioned at the state level. The resources could be used to fund extension safety positions or to fund

safety programs with a blend of state and federal funding. The effort continued until Congress eliminated the funding from its agricultural appropriations activity in 2002 (Farm Security and Rural Investment Act of 2002), thus spelling a near total collapse of extension activity in agricultural safety and health.

While nearly all agricultural safety professionals were united behind the banner of more safety education for all exposed to agricultural and forestry risks (fishing was not mentioned at this early stage), lone voices were calling for public policy intervention (Plambeck, 1983). OSHA's regulatory activities were not only controversial in agriculture and forestry but attracted an unusual array of critics in a variety of other American worksite sectors (Stang, 1952; OSHA, 1974). As enthusiasm for policy advocacy waned, educational approaches gained popularity; however, the efficacy of such approaches was continually questioned, and targeting the appropriate population proved to be elusive as unintentional injuries continued to mount.

Independently of those activities, clinical interest in and response to the mounting disease and injury toll were being documented. The Institute of Agricultural Medicine and Occupational Health was established at the University of Iowa in the 1950s, the National Farm Medicine Center of Wisconsin in the 1970s, and the Farm Safety and Health Center at the Mary Imogene Bassett Hospital in Cooperstown, New York, in the 1980s. Clinical acumen was gathered to target disease syndromes and acute and chronic injuries related to agricultural work. Clinicians in Canada were hosting international symposia to highlight exposures and results of selected interventions across the whole of North America and in selected European and Asian countries, and Scandinavians in agricultural safety and occupational health developed specific clinical "tracks" at European occupational symposia (see, for example, Dosman and Cockcroft, 1989; Svanström et al., 1989). By the mid-1980s, the CDC had awarded the first substantial resources for unintentional injury surveillance in rural areas of the United States (Gerberich et al., 1990). All those efforts added weight to the proposition that a national effort was needed, at the very least, as a response to moral imperatives surrounding a decent society and national security interests—security interests that suggested that a safe and affordable food supply for the nation's growing population was essential (Eken, 1991).

Several federal agencies other than NIOSH have contributed to AFF work-related research, including the CDC's Injury Prevention Branch, USDA, the National Institutes of Health's National Cancer Institute (NCI), the National Institute of Environmental Health Services (NIEHS), and the National Center for Health Statistics (NCHS). Fatal occupational injury surveillance efforts were provided by NIOSH, the NCHS, and several state-level agricultural safety specialists funded by USDA and state-level funding; occupational disease surveillance was conducted by NIOSH and NCI; rural injury surveillance was done through the CDC; intentional death

surveillance was conducted by the NCHS and select state health departments (Burkart et al., 1978; Marx et al., 1985; Zey et al., 1985; Gunderson et al., 1987, 1993; Blair, 1988; Meyers, 1988; National Mental Health Association, 1988; Pearce and Reif, 1988; Rodricks and Rachman, 1988; Stallones, 1988; Cohen et al., 1989; Wiener et al., 1989; Bresnitz et al., 1990), and a large body of educational initiatives was supplemented by those in academe involved in intervention research (Roman, 1987; NCASH, 1988; Gunderson, 1989, 1990; Schwartz and Cohen, 1990; Lexau et al., 1993; Ambruster, 1991; McGinnis, 1991; Von Essen, 1996). This has resulted in a body of research literature, clinical findings, and injury control education.

By 1988, state agricultural safety specialists, epidemiologists, policy analysts, and public health professionals were routinely meeting at professional conferences to explore the potential for national congressional action. Working from a template constructed by the Association of Schools of Public Health, they consulted with U.S. House and Senate staff as ideas entered formal stages (ASPH, 1988). Meetings, such as one sponsored by the National Coalition for Agricultural Safety and Health (NCASH) in 1988, provided an opportunity to explore recent surveillance findings and potential interventions (Donham and Storm, 1988; NCASH, 1988). Those efforts culminated in the passage by Congress of Public Law 101-517 in 1990 (U.S. Congress, 1990a), which directed NIOSH to establish a program for improving the health and safety of agricultural workers and their families. P.L. 101-517 specifically called for

- A *Farm Family Health and Hazard Survey* in order to develop more complete information on the circumstances of agricultural injury and other disease problems.
- Research exploring the etiology of agricultural injuries and disease.
- Establishment of extramural *Centers for Agricultural Disease and Injury Research, Education, and Prevention* at selected universities.
- Establishment of a national *Agricultural Health Promotion System* in collaboration with the nation's county extension agents.
- An *Agricultural Health Nurse Surveillance Program* in which rural hospitals would provide ongoing responsive (focused at intervention) surveillance to identify agriculture-related disease and injury problems.

Congress recognized that agricultural workers were suffering higher rates of unintentional injury and illness than other U.S. workers, even those in other extractive industries. Congress was led to believe, by the sheer weight of expert testimony delivered in support of P.L. 101-517, that NIOSH was capable of leading a comprehensive national effort devoted to preventing injury and disease in the nation's 3.4 million workers in agricultural settings (NIOSH, 1992a). The testimony pertained to production agriculture alone; forestry and fishing were not conceptually ad-

dressed in expert testimony during the formative stages of the AFF initiative. And intentional injuries, largely suicides, were not addressed by the legislation.

An innovative feature of P.L. 101-517 was the call to establish extramural centers. The legislation specifically charged NIOSH with responsibility to select and fund agricultural occupational safety and health centers at select universities. Specific language stated: "these centers would: (1) develop model programs for the prevention of 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 agents; and (5) provide consultation to researchers, safety and health professionals, agriculture extension programs, and others" (NIOSH, 2000c).

As surveillance results became available, the burden of injury borne by children and adolescents on farms and ranches was recognized (Gerberich et al., 1991). However, sentinel calls for attention to these vulnerable workers had been issued for decades, even when surveillance data were lacking. For at least 3 decades, children and youth had been the target of educational interventions (see, for example, National Safety Council, 1953; Farm Safety Review, 1954; or National 4-H Club News, 1958), even though the efficacy of such approaches was open to question. By 1958, the NSC had created the Youth Safety Activities Committee, whose role was to provide educational programming guidance and information exchange to individuals and agencies that wished to embark on youth safety programming. Those educational interventions for children in agriculture had high priority because people under 16 years old were excluded from OSHA regulations, given the exemption of labor for family farms.

The first national consensus conference relative to the unintentional injury burden in youth occurred in 1992 (Lee and Gunderson, 1992); other formative activities, including development of a National Action Plan for Childhood Agricultural Injury Prevention, followed and resulted in the design of a second national initiative that targeted vulnerable child and adolescent populations (NCCAIP, 1996). Congress adopted the plan in 1996 and passed legislation in the same year (P.L. 104-208), with the conference report (H. Rept. 104-863) specifically appropriating for

- Establishment of a national *Children's Center for Rural and Agricultural Health and Safety* to plan and coordinate a national response to the epidemic of injury among children and adolescents exposed to agricultural worksite risk.
- Surveillance exploring the etiology of child and adolescent agricultural injury.

- Development of work guidelines and other aids for use by parents and supervisors in agricultural worksites.
- Design of communication strategies capable of reaching agricultural populations.

Fishing

U.S. fishing industry policies predate the Fair Labor Standards Amendment of 1989 (P.L. 101-157). The hazards of commercial fishing did not fully capture congressional attention until the death of Peter Barry when the fishing vessel *Western Sea* sank in August 1985. Peter Barry was the son of Robert and Peggy Barry. He was chief U.S. delegate in North Atlantic Treaty Organization talks with the Soviet Union. With a variety of factors at play and the right timing, Peggy Barry made it her mission to bring the lack of safety regulations of commercial fishing to the attention of Congress and gave a voice to the efforts of many in the U.S. Coast Guard and other groups. Through their combined efforts, Congress enacted the Commercial Fishing Industry Vessel Safety Act (CFIVSA) of 1988 (P.L. 100-424). Among other items, the CFIVSA required each vessel to carry various survival equipment and charged the U.S. Coast Guard with regulation enforcement. It led to Regulation 26 CFR Part 28, released in 1991.

The CFIVSA also directed the Secretary of Transportation to conduct an assessment of safety problems in the industry. The National Research Council completed the safety assessment in the 1991 report *Fishing Vessel Safety—Guide to a National Program*. The report's recommendations included proposals for safety administration and for alternatives related to vessels, personnel, survival, and fishery management. The recommendations resulted in several programs: the Coast Guard Fishing Vessel Safety Decal Program (1992), the Fishing Vessel Safety Decal (1998), and the Dockside Enforcement Program for Crab Fisheries (1999) (DHS, 2005). More recently, rules pertaining to additional safety procedures and vessel seaworthiness assessment have been developed, but they have not been formally released. The National Transportation Safety Board also proposed several safety recommendations for the commercial fishing industry. NIOSH itself has commented on selected aspects of congressional interest in fishery management that affect worker safety and health (U.S. House of Representatives, 2007). Testimony on the affect of the Halibut and Sablefish Individual Fishing Quota policy on search and rescue efforts and fatalities was also used to develop recent crab rationalization efforts and other similar efforts in other fisheries, which allow fisheries to be managed by vessel-allocation quotas. The quota system enables fishermen to wait an additional day or so rather than rushing out to sea in tumultuous weather or using a vessel or equipment that needs repair.

ORGANIZATION OF THE REPORT

The remainder of the report presents the findings from the committee's evaluation. Chapter 2 provides the committee's assessment of the "ideal" research program in AFF, which is intended to provide a benchmark with which to compare the existing program. Chapter 3 evaluates the overall AFF Program according to its strategic goals and other elements. Chapters 4-8 review the subjects of the major research goals of the AFF Program: hazard surveillance, priority populations at risk, health effects of agricultural agent exposures, hazard control systems, and outreach. Chapter 9 evaluates other AFF Program elements that the committee identified as compared to its ideal program. Chapter 10 rates the research program's relevance to and impact on reducing workplace injury and illness, and provides rationale for the AFF Program's scores. Chapter 11 reviews the program's mechanisms for identifying emerging issues in the AFF work sectors, and identifies issues that merit future attention. Chapter 12 provides recommendations to strengthen the NIOSH AFF Program and increase its relevance and impact.

2

The Ideal Agriculture, Forestry, and Fishing Research Program

As its first step in evaluating the National Institute of Occupational Safety and Health (NIOSH) Agriculture, Forestry, and Fishing Research Program (AFF Program), the committee was directed by the Framework Document to independently identify the major program challenges for an occupational safety and health research program in agriculture, forestry, and fishing. The committee relied on surveillance findings and its expert judgment to determine the major components of an "ideal" research program that would cut across the three sectors. This chapter outlines the committee's deliberations regarding the ideal safety and health research program in agriculture, forestry, and fishing and provides a methodology for the program to fulfill its congressional mandate. The committee used the ideal program as a benchmark to measure the goals and activities of the existing NIOSH AFF Program, which is assessed in Chapters 3-10.

OVERARCHING PROGRAM CHARACTERISTICS

The ideal NIOSH AFF Program would have adequate resources to set priorities among and accomplish the congressionally stated goals of surveillance, research, and intervention through (1) identification and characterization of injuries and illness and detailed characterization of populations at risk through **surveillance**; (2) identification and characterization of **special populations** and the unique health and safety risks they face; (3) identification and characterization of **health effects** associated with chemical, physical, and biological agents encountered in agricul-

ture, fishing, and forestry; (4) identification, development, evaluation, and implementation of **control systems** to reduce injury and illness; and (5) development of efficient and effective **outreach mechanisms** for dissemination and delivery of knowledge developed through research.

Those resources would include adequate staff, scientists, engineers, and administrators who work together with clearly defined goals, strategies, and evaluation methods to ensure success in achieving AFF Program goals. Their combined experience and expertise would be specific to agriculture, fishing, and forestry, to the extent possible. There would be clearly defined reporting mechanisms and procedures for maintaining accountability, and a well-organized system would be in place for creating an archive of program work products for future reference. A single person would be charged with directing the entire program and overseeing, evaluating, and communicating its plans. However, content experts would be in charge of each arm of the program: a separate leader for agriculture, for forestry, and for fishing. The committee envisions a relatively flat organization chart; the person in charge of each arm would have a fair amount of responsibility to make decisions. The management matrix or organization structure would be flexible so that the AFF research teams can recognize and react quickly to changes in the AFF industries, the economy, new technologies, and relevant results of research in other programs, and managed in such a way that AFF research teams are encouraged to be proactive in anticipating and mitigating emerging risks and hazards. The AFF Program would be informed of current issues through contacts in the U.S. Department of Agriculture, Cooperative Extension System, and industry representatives.

The AFF Program would have world-class research facilities and laboratories devoted to solving problems specific to the strategic plan. The facilities would focus on elements of the strategic plan that may not be adequately addressed through extramural research projects, such as the development of analytic methods directly relevant to the AFF mission. AFF resources would not be used to duplicate capabilities available in partner agencies or programs or when the foremost expertise is available through extramural programs. In addition to projects funded at the NIOSH Centers for Agricultural Disease and Injury Research, Education, and Prevention (Ag Centers), the AFF Program would consider funding extramural projects that address important issues and innovative technologies. The AFF Program would include the means to fund large multicenter studies to answer scientific questions that cannot be addressed any other way; an example might be gene-environment interaction studies, which have become important in fields ranging from the risk of lumbar disk herniation to the risk of airway obstruction related to animal feeding operations. Ethical issues related to findings from gene-environment interaction studies would be considered, including the possible impact on employment.

Resources would be distributed among the three industries covered by the program according to appropriate measures of impact, such as numbers and types of fatalities and nonfatal injuries and illnesses, and the application of objective metrics of direct and indirect costs. Appropriate resource distribution requires a complete understanding of populations at risk, and requires surveillance to characterize injuries, illnesses, and associated costs and to detect new trends. Surveillance methods specific to the regions of the population at risk would be used to ensure adequate coverage. Strategies for developing new objective approaches to measure the socioeconomic impact of work-related injury and illness would be established.

The ideal AFF Program would be highly visible in the industries covered at federal, state, and local levels. The program would have representation across the country in numbers proportional to the population at risk. The program would form partnerships with existing agencies, universities, or other organizations that have complementary missions and would leverage infrastructure and relationships toward accomplishing its goals, with emphasis on surveillance and outreach. The ideal program would address the research needs of large, medium, and small-sized operations. Large corporations produce most of our food and fiber products, are able to harness resources to implement many recent technological developments, and would be viewed as valuable partners of NIOSH.

Program evaluation procedures that use both internal and external reviews would be conducted at regular intervals. A short summary of the reviews would be accessible to the public.

SPECIFIC PROGRAM COMPONENTS

When considering the ideal research program, the committee focused its efforts on identifying the following program components that would comprehensively and effectively address the safety and health issues that face workers in agriculture, forestry, and fishing:

- Identify and engage stakeholders,
- Identify populations at risk,
- Conduct surveillance,
- Conduct health effects research,
- Conduct intervention research,
- Conduct health services research and training,
- Conduct research on knowledge diffusion and technology transfer,
- Inform public policy and provide regulatory assistance,
- Conduct program evaluation initiatives.

Stakeholders

The occupational safety and health program for the AFF industries would be founded on an understanding of and respect for the unique characteristics of the AFF communities. Healthy and safe workers and families are the foundation of the economic and social well-being of the industries. Government, private, academic, and healthcare professionals all have unique strengths that complement those of the AFF Program, and all parties are needed to maximize its effectiveness. The program would be participatory and community- or work population-based and have the support of the AFF community so that there is buy-in for research intervention developments. The program would also empower the community to action so that involvement goes beyond involving stakeholders merely at the beginning and end. The concept of broader deliberation and decisionmaking among researchers and populations at risk from the inception of research ideas to their completion as applications would be explored more in-depth.

Partnership and collaboration with stakeholder groups are integral to favorable change and improved outcomes. Involving these groups would enable the AFF Program to "think outside the box"; stakeholder involvement is especially important when researchers devise various ways to reach AFF workers for input. Regional priorities would be developed in collaboration with carefully selected community study groups in each U.S. Department of Agriculture region where a substantial portion of the identified population at risk resides and works. For example, a state-level or regional community study group would include representatives of each of the five types of workers (see Populations at Risk section within this chapter for worker classification). The private sector—including the agricultural service and supply industries, insurance companies, private foundations, legal services providers, industry trade associations, ethnic self-help groups, and community service organizations—is an essential part of an effective national strategy. Careful selection implies that both organizational representatives and unaffiliated individual workers will be represented. It is expected that community study groups will also monitor and report to the public on the progress of the program. A reasonable allocation of program resources to staff and nurture these groups will be required to support a successful long-term effort. Special efforts will be required to include full participation of and direct representation of non-English speaking workers, whether self-employed or hired.

Surveillance

A successful surveillance program requires knowledge about the size, distribution, and characteristics of "at-risk" populations. That would be followed by systematic analysis of data and surveillance of hazards, injuries, and illnesses. NIOSH

AFF Program staff would routinely provide surveillance data so that intervention initiatives can be appropriately targeted. Furthermore, periodic evaluation of AFF surveillance mechanisms is needed to update procedures as work practices, hazards, diseases, injuries, and worker populations change.

Health and hazard surveillance is central to the design of interventions for the AFF sectors. Surveillance would be broad in light of the diversity of settings, employment practices, and populations, such as female spouses, the elderly, and children. Datasets would include demographic characteristics to assist in the identification of populations at risk. It has been noted that "hazard surveillance is the assessment of the occurrence of, distribution of, and secular trends in levels of hazards (toxic chemical agents, physical agents, biochemical stressors as well as biological agents) responsible for disease and injury" (Halperin et al., 1992). Surveillance would be continuous to monitor the effects of technological changes, geographic and other shifts in production, policies, population changes, and market forces that affect AFF worksite organization and management. On occasion, special non-routine surveillance efforts would be launched to address rapidly emerging developments and unique populations of workers.

Surveillance is the cornerstone of a successful long-term program; it is a means of identifying dangerous conditions and monitoring trends in AFF industries and is aimed at prevention and knowledge translation. Surveillance of important risk factors for injury and illness would be continuous so that the effects of technological change, geographic and other types of shifts in production, population changes, and other external factors can be monitored. Surveillance will rely on various sources: in addition to federal or other government institutions, other sources would be consulted, such as workers' compensation insurance records, death certificates, and hospital emergency room records. Trade association meetings and conferences can also provide useful information on current trends.

For some industries and populations, it may prove necessary to commission special surveillance studies. Such studies would be initiated by a group of experts who meet jointly with carefully selected spokespersons representing important subgroups of the population of interest.

The surveillance effort would regularly produce summary reports that are carefully designed in collaboration with experts and that are made available to the public through the Internet. Each AFF project would have priorities in surveillance for not only gathering data but analyzing findings to assist NIOSH in establishing research and intervention priorities.

Populations at Risk

Risk exposure is a component of research in occupational safety and health. It is fundamental that increased risk exposure leads to a greater incidence of

occupational injury or illness. Injury and disease rates in occupational settings would be computed to appropriately assess populations that are at higher or lower risk of exposure. Rate computation requires knowledge of the number of people at risk (the denominator). Assessing the number of AFF workers by race or ethnicity, age, and gender requires use of information outside traditional occupational safety and health data collection systems. Unlike nearly all other major industry sectors, the AFF workforce is comprised of mostly self-employed and seasonally employed workers. In addition, because of the reliance on natural resources for production, there are millions of distinct AFF worksites: farms, forests, and fishing vessels on open waters.

The ideal AFF Program would have thorough, accurate, and up-to-date knowledge of the AFF workforce. The size, geographic distribution, seasonal variations in employment, and demographic characteristics of the overall population and of substantial groups would be identified with reasonable precision.

There are five types of workers to consider (some examples of each are indicated):

- Self-employed workers (such as farmers, ranchers, fishermen, and loggers).
- Unpaid family workers (such as spouses, adult children, and children under 18 years old).
- Direct-hire workers (such as farm laborers, fishing vessel crews, and lumber company employees).
- Contract-hire workers (such as labor contractor employees, custom harvesters, and service company employees).
- Workers employed by larger-scale businesses.

AFF workplaces are, by their relationship to natural resources, extensive as opposed to localized; therefore, other persons may be at risk owing to their residence on or next to worksites. They may include children, spouses, or other kin of AFF workers. Minors, whether they are unpaid family workers or hired workers, are of special concern in the AFF workforce. Non-working minors who reside on a farm, near crop fields, or adjacent to livestock facilities are also of concern as they may face exposure to hazards normally associated with employment. The occupational safety and health of minors working in agriculture is addressed in federal law and in several state laws (see Appendix F). A few farm family health and hazard surveillance studies have included women in the study populations, and reports have been published on work-related injuries (Xiang et al., 1997; Stallones and Beseler, 2003). Some studies have documented the extent of women's contribution to work in agriculture and their risk of injuries (Engberg, 1993; Xiang et al., 1997; Reed et al., 1999; McCoy et al., 2001; Stallones and Beseler, 2003; Stallones, 2004); however,

little has been done in either forestry or fishing. The ideal program's extramural research review process would include gender-related studies, because women have thus far received little attention as a group of concern.

The committee established a detailed analysis for the ideal AFF Program to identify various AFF workforce populations in Appendix E.

Health Effects Research

Investigation of health effects in AFF would be the foundation of the AFF Program. Health effects to be studied include those caused by physical, chemical, and biological hazards. The health effects would include traumatic injury, hearing loss, cancer, musculoskeletal conditions, lung disorders, dermatological conditions, psychosocial effects, mental health disorders, and zoonotic diseases. Tuberculosis is a persistent problem and would also be studied in AFF workers, because it is transmitted in the work setting and disproportionately affects AFF workers. The physiological effects of working in extreme temperatures and of exposure to vibration from tools would also be explored in AFF workers. The relationship between incentive pay, worker productivity, and product quality has been studied (Billikopf, 1985), but the health effects of incentive-based pay systems—such as piece rate that is widely used in agricultural harvest work and other forms of incentives to increase worker productivity—remains unknown and needs to be examined. There is also an urgent need to investigate the effects of shift work and other causes of work-related sleep deprivation on AFF workers. The results of all those studies will be the foundation of intervention research in the AFF Program. A key element of intervention research is to disseminate research findings to AFF workers, company safety officers, Cooperative Extension agents, and public health workers. The existing NIOSH Ag Centers could play a larger role in this effort than they have to date. Means of disseminating information relevant to forestry and fishing will have to be devised. Accurate evaluation of the results of the dissemination effort would be part of the dissemination plan. Epidemiological research, toxicological research, laboratory-based physical and safety risk factor research, and exposure assessment research would be conducted as part of the ideal AFF Program.

Epidemiological Research

An ideal research program would use the surveillance results to identify target illnesses for further epidemiological study. Appropriate study designs for discerning disease associations and causation, such as long-term prospective cohort studies, would be used in such a way as to ensure that results are applicable to the overall population and important subpopulations. The ideal AFF Program would conduct population-based studies with adequate staffing to define a variety of health effects

related to production AFF. This effort would require a large financial commitment and careful coordination on a local and national level. Some critical work aimed at answering many important questions can be done only with a multicenter approach. The ideal program would explore emerging topics, including genetic susceptibility to health effects of AFF exposures. Gene-environment interactions relevant to various illnesses and injuries common in AFF workers would be explored with a combination of laboratory and clinical methods in the new field of genetic epidemiology. The risk of zoonotic disease transmission has emerged as a concern; specifically, there have been several cases of avian influenza A (H5N1) transmission from birds to humans in Asia and Europe (CDC, 2007), and this could emerge as a threat to U.S. poultry handlers if the disease spreads to the United States. Challenges to conducting large epidemiological studies include the resources required and the diversity of the AFF industries with regard to regions, occupations, methods, and exposures. Existing collaborations between NIOSH and other agencies conducting the Agricultural Health Study could be expanded to avoid duplication of efforts.

Toxicological Research

The ideal AFF Program would have partnerships with other agencies and organizations, including chemical manufacturers, to ensure that toxicological studies are performed to characterize mechanisms of health effects and disease in connection with all exposures relevant to AFF occupations. Challenges would include the resources required for detailed toxicological studies, the logistics of partnering with other agencies to influence direction, and the large number of chemical, physical, and biological agents to which AFF workers are exposed.

Laboratory-Based Physical and Safety Risk-Factor Research

The ideal AFF Program would have access to state-of-the-art laboratory facilities adequately equipped to conduct the research needed to characterize safety risk factors for each AFF occupation. The program would also work closely with the manufacturers of equipment identified as being most often associated with injury exposure. Challenges include the resources required, including physical facilities, technical expertise, and partnerships with equipment manufacturers.

Exposure Assessment Research

The ideal AFF Program would have projects in place to ensure that exposures to physical, chemical, and biological agents in the AFF industries that cause injury or illness are fully characterized. Typical exposures, ranges of exposures, and exposure

distributions would be characterized. The ideal AFF Program would develop convenient and effective clinical methods for detecting and characterizing exposures and disease in the populations at risk. Tests would be economical, noninvasive, field-ready, and reliable. Exposure assessment algorithms would be developed for use in retrospective epidemiological studies and prospective studies. Ideally, exposure assessment would be a continuous part of prospective cohort studies. Where resources limit the establishment of large cohorts, exposure assessment activity on a smaller scale would form the basis of algorithms for use in quantifying exposure in epidemiological studies. Challenges include financial resources, technical expertise and limitations in available technology, the variability of exposures among the different AFF occupations, and the extreme diversity of chemical, physical, and biological agents to which workers are exposed. The ideal AFF Program would take into consideration the complex mixtures of chemicals and environmental factors to which workers are routinely exposed.

Intervention Research

Intervention research has been described as the study of planned and applied activities designed to achieve desired outcomes (Goldenhar and Schulte, 1994), and focuses on the examination of the efficacy of new and existing prevention strategies in the workplace (Rosenstock, 1996). In explaining a commitment to increase extramural and intramural support in 1996, NIOSH Director Linda Rosenstock stated that it was important for NIOSH to use intervention research more aggressively to provide a mechanism of evaluation that goes beyond investigation, identification, and recommendations (Rosenstock, 1996). Given the focus on intervention research and the development of guideline documents for evaluating the effectiveness of interventions (see Figure 2-1) (Goldenhar et al., 2001; Robson et al., 2001), it is appropriate to consider an ideal or benchmark intervention research program in describing the ideal AFF program.

The ideal or benchmark intervention research program would have the following characteristics:

- A comprehensive surveillance program to ensure that the incidence of acute and chronic illness and injury, relevant exposures and risk factors, and the affected populations can be fully characterized.
- Funding, facilitation, and promotion of intervention research that focuses on the highest-priority populations and problems (identified through surveillance) and that is conducted according to established and accepted theory and frameworks related to development, implementation, and evaluation.

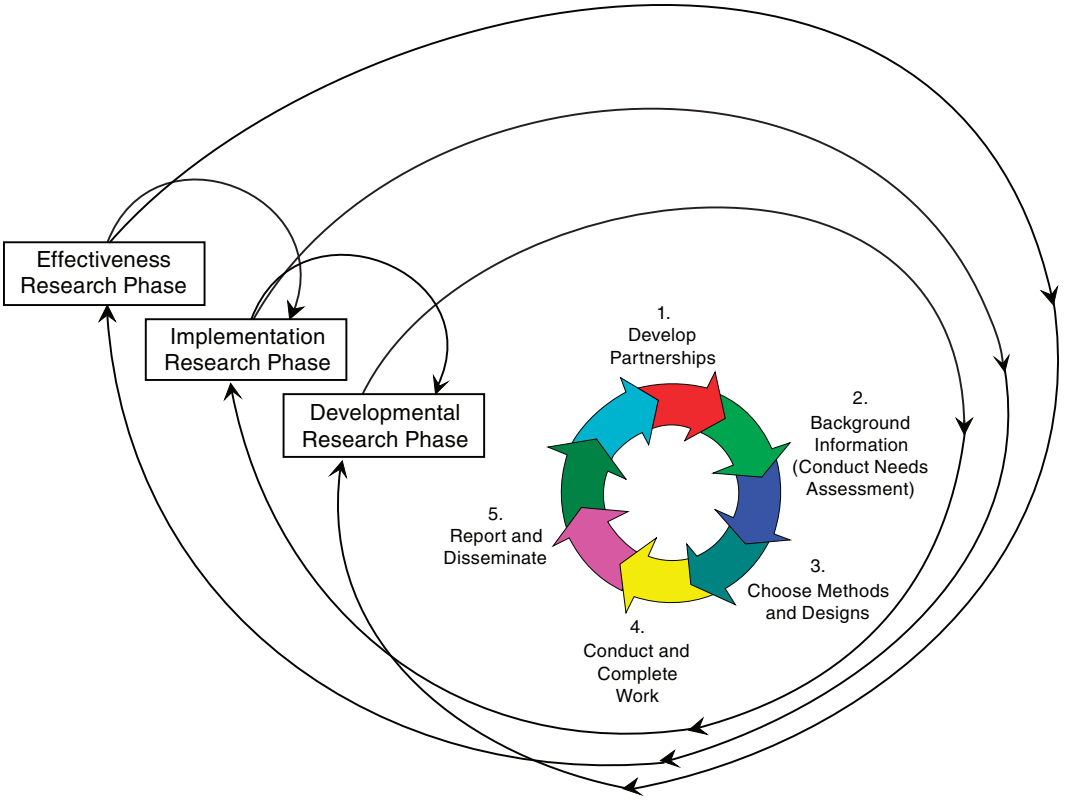

FIGURE 2-1 The intervention research framework and phases.
SOURCE: Adapted by L.M. Goldenhar from Goldenhar et al., 2001.

- Funding mechanisms that allow for the evaluation of long-term effectiveness.
- Support of long-term prospective cohort studies of which intervention research is a substantial component.
- Preference of research on engineering intervention strategies when feasible but consideration of administrative and personal or behavioral intervention research when appropriate.
- Partnerships with production equipment and personal protective equipment manufacturers throughout the process to assist in identifying good candidates for modification and to facilitate testing and deployment of new control technologies.

- Intervention effectiveness research conducted according to scientific standards.
- Ensuring that detailed results are disseminated quickly and effectively so that all stakeholders are aware of both successful and unsuccessful intervention strategies.
- High visibility at all levels in each of the industries and active engagement in community-based participatory programs to deploy effective interventions and disseminate information.
- Evaluation mechanisms to measure the effectiveness of different strategies for implementing controls and transferring information.
- A group devoted to evaluating policy development and potential effects on implementation of control strategies for reducing injury and illness in AFF industries.
- Extensive involvement in research to characterize and identify the best strategies for implementing new control approaches.
- Development and use of objective measures for assessing the cost-effective distribution and acceptance of control strategies.
- Coordination and sharing of activities and results across all intramural and extramural research groups and external partners to avoid duplication of efforts and to ensure dissemination of effective strategies.
- Established effective national networks for rapid dissemination of relevant intervention strategies to users.
- Readily available results of all intervention research to anyone interested and in a standardized format that allows for quick determination of the relevance and likely effectiveness of a given strategy for another application.

Health Services Research and Training

The ideal AFF Program would fully describe access to occupational health services for each AFF industry in all regions and for all subpopulations. All important barriers to obtaining such services would be identified and characterized. The program would then use strategies that allow effective delivery of occupational healthcare services to all populations at risk in each industry. When feasible, health promotion and preventive health services would also be offered. The workplace is the primary location at which those services are delivered to many workers, and this justifies the allocation of occupational health resources to meet general wellness needs.

A special effort will be required to integrate health services research into the NIOSH agenda. Health services research is central to the NIOSH agenda and would be conducted in both intramural and extramural settings. A substantial propor-

tion of resources would be devoted to extramural, competitive grant programs that complement intramural research. Approaches may be specific to industries, occupations, regions, and workforce demographics. Each of the three sectors—agriculture, forestry, and fishing—would receive resources for health services research in an equitable way that is proportionate to injuries and illnesses affecting their worker populations. An effort would be made to nurture the careers of young investigators engaged in occupational health services research. Training programs for occupational safety and health students and practitioners pertinent to all aspects of occupational health relevant to AFF would be further developed, including training for subspecialist physicians with expertise in areas such as pulmonary disease and allergies. The existing NIOSH training of rural nurses with occupational expertise would be expanded. Barriers to completing this work include the historic difficulties encountered when attempting to insert material on occupational and environmental health relevant to all aspects of AFF into the curriculum for health professions students. Existing programs would be reviewed for the relevance of their content and approach. Monetary support of training programs would be offered to fill a gap left by waning institutional support of such programs.

The ideal AFF Program would seek new ways to reach worker populations with preventive services and information. The possibilities include partnerships with workers' compensation insurance carriers to improve characterization of the incidence of illness and injury in the AFF industries and to quantify and control costs. The AFF Program could also work with WC carriers to develop and implement strategies for reaching workers with training materials to increase their awareness of key health and safety topics and to offer incentives for reduction in occupational illness and injury. Incentive-based programs carry the possible danger that workers may be discouraged from reporting injuries or illnesses, but new research is needed to more fully document the impact of such programs. To implement such a program, WC insurance companies would need the cooperation of employers that purchase their insurance, because insurance companies ordinarily do not have direct access to workers unless a claim is filed. NIOSH could play a key role in facilitating such relationships by preparing educational materials and interpreting injury and illness data.

Knowledge Diffusion and Technology Transfer

For research and technological development to be effective, people at risk of disease or injury would need to apply the information that results from such research and technological development. Knowledge diffusion makes it possible for new information to be shared beyond the narrow confines of researchers. AFF workers can be difficult to reach because they do not work in well-defined settings

and often are not native English speakers. New approaches need to be developed to reach such disparate groups. In some instances, research is needed to develop new approaches and to evaluate their effectiveness and efficiency in reaching the at-risk population. That would be a critical activity in the ideal AFF Program.

Technology transfer refers to the application of new approaches that can reach at-risk working populations. There are opportunities to develop highly technical approaches to reducing illnesses and injuries among AFF workers, but these approaches would need to be useful in extreme work conditions with highly variable temperatures and weather conditions and with minimal disruption of work productivity. Field testing of new equipment and approaches is essential in an ideal AFF Program because the work environments of farmers, hired farm workers, loggers, and fishermen are substantially different from those in manufacturing and other work settings.

Public Policy and Regulatory Advice

As the research arm in occupational safety and health, the ideal AFF Program would offer independent, scientifically sound advice to inform public policy and assist regulatory agencies in protecting AFF worker populations. Research would include retrospective cohort studies that aid decisionmaking and inform regulatory activities to reduce workplace injury and illness. In Appendix F, the committee provides detailed information about federal and state policies and regulations that directly affect AFF workers.

Program Evaluation Initiatives

Effective periodic evaluation throughout the NIOSH process as indicated in the logic model is crucial. All aspects of the AFF Program—including activities, outputs, and outcomes—need to be evaluated for relevance and impact. Assessment of the impact of such programs and use of the assessment results in priority-setting are essential. For such assessment to be useful, the program needs both clear and repeatable processes for tracking and collecting information on fatalities and injuries. Robust surveillance data constitute an absolute foundation for quantitatively measuring program impacts.

In some cases, research initiatives would be evaluated on an ongoing basis by third-party professionals who contract directly with the AFF Program. Whenever practical, interventions developed by the AFF Program would rely on the "gold standard" of evaluation: comparing workers exposed to the hazard with all or randomly selected non-exposed workers. An essential element of evaluation is transparency, which can be enhanced by holding local, regional, or national con-

ferences at which information derived from basic and applied research and from surveillance is exposed to public scrutiny.

In addition to internal and external program reviews, overall program evaluations can provide a high level of evaluation of the overall NIOSH program, with examples including recent National Academies studies (IOM and NRC, 2006; NRC and IOM, 2007). Such reviews are essential to help NIOSH maximize its impact on safety and health.

3

Overall Program Assessment

INTRODUCTION

Agriculture, forestry, and fishing are three distinct sectors with disparate workforce populations, relevant stakeholders, and occupational concerns. The committee initially attempted to conduct a separate evaluation of the National Institute for Occupational Safety and Health (NIOSH) research program in each of those sectors. After considering information provided by the NIOSH Agriculture, Forestry, and Fishing Research Program (the AFF Program) and discovering that agricultural safety and health represented nearly 99% of the program's resources, the committee decided instead to evaluate the AFF research program as a whole. The committee focused its evaluation on research in agricultural safety and health but also assessed safety and health efforts in forestry and fishing to the extent that information was provided by NIOSH.

The committee provides an overall evaluation of the AFF Program's strategic goals, including "external" factors that, although beyond the program's control, affect its activities and performance. It then identifies other important activities that the AFF Program ought to pursue and is pursuing: identifying and engaging stakeholders, conducting health services research and training, carrying out program evaluation initiatives, and providing input to public policy. Finally, the committee highlights an element that in many ways has the characteristics of the ideal AFF Program described in Chapter 2.

AGRICULTURE, FORESTRY, AND FISHING RESEARCH PROGRAM GOALS

The AFF Program identified five major goals consistent with its congressional mandate: surveillance, special populations at risk, health effects of exposure to agricultural agents, control systems, and outreach (see Box 3-1). The committee evaluated each major goal and compared programmatic components of the existing program with those of the ideal AFF Program described in Chapter 2. The committee chose to rename the major goals so that their names would better encompass and depict the subjects that the AFF Program had identified: surveillance (Chapter 7), populations at risk (Chapter 8), health effects research (Chapter 9), intervention research (Chapter 10), and knowledge diffusion and technology transfer (Chapter 11).

Following the guidance of the Framework Document, the committee carried out its evaluation by using the terminology and organization of a logic model

BOX 3-1
Major Goals of the AFF Program

Goal 1: 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.

Goal 2: Priority 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.

Goal 3: 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.

Goal 4: Hazard-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.

Goal 5: Outreach—Reduce injuries and illnesses by informing and educating employers and employees in AFF about occupational safety and health hazards and control systems.

SOURCE: NIOSH, 2006a.

adopted by NIOSH to characterize the steps in the committee's work. An examination of goals, inputs, activities, and outputs was used to assess the relevance of the program's research. Intermediate outcomes and end outcomes were examined to evaluate the impact of the program's research. Illustrative examples of each of those terms, as defined by the Framework Document and used in this report, are provided in Box 3-2.

Evaluation of Strategic Goals and Objectives

The AFF Program's stated goals are general and appear appropriately aligned with congressional mandate, but they do not include specific measurable objectives that would guide the subprograms and allow for assessment of progress. Furthermore, it does not appear that strategic goals have been developed specifically for each sector, that is, agriculture, forestry, and fishing. The committee requested additional information from NIOSH regarding the strategic plan for the AFF subprograms and questioned whether there were separate plans for each sector. The NIOSH response indicated that although a series of informal planning meetings focusing on safety and health research in agriculture was organized in the early 1990s, management of the resulting projects followed the established process and structure: projects were primarily investigator-initiated and proposed to meet needs described in general plans but with very little institute-wide tactical planning or programmatic management. Each NIOSH division then made annual continuation and funding decisions on the basis of perceived need on a project-by-project basis (NIOSH Response to Committee Questions 1-3, see Appendix C).

In 1996, on the basis of input from more than 500 stakeholders, NIOSH presented the National Occupational Research Agenda (NORA) that identified 21 priority research areas in the broad categories of Disease and Injury, Work Environment and Workforce, and Research Tools and Approaches. Priority research included traumatic injuries, special populations at risk, control technology and personal protective equipment, intervention effectiveness research, and surveillance research methods. It appears that NORA was used in lieu of a more formalized sector-specific strategic planning process for the first decade (1996-2005).

NORA repeatedly raised the question of sector-specific research (NORA, 2000). NIOSH decided that the most effective way to integrate consideration of research in specific sectors was to apply a "matrix approach" of coordinated research in some or all of the 21 priority areas for each sector. As evidence of the success of that approach, NIOSH presented data showing roughly half the NIOSH NORA research funds for FY 2000 going to agriculture ($8.3 million), construction ($9.3 million), mining ($12 million), and healthcare ($5.1 million). However, it is not clear whether funds spent in those sectors were directed toward projects that would

BOX 3-2
Logic Model Terms and Examples

Planning Inputs: Stakeholder input, surveillance, and intervention data, and risk assessments (e.g., input from Federal Advisory Committee Act panels or the National Occupational Research Agenda research partners, intramural surveillance information, Health Hazard Evaluations [HHEs]).

Production Inputs: Intramural and extramural funding, staffing, management structure, and physical facilities.

Activities: Efforts and work of the program, staff, grantees, and contractors (e.g., surveillance, health effects research, intervention research, health services research, information dissemination, training, and technical assistance).

Outputs: A direct product of a NIOSH research program that is logically related to the achievement of desirable and intended outcomes (e.g., publications in peer-reviewed journals, recommendations, reports, website content, workshops and presentations, databases, educational materials, scales and methods, new technologies, patents, and technical assistance).

Intermediate Outcomes: Related to the program's association with behaviors and changes at individual, group, and organizational levels in the workplace. An assessment of the worth of NIOSH research and its products by outside stakeholders (e.g., production of standards or regulations based in whole or in part on NIOSH research; attendance in training and education programs sponsored by other organizations; use of publications, technologies, methods, or recommendations by workers, industry, and occupational safety and health professionals in the field; and citations of NIOSH research by industry and academic scientists).

End Outcomes: Improvements in safety and health in the workplace. Defined by measures of health and safety and of impact on processes and programs (e.g., changes related to health, including decreases in injuries, illnesses, or deaths and decreases in exposures due to research in a specific program or subprogram).

External Factors: Actions or forces beyond NIOSH's control (e.g., by industry, labor, regulators, and other entities) with important bearing on the incorporation in the workplace of NIOSH's outputs to enhance safety and health.

SOURCE: Framework Document (see Appendix A).

be identified by stakeholders as having the highest priority. And it is unclear how the manager or coordinator of a sector-specific research program (such as the AFF Program or the Mining Program), even if armed with a well-defined, clearly described strategic plan with detailed measurable objectives, could influence allocation or direction of resources to achieve sector-specific goals.

NIOSH is currently restructuring its research portfolio (NORA 2). The research programs will be subdivided into eight NORA sector programs based on industry-sector groups; 15 NIOSH cross-sector programs based on occupational health outcomes, statutory programs, and global health efforts; and seven NIOSH-coordinated emphasis areas, which are cross-cutting programs to be integrated into the sector and cross-sector programs (FY07 Project Planning Guidance in NIOSH, 2006a). Each of the 30 research programs will have a manager and coordinator.

AFF is one of the eight sector programs and is developing strategic goals. The Office of Management and Budget (OMB) requires that the strategic goals be organized by outcomes, such as reductions in injuries and illnesses, instead of more general topics, such as reducing all occupational mortality in AFF industries. That approach would yield specific targeted outcomes, performance measures for evaluating progress toward meeting outcome goals, and intermediate objectives necessary to meet goals. NIOSH identified the following challenges to setting such goals (available at *http://www.cdc.gov/niosh/programs/agff/goals.html*):

- The focus is on a subgroup of issues where NIOSH can have an impact. A long list would spread resources too thin; not all worthwhile topics can be included.
- It is difficult to develop performance measures. Injury statistics have limitations, and exposure and health outcome measures are often unavailable.
- NIOSH is a research agency and so it does not often directly influence outcomes. It is ambitious to set goals to achieve such outcomes as reductions in a national mortality rate; NIOSH would need to form effective partnerships and influence other groups to show results.

On the basis of that information, it appears that the AFF Program will be moving toward an improved strategic planning process that will entail development of well-defined, clearly described goals with measurable objectives. However, it remains to be seen whether the complex nature of this program portfolio matrix will facilitate or hinder research planning, implementation, communication, and assessment. It was noted that intervention effectiveness research no longer has specific emphasis in NORA, although it would probably fall in the AFF sector or appropriate cross-sector programs or coordinated emphasis areas, such as personal protective technology or engineering controls.

Inputs

Planning Inputs

Planning inputs include surveillance data, stakeholder needs, partner aims, information emanating from symposia and conferences, program evaluations, and program goals. Complete and accurate surveillance data with complete detail are critical for the success of the AFF Program and are required to define the current health status of the population at risk, identify health risks within the population, track changes in the population health risk, and identify the need for and evaluate the effectiveness of interventions. Most available data on occupational illness, injury, and hazard surveillance have relied heavily on the Bureau of Labor Statistics Survey of Occupational Injuries and Illnesses (SOII). However, the SOII has shortcomings that result in incomplete information on the AFF Program population at risk: it does not cover farming establishments with 10 or fewer full-time workers (which make up more than 95 percent of U.S. farms) and does not track injuries on farms that have no hired workers (74 percent of U.S. farms) (NIOSH, 2006a). NIOSH has attempted to fill the surveillance gaps through various means, including intramural and extramural programs in illness surveillance, injury surveillance, and traumatic death surveillance. Despite those efforts, the surveillance input remains inadequate, and the size and characteristics of the populations at risk, the health risks, and changes remain uncertain. The uncertainties hamper the ability of AFF Program personnel to plan and to evaluate the effectiveness of previously implemented programs.

Shortcomings in the program goals themselves have been described previously: the stated goals of the AFF Program are general and do not include specific measurable objectives that would guide the subprograms and allow for assessment of progress. The strategic goals do not appear to have been developed specifically for each AFF sector. Thus, progress toward measurable objectives cannot be used as a planning input to direct future activities.

The lack of more specific program goals and objectives also limits the effectiveness of program evaluations. The AFF Program has undergone several evaluations over the last decade to examine various components of the overall program (NIOSH, 2006a). The evaluations included review of the extramural cooperative agreement programs (Kennedy, 1995), review of intramural research by the subcommittee for agricultural review of the NIOSH Board of Scientific Counselors (NIOSH, 2000), and an annual self-evaluation of the NIOSH Centers for Agricultural Disease and Injury Research, Education, and Prevention (Ag Centers) orchestrated by the High Plains Intermountain Center for Agricultural Health and Safety (HICAHS). NIOSH has responded to recommendations made in the 1995 and 2000 evaluations, but the ability of those review groups to evaluate the

AFF subprograms was probably hindered by a lack of formal program goals with measurable objectives.

Planning inputs in the form of stakeholder needs, partner aims, and information on emerging issues and the effectiveness of practices and programs seem to come largely from interaction and networking at conferences and symposia. In addition, on the recommendation of the 1995 program review, NIOSH established an internal NIOSH Agricultural Steering Committee (NASC) that included representatives of all divisions engaged in the agricultural research program. The group met annually and established research priorities; however, NASC did not manage existing projects or approve new ones, so participation waned; there have been no meetings since 2003. The history of the steering committee is cause for concern because it is unclear whether the approach outlined for NORA 2 addresses the supposed causes of the lack of effectiveness, that is, will the sector-based approach give the director of the AFF Program adequate authority and resources to direct the intramural and extramural research subprograms effectively?

Production Inputs

Production inputs include budget, staff, facilities, management structure, extramural entities, and partners. Over the period 1997-2006, the annual agriculture budget averaged about $24 million (a total of $237,750,550 for 1997-2006). The funds were distributed among Ag Centers (31 percent), intramural programs (44 percent), and other extramural programs (25 percent). Of the total research budget for the 10-year period, about 57 percent ($136 million) was administered through the Office of Extramural Programs (OEP) and directed toward goals in surveillance, priority populations, health effects, control systems, health promotion, support, and the Ag Centers. The remaining 44 percent was distributed among the various divisions, laboratories, and offices performing agricultural research, including the Division of Applied Research and Technology (DART), the Division of Respiratory Disease Studies (DRDS), the Division of Surveillance, Hazard Evaluations, and Field Studies (DSHEFS), the Division of Safety Research (DSR), the Education and Information Division (EID), the Health Effects Laboratory Division (HELD), the National Personal Protective Technology Laboratory (NPPTL), the Pittsburgh Research Laboratory (PRL), and the Spokane Research Laboratory (SRL).

It is difficult to determine the total amount of funding directed specifically to intervention research in the AFF Program because detailed funding information on the Ag Centers was not provided. The lack of that information limits the effectiveness of a review of the subprograms and hinders efforts to evaluate progress toward goals. Apart from intervention research that occurs in the Ag Centers, cumulative total funding for AFF intervention research appears to be around $16 million,

which represents about 7 percent of the AFF Program budget ($238 million) for 1997-2006. That percentage, which would increase with the inclusion of Ag Center intervention research, demonstrates a substantial commitment by the AFF Program.

The annual number of NIOSH full-time equivalents (FTEs) working on agriculture has ranged from the current low of about 60 (in 2006) to slightly more than 90 in 1999. A breakdown of cumulative FTEs for the 10-year period by program goals shows about 270 FTEs (43 percent) devoted to health effects, about 140 (22 percent) to surveillance, about 110 (17.5 percent) to control systems, about 70 (11.1 percent) to health promotion, and about 40 (6.4 percent) to priority populations. That distribution reflects only NIOSH FTEs and does not show the distribution of Ag Center personnel by AFF Program goals. It is difficult to evaluate the inputs for the Ag Centers because the evidence package presents the overall funding and does not provide more detailed information on how funding was distributed among centers and toward which goals the funds were allocated.

It is difficult to assess the adequacy of AFF Program budget and staff allocations without some type of benchmark or reference research program for comparison. The AFF Program could accomplish more with additional funding, but there is no way to assess the performance of the program without additional information or metrics. Regarding staff inputs, a simple comparison of the ratio of FTEs to intramural research dollars shows that the AFF Program has a higher result (62 FTEs/$9 million = 6.9 in 2006) than other research agency or institute intramural programs, such as that of the National Cancer Institute [1766 FTEs/$687 million = 2.6 in 2006 (NCI, 2006)] and that of the National Institute of Environmental Health Sciences [468 FTEs/$167 million = 2.8 in 2006 (NIEHS, 2007)]. The ratio of FTEs to budget dollars is 5.5 FTEs/$1 million for NIOSH as a whole in 2006 compared with 0.6 and 0.9 for NCI and NIEHS, respectively. That metric may not be appropriate for comparing intramural staffing for research programs of such widely different scope and size, but the result suggests that NIOSH staffing levels are at least as high as those of other organizations when standardized according to funding levels.

Despite the fact that the total number of FTEs associated with the AFF Program seems to be adequate, the management structure and its influence on the effective use of production inputs would also need to be considered. The management structure of NIOSH is based on the divisions, laboratories, and other administrative organizational components, whereas the research programs are organized in groupings that cut across the divisions. As a result, a tabulation of FTEs for the AFF Program includes scientists and engineers in the divisions and laboratories who do not report to the director of the AFF Program. That most probably limits the ability of the AFF director to manage and allocate resources, and this limitation could

lead to the same set of circumstances that limited the effectiveness of the NASC, that is, the inability to manage existing projects or approve new ones.

NIOSH has division, laboratory, and office facilities in Pittsburgh, Pennsylvania; Morgantown, West Virginia; Spokane, Washington; Cincinnati, Ohio; Washington, DC; and Atlanta, Georgia. No information was provided regarding the condition of those facilities, so it is not possible to assess their adequacy as production inputs.

No specific production input information on extramural entities and partners was provided.

Intramural and Extramural Research

Faced with a relatively small annual budget and what was characterized by Congress as a national crisis concerning the health of farmers and other agricultural workers, NIOSH made two pivotal and far-reaching decisions. The first was to conduct intramural research in fields of science that appeared less well developed. For example, NIOSH conducted ground-breaking work in endotoxin analysis and assisted university-based scientists in describing respiratory effects of particulate exposure in intensive animal production just as that industry was undergoing marked production changes from small, family, largely outdoor operations with little human exposure to large indoor facilities with the emergence of the intensively exposed "8-hour/day" worker.

The second was to establish the Ag Centers: university-based, regionally distributed centers for research, training, and prevention (see Box 3-3). NIOSH was able to encourage regional capacity development across the nation and to take advantage of the extensive support that is a characteristic of university-based research and development. When the 1985 NIOSH-supported International Symposium on Health and Safety in Agriculture was held in Canada, the majority of the little science available was descriptive; there was almost no analytical research and virtually no advanced training or prevention programs. That NIOSH was able, in a period of less than 20 years, to stimulate the development of a legitimate scientific field with new students being trained and good science being conducted across the country has to be regarded as one of the major successes in linking government, universities, and the private sector. Notwithstanding those accomplishments, the committee concludes that a more tightly led cohesive program might have resulted in more gains for AFF workers and their families.

The move to support regionally distributed, university-based programs as a key aspect of the AFF Program has produced far-reaching effects on the quality of research and training and on the diversity of subjects studied. In establishing the university-based Ag Centers, NIOSH appears to have successfully predicted that,

BOX 3-3
NIOSH Centers for Agricultural Disease and Injury Research, Education, and Prevention (Ag Centers)

The Ag Centers were established as part of the Centers for Disease Control and Prevention (CDC) NIOSH Agricultural Health and Safety Initiative in 1990. The enabling legislation (P.L. 101-517) called for the Ag Centers to "develop model programs for the prevention of illness among agricultural workers and their families . . . and [to] educat[e] on agricultural safety and health." The centers were established as cooperative agreements that are geographically distributed to be responsive to agricultural health and safety issues peculiar to different regions of the country. At the time of this report, 10 centers were listed on the NIOSH Web site. The Ag Centers represent well over half the AFF Program investment in extramural research and constitute one of the most important contributions to the AFF Program. The centers are described briefly below.

Great Lakes Center for Agricultural Safety and Health, Columbus, Ohio

The goal of the Great Lakes Center for Agricultural Safety and Health (GLCASH) is to promote agricultural safety and health for farm, forestry, and fishery employers, workers, families, and their communities in the Great Lakes region. GLCASH serves Illinois, Indiana, Kentucky, Michigan, Minnesota, Ohio, Pennsylvania, Wisconsin, and West Virginia. Other Ag Centers overlap in some of those states; it is expected that activities in these states will be communicated and coordinated among centers. The states in the GLCASH working circle share many attributes, such as crops, farming practices, farm sizes, migrant streams, poverty in the Appalachian areas, and strong commercial fishing and timber industries.

Great Plains Center for Agricultural Health, Iowa City, Iowa

Serving Iowa, Kansas, Missouri, and Nebraska, the Great Plains Center for Agricultural Health is dedicated to one central goal: finding ways to protect and promote the health and safety of farmers, farm workers, their families, and their neighbors.

High Plains Intermountain Center for Agricultural Health and Safety, Fort Collins, Colorado

The High Plains Intermountain Center for Agricultural Health and Safety (HICAHS) is dedicated to the improvement of the occupational health, safety, and well-being of the residents of Colorado, the High Plains, and the Rocky Mountain region. HICAHS has served the agricultural population of Public Health Service Region VIII (Colorado, Utah, Wyoming, Montana, North Dakota, and South Dakota) for more than 10 years. The overarching goals of HICAHS are to reduce agricultural injury and illness through focused research, education, and intervention.

continued

BOX 3-3
Continued

National Children's Center for Rural and Agricultural Health and Safety, Marshfield, Wisconsin

The National Children's Center for Rural and Agricultural Health and Safety provides guidance for childhood injury prevention programs in the private and public sectors; guides and supports efforts of major agriculture-related organizations in identifying potential interventions to protect children from agricultural hazards; convenes consensus development sessions to address complex or controversial issues in childhood injury prevention; addresses rural recreational safety, including horses and all-terrain vehicles; provides technical assistance and training for professionals on youth-safety issues; collaborates with major agricultural organizations, health and safety professionals, and youth-serving groups; and enhances communication linkages among child-safety advocates in the public and private sectors.

Northeast Center for Agricultural and Occupational Health, Cooperstown, New York

The New York Center for Agricultural Medicine and Health (NYCAMH) was established by the New York state legislature in 1988. Recognizing the unacceptably high rates of occupational injury and illness in New York's largest industry, the legislature charged NYCAMH to provide research into the causes and prevention of agricultural injury and illness, education and prevention activities in the farm community, education of professionals serving the farm community, and clinical help for farm-related health problems. In addition to its state mandate, NYCAMH has been designated by NIOSH as the Northeast Center for Agricultural Safety and Health (NEC). Serving a 13-state region from Maine through Virginia, NEC promotes farm health and safety research, education, and prevention activities.

Pacific Northwest Agricultural Safety and Health Center, Seattle, Washington

The Pacific Northwest Agricultural Safety and Health (PNASH) Center works with the farming, forestry, and fishing industries to improve workplace safety and health in Washington, Oregon, Idaho, and Alaska. The main research focus is on developing interventions to reduce injuries and illnesses. The PNASH Center extends the knowledge gained to employers and workers through outreach and professional education.

Southeast Center for Agricultural Health and Injury Prevention, Lexington, Kentucky

The mission of the Southeast Center for Agricultural Health and Injury Prevention is to develop and sustain an innovative program of research, education, and health advocacy to prevent work-related illness and injury and to improve the safety and health of agricultural workers and their families in the southeastern United States. The center serves stakeholders in Kentucky, Tennessee, Alabama, Mississippi, North Carolina, South Carolina, Florida, Georgia, West Virginia, and Virginia.

BOX 3-3
Continued

Southern Coastal Agromedicine Center, Greenville, North Carolina

The Southern Coastal Agromedicine Center is an integral component of the North Carolina Agromedicine Institute. The center extends the reach of the institute's activities through the involvement of partner states in Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Florida, Puerto Rico, and the Virgin Islands. These states and territories face many common agromedicine issues related to climate, crops, strong timber and fishing industries, a large migrant worker population, and endemic rural poverty.

Southwest Center for Agricultural Health, Injury Prevention, and Education, Tyler, Texas

The mission of the Southwest Center for Agricultural Health, Injury Prevention, and Education is to foster, disseminate, and evaluate activities related to health, injury prevention, and education among agricultural interest groups to promote health and safety practices among agricultural workers and their families in New Mexico, Texas, Oklahoma, Arkansas, and Louisiana.

Western Center for Agricultural Health and Safety, Davis, California

The Western Center for Agricultural Health and Safety is a comprehensive, multidisciplinary program dedicated to the understanding and prevention of illness and injury in western agriculture. The center is affiliated with the University of California, Davis Medical School and the Department of Public Health Sciences. The center conducts extensive surveillance and documentation of health needs. Research focuses on small particulate matter and respiratory health.

SOURCE: NIOSH, 2007a.

by and large, the centers would be responsive to regional issues. That the budgets for the Ag Centers have been generally modest appears to have reflected NIOSH's understanding that in an extremely diverse set of industries, the AFF Program could aspire to be only representative, not comprehensive. Given the budget amounts available to NIOSH and the magnitude of the task, the committee believes that that was a prudent approach.

Funding and Review Extramural research is funded by two different mechanisms: cooperative agreements and research grants (such as R01 or R21 grants). The Ag Centers are funded through cooperative agreements, and individual researchers or groups of investigators are funded through traditional research grants. The

committee believes that there has been too much reliance on the latter for national direction on AFF research issues. National priorities would stem from AFF Program leadership to guide extramural research efforts; cooperative agreements provide structure for specific responses to AFF issues, while the research grants maximize investigator interests and competencies.

Stakeholder Input

The AFF Program organized or participated in numerous conferences, symposia, working meetings, and so on, devoted to engaging stakeholders in discussions of vulnerable working populations and small operators. Some activities are found in Table 3-1. The Iowa Center for Agricultural Safety and Health has sponsored regional and national symposia structured around specific AFF issues, such as the national agricultural research agenda (1992 Surgeon General's Conference on Agricultural Health and Safety), design of occupational and environmental medical

TABLE 3-1 Conferences, Symposia, and Working Meetings to Engage Stakeholders

Conference	Year
CHILDHOOD AGRICULTURAL INJURY	
Surgeon General's Conference on Agricultural Safety and Health	1991
Childhood Agricultural Injury Prevention Symposium	1992
Child and Adolescent Rural Injury Control	1995
4th International Symposium: Rural Health and Safety in a Changing World	1998
Agricultural Safety and Health in a New Century	2000
National Occupational Injury Research Symposium	2000
Federal Interagency Working Group on Preventing Childhood Agricultural Injuries	2001
National Institute for Farm Safety—Annual Meeting	2001
2001 Summit on Childhood Agricultural Injury Prevention	2001
National Injury Prevention and Control Conference	2005
MINORITY POPULATIONS	
Expert Panel on Hired Farmworker Occupational Health and Safety	1995
LOGGING	
Three workshops devoted to helicopter logging standards in Alaska	1993-1997
FISHERMEN	
Fishing Industry Safety and Health (FISH) Workshop	1992
FISH II Workshop	1997
1st International Fishing Industry Safety and Health (IFISH) Workshop	2000
IFISH II	2003
IFISH III	2006

SOURCE: NIOSH, 2006a.

capacity within Education and Research Centers and the Ag Centers (1988 Institute of Agricultural Medicine and Occupational Health), conducted annual training since 1996 of healthcare professionals who prevent and treat occupational illnesses and injuries occurring on agricultural premises, studied violence prevention within rural areas (1992 Conference on Handgun Injuries: A Public Health Approach), and responded to the agricultural tractor-related death and injury crisis in the United States (1997 Tractor Risk Abatement and Control: The Policy Conference) (Donham et al., 1998). Both the High Plains Intermountain Center for Agricultural Health and Safety and the Southwest Center for Agricultural Health and Safety co-sponsored a national conference examining worker health issues associated with agro-terrorism in 2004. Additionally, the Southeast Center for Agricultural Health and Injury Prevention led the effort from 2005-2007 to assess farmer and rancher attitudes towards retrofitting older agricultural tractors as a part of the National Agricultural Tractor Safety Initiative. The Western Center for Agricultural Safety and Health assembled a multi-disciplinary team from the United States and Canada in 2006 to assess the ergonomic and anthropometric parameters of the North American Guidelines for Children's Agricultural Tasks (NAGCAT) pertaining to tractor operations.

In January 2007, the High Plains Intermountain Center for Agricultural Health and Safety prepared a report evaluating the 10 Ag Centers, and found that the centers collectively produced over 800 products and reached about 4.2 million people.

Responsiveness to Stakeholder Input

Much of the interaction between AFF Program personnel and stakeholders occurs at formal meetings, conferences, and symposia and through NORA town hall gatherings. It is apparent that there is also extensive interaction among investigators and research staff and the stakeholders who partner or participate in research activities. There are numerous examples in the project descriptions of activities that undoubtedly provide opportunities for stakeholders to offer input. However, despite those opportunities and NIOSH's response to stakeholder input, only a small fraction of all stakeholders participated in the process and felt that they were actively engaged in AFF Program efforts.

There is also a conceptual gap between seeking stakeholder involvement and actually engaging stakeholders, given the large numbers of AFF workers. Convening a conference or a public gathering, in the manner generally used by federal agencies, normally brings "the usual suspects" to the forefront. Advocacy groups claim to speak on behalf of various AFF workers and are often readily able to participate in the types of gatherings described above, whereas a paucity of AFF workers speak on their own behalf. This gap is not entirely the fault of the agency; it is difficult to

engage important segments of the AFF workforce, especially non-English speaking workers, or the large numbers who lack authorization for U.S. employment.

Special efforts are clearly needed to reach and engage workers in settings that they feel comfortable in, and the AFF Program staff in general has yet to show inclination to initiate direct worker involvement. The notion that simply "hearing" what stakeholders and their representatives have to say about workforce needs is sufficient for input is wrong. A more meaningful way to engage stakeholders would be to directly include them in ongoing discussions of designing and implementing AFF research.

Consistency of Production Inputs with Program Goals and Objectives

Considerable resources are being directed toward achieving the goals of the AFF Program. It is difficult to assess the adequacy of production inputs given the lack of detail regarding the distribution of Ag Center funding and how it is directed toward program goals. The management structure of NIOSH seems to limit the role of AFF Program personnel in directing resources, managing projects, and evaluating progress toward measurable objectives. The lack of a formal strategic planning process with stated aims and measurable objectives exacerbates the problem of management structure and hampers program evaluation. If the role of the AFF Program management is only to compile and manage information, there are substantial shortcomings in the current process for compiling, categorizing, coding, and sorting through the large quantity of information related to the activities, outputs, and outcomes of the various projects.

Activities

Promotion of Activities: Quantity and Quality

The committee found no evidence that inputs were squandered or devoted to activities unrelated to the defined program goals. A more difficult and more important question is whether the limited resources were allocated in a way that would maximize the impact on the highest-priority subjects for the program. The general nature of the program goals and the lack of a more formal strategic planning process with measurable objectives make it difficult to determine how well the inputs were used.

Adequate surveillance data are important for achieving an effective AFF Program, and there are recognized problems with the available sources of surveillance data for AFF populations; the inputs might not be adequate. On the basis of budget information provided in the evidence package (Figures 2-9 and 2-10 in NIOSH,

2006a), about 15 percent of AFF funding has been allocated to surveillance (Ag Center allocation to surveillance unknown). Additional surveillance efforts occur with respect to high-priority populations and would increase surveillance funding, but the amount cannot be determined from the data provided. As mentioned previously, the distribution of FTEs by AFF Program goals (Figure 2-14 in NIOSH, 2006a) shows a disproportionate number devoted to health effects (roughly twice that to surveillance). There may be valid logistical reasons for program goals to require different levels of personnel, but it is unclear why a goal that is fundamental to the success of the AFF Program (surveillance) would require so many fewer FTEs. Even if high-priority population FTEs (about 40) are combined with surveillance FTEs (about 140), the total (180) is still much lower than the number for health effects (about 270).

The distribution of intramural and extramural funding across the AFF Program appears to be roughly comparable (about $30-40 million) for surveillance and health effects over the period 1997-2006 (Figure 2-9 in NIOSH, 2006a). Again, given the critical nature of surveillance, an equal distribution of resources across the goals may not be the most effective strategy. AFF Program leaders, stakeholders, partners, and so on would need to first determine what resources would be required to establish a comprehensive surveillance program for AFF populations, implement the strategy, and then use the resulting data to allocate remaining resources and direct research in the other subjects.

Planned Transfer Activities

The most recent request for application (RFA) for Ag Centers (PAR-06-057) states specific goals requiring elements of transfer activities. These include the development, implementation, and evaluation of education projects; providing consultation or training to researchers, safety and health professionals, and agricultural extension agents; development, implementation, and evaluation of model programs for prevention of illness and injury; and development of linkages and communication with other government and non-government bodies involved in agricultural health and safety with emphasis on communication with other agricultural safety and health programs. Those requirements ensure that Ag Centers engage in some minimal amount of transfer activity. That is not to suggest that the centers are not now engaged in transfer activities; centers undertake extensive education and outreach activities as described in the comprehensive reports in the evidence package.

Although the AFF Program does not have a planned set of transfer activities, it has funded the development and maintenance of the National Agriculture Safety Database (NASD). That project established a national central repository of

agricultural health, safety, and injury prevention materials for the agricultural community and agricultural safety specialists. The goals of the NASD are to provide a national information resource for the dissemination of information; disseminate information to agricultural workers on prevention of occupational hazards associated with injury, death, and illness; promote the consideration of safety and health issues in the management of agricultural operations; and provide a convenient way for the agricultural safety and health community to share educational and research materials.

Peer-Review Process

The peer-review process for intramural and extramural research programs is a strength of the AFF Program. Ag Center activities are supported under an RFA process specifically requiring centers to include prevention or intervention programs that address agricultural safety and health. The most recent RFA (PAR-06-057) says that Ag Centers will

1. Conduct research studies related to the prevention of occupational disease and injury in agricultural producers, workers, and their families.
2. Develop, implement, and evaluate education projects for promoting health and safety for production agriculture, forestry, and fishing, including farmers, workers, and their families. This would include providing consultation or training to researchers, health and safety professionals, graduate and professional students, agricultural extension agents, and others in a position to improve the health and safety of agricultural workers.
3. Develop, implement, and evaluate model programs for the prevention of illness and injury in agricultural producers, workers, and their families.
4. Develop linkages and communication with other government and nongovernment bodies involved in agricultural health and safety with emphasis on communication with other agricultural health and safety programs.

The RFA and the peer-review process that leads to an Ag Center award ensure that there is a commitment to intervention research and specifically requires that centers include process and outcome measures of intervention research to the extent possible. The process measures are to be detailed enough to allow for replication in other fields. The outcome measures include exposure to injury hazards, knowledge of safety and health hazards, documentation of safety and health behavior change, and changes in the incidence of disease, injury, and death.

Given the management structure of the AFF Program, the peer-review process and the Ag Center RFAs are critical for ensuring that resources are directed

toward high-priority topics and that activities are consistent with achieving the program goals. The peer-review process is similarly critical for other extramural and intramural research projects. Because AFF Program personnel do not directly manage projects, the only mechanism to ensure that research funding can support projects related to AFF goals is the inclusion of the priorities in NORA *and* in the initial peer-review process that directs funding to the most relevant projects. An important disadvantage of this approach to project funding is that it assumes an adequate pool of intramural and extramural investigators who will submit high-quality proposals that target the priorities of the AFF Program. If for some reason there are not enough proposals directed toward AFF Program priorities, the funding is likely to go elsewhere. It seems likely that the NORA 2 sector-based approach will strongly encourage proposals targeting AFF priorities; under NORA 1, there were no AFF-specific priorities.

Quality-Assurance Procedures

The AFF Program lacks a program-wide approach to monitoring quality assurance. Quality-assurance controls occur mainly at the beginning of a project through the peer review of the proposal and the comments of reviewers and toward the later stages of a project when outputs are typically presented as peer-reviewed manuscripts or at professional conferences or meetings where peers have the opportunity to review and comment. Although opportunities to assess quality through review of progress reports are needed, there is usually little feedback provided to investigators through this mechanism. In general, investigators assume the responsibility for quality assurance and for oversight of a research project that will lead to credible data, analyses, and conclusions.

Outputs

In the early years of the AFF Program, conferences were the principal mechanism for evaluating progress. The conferences brought together intramural and extramural investigators to facilitate coordination of activities and promote collaboration. The conferences have included the following:

- Surgeon General's Conference on Agricultural Safety and Health (1991)
- Farm Flood Response Workshop—Implications for Agricultural Safety and Health (1993)
- First National Conference for NIOSH-Sponsored Centers (1994)
- Second NIOSH Agricultural Health and Safety Conference (1995)
- 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)
- Construction-Agriculture-Mining Partnership (CAMP) Workshop (1999)
- International Fishing Industry Safety and Health Conference (2000)
- ASH-NET Agricultural Safety and Health Conference (2001)
- Summit on Childhood Agricultural Injury Prevention (2001)
- Second International Fishing Industry Safety and Health Conference (2003)
- National Symposium on Agricultural Health and Safety (2004)
- Third International Fishing Industry Safety and Health Conference (2006)

It is not possible to characterize how well the AFF Program outputs are disseminated as a whole. Because there is no unified, program-wide approach to transfer activities, the program relies on individual centers and investigators to undertake the process of research-to-practice. In general, it is more difficult to accomplish transfer activities on a larger scale, so the projects that are most successful are probably the ones that have a manageable number of stakeholders or that have partners and existing infrastructure to facilitate widespread dissemination of outputs. The success of transfer activities also depends on the targeted audience. If the primary "consumer" of an output is the community of agricultural health and safety researchers and professionals, presentation at a professional conference or research symposium or in the peer-reviewed literature can be a highly effective means of transfer. Because of the diverse nature of the numerous intervention research projects undertaken and differences in the targeted consumers and partners, some projects are more successful than others; there is no standardized objective means of evaluating the success of transfer activities.

Intermediate Outcomes

The committee lists here a number of the contributions of AFF Program research to inform public policy and regulatory action.

State-level policies in which AFF Program research informed decision-making:

- *Morbidity and Mortality Weekly Report (MMWR)* article in August 2004 about chloropicrin drift exposure in California (CDC, 2004) provided justification of new legislation in California requiring growers to reimburse medical expenses incurred by persons injured by pesticide drift.

- Wisconsin Act 455, passed in 1996, prohibits people younger than 16 years old from driving farm tractors on public roads until they complete a tractor and machinery certification course; it was based on Agricultural Health Promotion System research in Wisconsin.
- *MMWR* article in November 1999 about illnesses associated with pesticides used to control Medfly infestations (CDC, 1999a) led the U.S. Department of Agriculture (USDA) and the Florida Department of Agriculture to adopt non-pesticide methods for Medfly control.
- Washington State Supreme Court mandated in 2000 that the Washington State Department of Labor and Industries develop a cholinesterase (ChE) monitoring program for workers handling acutely toxic pesticides. Research supported by the AFF Program in California discovered substantial limitations on the accuracy of ChE field testing and led to a new approach to optimize clinical determinations. In 1995, a Technical Advisory Group formed by the Washington department found that a ChE monitoring program was technically feasible and necessary to protect worker health. The rule was implemented by the department in February 2004.

Federal policies in which AFF Program research informed decisionmaking:

- The Occupational Safety and Health Administration (OSHA) used a 1976 NIOSH document for a proposed logging standard as a basis of the 1994 OSHA logging standard (29 CFR 1910.266). From July 1989 to October 1990, NIOSH provided three sets of comments to OSHA supporting a proposed logging rule. OSHA's final logging standard incorporated most of the comments.
- In 1999, the U.S. Coast Guard (USCG) initiated a Dockside Enforcement Program to identify and correct safety hazards identified by NIOSH in crab fishing. The program has been "institutionalized" by USCG.
- The U.S. Environmental Protection Agency (EPA) banned chlorpyrifos for residential use in 2000 partly on the basis of AFF Program neurological effect studies.
- On October 25, 1994, the AFF Program submitted comments to the U.S. Department of Labor (DOL) in response to an advance notice of proposed rulemaking regarding child labor. In its comments, the AFF Program provided recommendations for new hazardous orders for both nonagricultural and agricultural industries.
- The Youth Worker Protection Act introduced in both 2003 and 2005 by Representative Tom Lantos intended to revise child-labor law was based largely on NIOSH hazardous order recommendations released in 2002. In 2005, the CARE Act (HR 3482) introduced by Representative Lucille Roybal-Allard proposed changes in child-labor laws in agriculture and identified youth farm injury data collected

by the AFF Child Agricultural Injury Survey as a source of data to be used in an annual report on occupational injuries in youths working on farms in the United States.

End Outcomes

Aside from data provided by the Alaska Field Station and the childhood agricultural initiative, few data were available to link AFF Program research conclusively with reductions in injuries and illnesses in AFF populations. A more thorough examination of end outcomes by research goals is found in Chapters 4-8.

External Factors

The AFF Program operates in an environment shaped by many factors that it cannot control. Some are so fundamental to the nature of the program that the committee found it essential to keep them in mind for all aspects of its review.

The AFF Program is limited in its ability to effect change in the workplace because of the various stakeholders involved (Box 3-4). As a program in a research agency, the AFF Program is in a position to produce knowledge about workplace hazards that could cause injuries and illnesses and to promote the application of this knowledge in the workplace, but it is not responsible for minimizing hazardous workplace environments or ensuring worker compliance; this responsibility falls ultimately on employers, who respond to economic and regulatory imperatives. Some employers may resist implementing recommended measures in the workplace for economic reasons. Authority to establish and enforce workplace regulations lies with DOL's OSHA. NIOSH is expected to make recommendations to OSHA, but OSHA needs to consider the views of other interested parties that may have concerns that differ from those of NIOSH. Where statutory and labor exemptions apply, NIOSH faces federal regulatory constraints that make it difficult to affect worker safety and health.

NIOSH is a part of a federal agency whose agenda and budget are subject to congressional directive; this makes it difficult for the AFF Program to develop subprograms and dedicate funding for long-term research activities. As a government entity, NIOSH complies with rules and standards in seeking and submitting information. The external approval process has yet to be streamlined by other government agencies, so long delays are common and often hold up research projects and information dissemination. Furthermore, national policy developments can affect employment and harvest patterns in agriculture, forestry, and fishing. The Food Security Act (the Farm Bill), management of fisheries, energy policies, immigration policies, and trade policies are examples of policies that dictate the types

BOX 3-4
External Factors That Affect the AFF Program (as identified by NIOSH)

The extent to which research activities lead to reductions in injury, illness, or exposure is affected by stakeholder activities and inputs. Actions of industry, labor, and other entities are beyond NIOSH control and have a substantial bearing on the adoption of AFF Program outputs in the workplace. NIOSH has identified three general categories of external factors that may influence AFF Program outcomes: social conditions, economic conditions, and the current regulatory environment.

Social Conditions: NIOSH identified difficulties in identifying and working with the most effective partners as an external factor in the category of social conditions. It stated that early attempts to use the USDA extension service model to distribute research findings and outputs was abandoned to move toward application of the community nurse model in rural settings combined with an active surveillance component. No additional information on the change in tactics was provided. NIOSH also reported some difficulty in partnering with the medical community to deliver cancer-prevention messages directly to patients: It was found that physician cooperation was partial or uneven. As an example of favorable but unpredictable external factors, NIOSH noted the activities of several stakeholder organizations. The National Safety Council adopted a "Farm Safety and Health Week" and established the National Education Center for Agricultural Safety in Iowa. The American Society of Agricultural Engineers (now the American Society of Agricultural and Biological Engineers) established priorities in safety and health and initiated the *Journal of Agricultural Safety and Health*. The Farm Foundation established an agricultural safety workgroup, and a number of tractor manufacturers launched at-cost rollover-protective-structure retrofit programs. Finally, the Kellogg Foundation funded several grants that targeted sustainable interventions for special populations.

Economic Conditions: NIOSH noted a continuing decrease in the number of farmers and a corresponding increase of concentration in agricultural production. Although the number of farms has declined, the demand for agricultural products has increased. The demand has been met through the use of large-scale mechanization, improvements in crop varieties, and the use of commercial fertilizers and pesticides. The need for human labor has decreased, as indicated by an increase in labor efficiency from 27.5 acres/worker in 1890 to 740 acres/worker in 1990. Another trend in farms is the aging of self-employed principal farm operators. This "graying" of the farm population raises concerns about the long-term health of family farms. It was noted that during the period 1989-2003, farm size shifted toward the smallest and largest sales categories, and production shifted sharply to very large family farms and non-family farms. It was predicted that shifts in production away from farms in the $10,000-249,999 sales class would continue. Small farms tend to specialize in raising beef cattle and various crops, whereas large farms tend to raise hogs and higher-value crops. Some 22% of farms produced more than two commodities, and 65 percent produced one or two commodities. Medium and large farms were more likely to

continued

BOX 3-4
Continued

produce more than one commodity. NIOSH also observed that although equipment dealers have generally resisted safety legislation, some have helped with interventions by selling safety equipment and accessories.

Current Regulatory Environment: AFF sector regulation is spread across several federal agencies, and there are large gaps in the coverage and enforcement of regulation. Agricultural operations are addressed in specific OSHA standards for agriculture and general industry; however, restrictions set through the appropriations process limit enforcement of regulations to operations that employ more than 10 workers. Similar limitations apply to regulation of commercial fishing. Regulation at the state level has varied: It has been somewhat effective in states such as California and Washington with a long history of labor organizing or workforce activism, and less effective in states where self-employed labor is dominant. With respect to the latter, a notable exception is rules requiring the use of slow-moving vehicle signs on farm vehicles traveling slower than 25 mph now in place in 49 states. Most AFF workers are not covered by workers' compensation programs or do not work for entities that are required to report injuries and illnesses, so few data are available to estimate injury and illness rates and economic costs. Several federal agencies have regulatory responsibilities for portions of AFF operations: EPA regulates pesticide applicators, DOL enforces the Migrant and Seasonal Agricultural Worker Protection Act, USCG enforces standards under the Commercial Fishing Vessel Safety Act, and the Department of Homeland Security, the Federal Aviation Administration, and EPA oversee aerial applications of pesticides and fertilizers.

SOURCE: NIOSH, 2006a.

of products that a region can produce, the amount harvested, and the number of workers employed. The AFF Program can and needs to anticipate policy changes, but it is difficult to predict how the changes will affect worker safety and health.

Over the course of its information gathering, the committee came to understand the degree to which the AFF Program is undergoing change as part of NIOSH's reorganization effort in conjunction with NORA 2 and by virtue of its self-scrutiny in preparation for this committee's evaluation. The program identified new research goals and named new leadership in 2006 as it prepared for this evaluation. The program intends to develop a strategic plan through its newly formed NORA 2 AFF Sector Council, but it has deferred results from that activity until the conclusion of the present committee's evaluation.

4

Review of Surveillance Research

Surveillance is a cornerstone of public health and provides evidence of emerging hazards, illnesses, and injuries as well as providing baseline information from which to evaluate the success of intervention programs. Occupational illness, injury, and hazard surveillance has developed over the past 35 years, but due to reliance on the Bureau of Labor Statistics (BLS) Survey of Occupational Illnesses and Injuries, standard surveillance has not provided adequate information on populations who work in AFF sectors. To address the issues related to the AFF sector, AFF Program staff have attempted to identify alternative data collection systems to augment the more traditional approaches.

STRATEGIC GOALS AND OBJECTIVES

Goal 1: Hazard 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.

The strategic goal related to hazard surveillance is critical to the development, implementation, and evaluation of all AFF sector efforts. The AFF Program goal has been met with mixed results that differ by sector, population at risk, and hazardous exposures. Overall, the focus of the program has been primarily on agricultural production, pesticide exposures, Alaska fishing, children, and hired workers. Where efforts have been focused clear progress in surveillance-based

information is evident, but other areas need better and more surveillance data. Further, the surveillance data need to be used in a more systematic manner for the development of research agendas and for the development and evaluation of intervention programs.

LOGIC SUBMODEL

Information received from the NIOSH AFF Program (NIOSH, 2006a) related to inputs, activities, outputs, intermediate outcomes, and end outcomes in surveillance is summarized in the surveillance logic submodel (Figure 4-1). Several factors were missing in the creation of an accurate logic submodel to evaluate the program's surveillance efforts. No formal infrastructure for the coordination of surveillance activities was described. A schema for identification of populations at risk that merited surveillance was not provided. And, planning input from stakeholders regarding surveillance activity was not identified.

INPUTS

Planning Inputs

Congress spelled out a specific charge to NIOSH for conducting surveillance in the Senate appropriations language of 1990 (as quoted in *http://www.cdc.gov/niosh/nas/agforfish/pdfs/app2-02.pdf*): Funds were specifically earmarked for a "U.S. farm family health and hazard" surveillance program. Testimony rendered by agricultural safety and public health professions in support of the legislation was explicit that surveillance of these worksites was central to all ensuing effort. The phrase *farm family* was not intended to refer only to farmers, ranchers, and their families; rather, it referred to all persons performing tasks or residing on a farm, including hired laborers and accompanying family members. The other planning input that was referred to in the evidence package was the National Coalition for Agricultural Safety and Health report (Appendix 2-01 in NIOSH, 2006a), which suggested that adequate population-based rates were not available for agriculturally related diseases and injuries, therefore health and hazard surveys of agricultural workers needs to be conducted. In forestry, strategic planning evidence came from the Pacific Northwest Center and addressed northwest forestry only. Significant efforts related to fatal injury surveillance in the Alaska fishing sector have been conducted with evidence that Gulf Coast fishing is being addressed by one of the NIOSH Centers for Agricultural Disease and Injury Research, Education, and Prevention (Ag Centers).

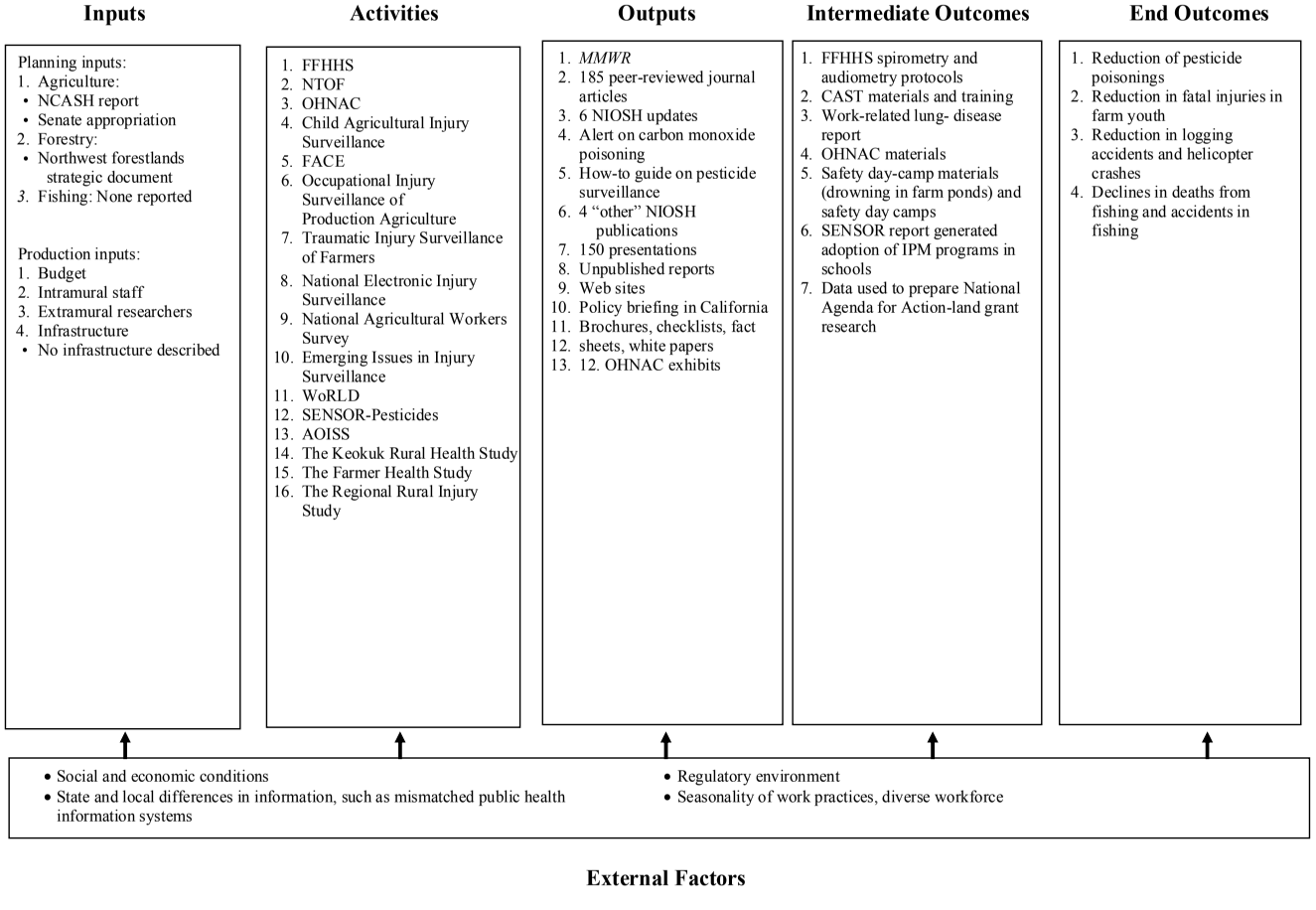

FIGURE 4-1 Surveillance logic submodel.
AOISS = Alaska Occupational Injury Surveillance System, CAST = Cooperative Agricultural Surveillance Training, FACE = Fatality Assessment and Control Evaluation Program, FFHHS = Farm Family Health and Hazard Surveillance, IPM = integrated pest management, *MMWR = Morbidity and Mortality Weekly Report,* NCASH = National Coalition for Agricultural Safety and Health, NTOF = National Traumatic Occupational Fatality Surveillance System, OHNAC = Occupational Health Nurses in Agricultural Communities, SENSOR = Sentinel Event Notification System for Occupational Risk, WoRld = Work-Related Lung Disease Surveillance Report.

Production Inputs

Production inputs include staff time, external investigators' time, and intramural and extramural budgets.

ACTIVITIES

Activities and funding related to surveillance identified in the evidence package (NIOSH, 2006a) and through review of other materials provided by NIOSH and available on the NIOSH Web site are detailed in Table 4-1. There has been substantial activity related to determining the hazards and injuries associated with agriculture, with less relative to forestry and fishing. There is little evidence of work on the surveillance for illnesses other than respiratory diseases. Absent from surveillance activities cited in the evidence package and supplemental materials were other disease and injury outcomes on the National Occupation Research Agenda (1996 to date) list (allergic and irritant dermatitis, hearing loss, infectious disease, musculoskeletal disease, and reproductive outcomes). Research on surveillance methods was also limited. AFF surveillance needs to be a major priority of the intramural program activities so that the appropriate information is used to plan future directions. Hazard surveillance has included extensive work related to the leading causes of injury-related deaths, tractors, and has focused on rollover protective structures (ROPS). FACE investigations have identified emerging problems related to AFF sector injury deaths.

Farm Family Health and Hazard Surveillance (FFHHS): These surveys were conducted with no planned long-term surveillance, and only six states were funded across the nation. A number of important issues for agricultural safety and health were identified by investigators involved in these survey and publications from these surveys continue to provide important information (NIOSH, 2006a). The degree to which the FFHHS programs interacted with the NIOSH Ag Centers has not been evaluated. Although NIOSH staff attempted to standardize data elements and definitions across the six efforts, that effort was not entirely successful, but there is limited evidence that the uniform elements were used effectively in comparative analyses (Zwerling et al., 1997b; Scarth et al., 2000). How successful the FFHHS programs were in completing surveys and generating information also varied by state. NIOSH has ensured that data obtained from the surveys can be accessed on a Web site (*http://www2a.cdc.gov/ffhhs/dictmain.asp*).

The committee identified barriers to the recommended surveillance activities. The evidence package indicates the full extent of underfunding of surveillance of hired farm laborer occupational safety (NIOSH, 2006a). The allocation of resources described in the document "Composite of Ag Budget by Goals and Program Areas"

TABLE 4-1 NIOSH Programs with Surveillance Activities

Program or Project	Division	Dates	Funding
Farm Family Health and Hazard Surveillance	DSHEFS	1990-2000	$1,540,907-2,000,000 per year for 10 years
Agriculture research, development, and planning use of state farm-family health and hazard surveys	DSHEFS	1998-2004	$1,001,616
National Traumatic Occupational Fatality Surveillance System	DSR	1984-2003	$226,663; 1990-1996, $300,000 in agriculture industry
Occupational Health Nurses in Agricultural Communities	DSHEFS	1990-2000	$15,000,000-16,000,000
Community Partners for Healthy Farming	DSHEFS	1996-2007	$6,550,341
Keokuk County (Iowa) Rural Health Study	—	1990-	Extramural unknown
The Farmer Health Study (California)	—	1990-	Extramural unknown
The Regional Rural Injury Study (Minnesota)	—	1990-1993	Extramural unknown
NEISS-CPSC sample of emergency department records and follow-up	DSR	1991-2010	$1,019,019
Work-related lung disease surveillance report	DRDS	2005-2010	Unknown
Respiratory health and hazards in agriculture report	DRDS	2000-2005	$496,321
National Agricultural Worker Survey	DSHEFS	1998-2008	$2,345,448
Childhood Agricultural Injury Prevention Initiative	DSR	2006-2015	$8,455,000
Child Agriculture Injury Prevention Initiative	DSR	1996-2010	$1,107,379
Surveillance of Occupational Injuries among Children and Adolescents	DSR	1995-1999	$13,827; 1995-1996, $9,300 in agriculture
Occupational traumatic injury surveillance of farmers	DSR	1993-1997	$40,374; 1993-1996, $1,160,000 in agriculture industry
Occupational injury surveillance in production agriculture	DSR	2001-2015	$1,725,687
Emerging problems in occupational injury epidemiology	DSR	1990-2004	$237,222
Injury risk factors in migrant and seasonal workers	DSR	1997-1998	$57,635
Traumatic injury surveillance of farmers	DSR	1993-1997	$40,374; 1993-1996, $1,160,000 in agriculture industry

continued

TABLE 4-1 Continued

Program or Project	Division	Dates	Funding
Fatality Assessment and Control Evaluation (FACE)—technical assistance	DSR	1983-2010	$406,113; 1990-1996, $552,000 in agriculture industry
Fatality Assessment and Control Evaluation (FACE)—state-based model	DSR	1988-2010	$3,476,602; 1990-1996, $1,200,000 in agriculture industry
Emerging Issues in Injury Surveillance	DSR	1985-2015	$213,751
Workplace Hazards to Children and Adolescents in Agricultural Work Settings	DART	1997-2000	$1,127,468
Occupational Injury Prevention in Alaska	Alaska Field Station	1990-2010	$3,388,092
SENSOR-Pesticides	DSHEFS	1987-2010	$1,554,918

NOTE: CPSC = Consumer Product Safety Commission, DART = Division of Applied Research and Technology, DRDS = Division of Respiratory Disease Studies, DSHEFS = Division of Surveillance, Hazard Evaluations, and Field Studies; DSR = Division of Safety Research, NEISS = National Electronic Injury Surveillance System, SENSOR=Sentinel Event Notification of Occupational Risk.

indicates that the cumulative total agriculture program funding allocated to the category "Migrant & Minority" was less than 10 percent of all its resources dedicated to "Priority Populations". In 1995, NIOSH staff convened a 12-member advisory group to recommend priorities for surveillance among hired farm laborers. This effort could be a model for future surveillance. NIOSH Cincinnati brought together a group of nationally known researchers and medical practitioners with many years of experience both studying occupational safety in this population and/or providing health services. The effort was chaired by noted stakeholders (Valerie Wilk of the Farmworker Justice Fund and Rose Holden of the Rural Community Assistance Corporation), and the California Institute for Rural Studies was eventually commissioned to prepare the report of this task force and forward the final document in 1998. The report and some of its recommendations were briefly mentioned in the evidence package (page 174 of NIOSH, 2006a).

National Agricultural Workers Survey (NAWS): NIOSH partnered with the U.S. Department of Labor (DOL) for the purpose of adding an occupational health and safety supplement to DOL's ongoing National Agricultural Workers Survey (NAWS) of hired crop farm workers during 1999.

Childhood Agricultural Injury Survey (CAIS): The definitions used for children in this survey were nonstandard. Child workers are legally minors and under 18 years of age. The inclusion of 18- and 19-year-olds created confusion because of the different legal status of child workers in agriculture under the Fair Labor Standards Act. In fact, the 1998 General Accounting Office (GAO, now the Government Accountability Office) report clearly states that the best available data indicated that there were about 155,000 15- to 17-year-olds working in agriculture in 1997; most (116,000) were hired workers (GAO, 1998). About 39,000 were self-employed and unpaid family workers (GAO, 1998). Workers under the age of 15 years need to also be considered, and the GAO report acknowledges that the finding is an underestimate.

Work-Related Lung Disease (WoRLD) Surveillance Report and System: This report (NIOSH, 2000b) contains data collected from only 22 states. Of the 22, only one corn-belt state was included, and most of the nation's major agricultural states were not included: Texas, Florida, and California were excluded. The authors grouped all crops together, even though "crop" could be anything from vegetables to citrus to soybeans. From the committee's perspective, the document is an example of a weak study design and of release of information by NIOSH that is not representative and therefore not as useful as it could be.

Alaska Occupational Injury Surveillance System (AOISS): This surveillance system includes fatal occupational injuries. Information provided focused on fishing-related fatalities. Oral testimony provided by AFF Program staff to the committee suggested a potential for replication of its design for the West Coast, Gulf, and North Atlantic fisheries. No details about how the effort would be expanded to national or regional settings outside Alaska were provided (NIOSH, 2006a).

OUTPUTS

Historical institutional experience may be helpful in assessing the adequacy of surveillance definitions routinely used by NIOSH as it implemented the 1990 congressional mandate for the AFF sector. Six years before the mandate, J. Donald Millar, former director of NIOSH, stated: "in the practice of epidemiological surveillance, the field of occupational safety and health is at least 70 years behind the field of communicable disease and control" (Halperin et al., 1992). The committee's review of materials relevant to surveillance for occupational illnesses and injuries related to AFF suggests this is still true.

NIOSH documents provided to the committee (NIOSH, 2006a) suggest there is no ongoing national health, hazard, or injury surveillance in agriculture, fishing, and forestry. There is little emphasis on hazard surveillance; the surveys have mostly collected disease and injury data with little attention to hazards and poten-

tially hazardous jobs, so it has been difficult to meet surveillance goals. Although NIOSH was encouraged as early as 1992 to address bias in surveillance effort related to Midwestern, Caucasian perspectives and values, the preponderance of the efforts reviewed suggests that such perspectives persist in the agriculture sector (Lee and Gunderson, 1992). The committee notes three exceptions. NIOSH has made some effort to obtain information on the number of tractors in use in the United States that lack ROPS. In the SENSOR-pesticides program, a surveillance system has been established with well-developed case definitions, and materials have been developed from which comparable data could be collected on pesticide poisoning and illness cases. And the occupational fatal injury surveillance system in Alaska appears to be well developed and comprehensive with regard to injuries and the dissemination of summary information; it might be possible to expand to other regions of the country.

Sentinel Event Notification System for Occupational Risks (SENSOR)-Pesticides Database: There is a how-to guide for developing a state-based surveillance program which includes a SENSOR case definition of acute pesticide-related illness and injury, signs and symptoms associated with several pesticides, a severity index for acute pesticide-related illness and injury, a flow diagram for assigning severity to cases, tables of signs and symptoms by severity category, and software to assist states in entering data (NIOSH, 2006a). A number of *Morbidity and Mortality Weekly Report (MMWR)* articles have been published on pesticide illnesses and injuries and are available on the Centers for Disease Control and Prevention Web site (*http://www.cdc.gov/mmwr*). Peer-review articles are also available. Web sites for state-based pesticide poisoning surveillance programs, general pesticide resources, and other materials are also provided on the Web site.

Childhood Agricultural Injury Survey (CAIS): There were government reports based on the CAIS for 1998, 2001, and 2004 (NIOSH, 2006a,b).

Fatality Assessment and Control Evaluation (FACE) program: From 1986 to 2003, there were 16 investigations conducted by NIOSH staff related to agriculture and 360 state-based investigations (NIOSH, 2006a). From 1983 to 2004, there were 28 logging-related deaths investigated by NIOSH staff and 67 state-based investigations. From 1992 to 1999, there were two NIOSH staff and 11 state-based investigations of fishing-related fatalities; only two of the state-based investigations were conducted outside Alaska (both in Massachusetts) and both NIOSH staff investigations were conducted in Alaska (NIOSH, 2006a).

Occupational Health and Safety Supplement to the National Agricultural Workers Survey (NAWS): In 1999, an Occupational Health and Safety Supplement was added to the NAWS (NIOSH, 2006a). Results have not yet been published, but a final report was prepared and is undergoing internal review in NIOSH. Several oral presentations of initial results were offered at various conferences on hired farmworker health.

INTERMEDIATE OUTCOMES

The AFF Program has not yet made extensive use of surveillance to produce intermediate outcomes. In the evidence package (NIOSH, 2006a), the program staff list as intermediate outcomes related to hazard surveillance one NIOSH Hazard Alert on farm machinery (1993), one state FACE investigation related to the use of Micotil 300® (tilmicosin) in cattle (to prevent shipping fever) that resulted in a farmer's death from self-injection, and the resulting workplace-solutions document and additional warnings by Elanco to all Micotil purchasers (NIOSH, 2006a).

The most logical intermediate outcome would be the use of surveillance data in developing and evaluating intervention programs. The fishing program in Alaska was the only program that used surveillance data to develop and monitor interventions in which the intermediate outcomes of the use of surveillance data were clearly evident (NIOSH, 2006a).

To a lesser degree, traumatic injury surveillance data related to tractors were used to identify commonly used farm tractors without ROPS. This information became the basis for providing low-cost designs to encourage farmers to retrofit tractors.

END OUTCOMES

The AFF Program staff provided evidence of the following changes (NIOSH, 2006a):

- A reduction in acute pesticide poisoning from 13.1 to 8.9 cases per 100,000 as a result of surveillance and research activities.
- A reduction, in both absolute numbers and rates, in youth injuries.
- Reductions in logging accidents and helicopter crashes.
- Significant reductions in fishery accidents and deaths brought about as a result of safety training and inspections.

Only the reductions in fishing accidents and deaths were linked with a specific intervention and the surveillance system (NIOSH, 2006a). The reduction in pesticide poisonings may have been due to the reduced use of organophosphate pesticides or due to decreased reporting resulting from increased healthcare costs; thus the reduction in poisonings may not be directly related to the work of the AFF Program.

OTHER OUTCOMES

Reports cited in documents provided to the committee (NIOSH, 2006a) related to agriculture (1986-2003) and logging (1983-2004) are sporadic. NIOSH Alerts occurred in 1986, 1988, 1990, 1994, and 1998 and appear to have been linked to some extent with the OHNAC programs (that is, they were agriculture-related) and to have ended when program funding ended. Hazard identifications and monographs (1994, 1998, and 2000) also are sporadic, and agricultural equipment was the only specifier that related to AFF.

5

Review of Research on High-Priority Populations at Risk

"Priority populations at risk", "populations at risk", and "special populations" are descriptors used by National Institute for Occupational Safety and Health (NIOSH) in referring to selected groups of people with various degrees of involvement in agriculture, forestry, and fishing (AFF) activities. The definition includes those "underserved by traditional occupational health approaches" and at high risk of illness or injury. In the agricultural sector, the AFF Program presented information on research among selected populations while for the forestry and fishing sectors all workers were viewed as special populations.

STRATEGIC GOALS AND OBJECTIVES

Goal 2: Priority Populations at Risk—Reduce injuries, illnesses, and fatalities in subgroups of the working population determined to be at high risk or underserved by traditional occupational health approaches.

Population studies outside the traditional occupational health approach make reference to the study of illness and injury, focusing less on the workplace and more on the social context within which illnesses and injuries occur. Although social context has been integrated into the study of illness and injury in many of the projects conducted by NIOSH in the last decade, research focuses on traditional views of worker populations that exclude family members, the elderly, and oftentimes women in the activities of the AFF Program.

The program listed goals for populations identified as meriting special attention:

- Child labor: Protection of children living and working on farms, understanding the exposure. Reduce injuries, illnesses, and fatalities among children working on farms.
- Minority populations: Reduce injuries, illnesses, and fatalities among migrant and minority farm workers.
- Logging: Reduce injuries, illnesses, and fatalities among logging workers.
- Fishing: Reduce injuries, illnesses, and fatalities among commercial fishermen.

The NIOSH research priority-setting process in relation to AFF populations at risk was based on perceived needs, consultation with experts, and charges given to the agency.

As defined by NIOSH, populations at risk include children, minority groups, logging workers, and fishery workers. Child labor is a complicated issue because children living in a farm environment are involved in various farming activities often viewed as chores rather than work by parents. Minorities are classified by race and ethnicity, and studies included Hispanic and Latino, Navajo, and black farmers and farm workers. Many of the studies of Hispanics and Latinos have centered on hired orchard workers. Loggers and fishermen have received less attention in the AFF Program than agriculture, consequently high-risk populations in those sectors have not been well described. Other age, gender, racial, and ethnic minority groups were not included as populations at risk in the agricultural sector. Intramural activities related to populations at risk in all sectors have focused on surveillance to fill in data gaps peculiar to AFF, such as gaps in data from the Department of Labor, Bureau of Labor Statistics (DOL/BLS). The extramural activities have been regionally appropriate and include a wide range of agricultural settings and populations that integrate the social context in which illnesses and injuries occur. In forestry and fishing, there was some extramural funding provided on a regional basis.

The high-priority research topics defined in the National Occupational Research Agenda (NORA) have been modified recently to adopt an approach based on industry sectors and to establish sector-specific research goals and objectives. This emphasis promotes research-to-practice through sector-based partnerships. "Special populations at risk" were aligned with work environment and workforce categories and share priority status to a lesser degree with emerging technologies, indoor environment, mixed exposures, and work organization. It is not apparent how the priorities based on industry sectors might be used to differentiate issues associated with, for example, child labor in the context of a small family fishing operation or a small family farm operation. Although the setting is different, some

of the concerns about children working in family-run operations—such as youth operating machinery and children playing at or visiting the workplace—are similar. To establish an approach based on industry sectors and to develop sector-specific research goals and objectives may be disadvantageous in relation to an approach that requires the integration of social context and the interconnectedness of all AFF activities and populations at risk.

Given that there was no clear definition of populations at risk in its review of NIOSH's AFF activities, the committee used the NIOSH AFF classifications of populations at risk.

LOGIC SUBMODEL

Information received from the NIOSH AFF Program (NIOSH, 2006a) related to inputs, activities, outputs, intermediate outcomes, and end outcomes in research on priority populations at risk is summarized in the priority populations at risk research logic submodel (Figure 5-1).

INPUTS

Child Labor

In 1996, NIOSH was charged with reducing injuries and illnesses in child workers. As a result, it assigned 75 percent of available funds ($5 million dollars) to extramural research and 25 percent to intramural activities, which consisted primarily of surveillance.

ACTIVITIES

Child Labor

The major issues in relation to child labor identified by NIOSH and stakeholders were traumatic and cumulative injuries related to farming activities. Those activities included living on, working on, and visiting a farm. Efforts were focused on childhood injury prevention, surveillance of fatal injuries, and childhood agricultural musculoskeletal disorders (MSDs). In consultation with experts, NIOSH did a thorough qualitative review of the hazardous orders (HOs) for youth working in agriculture and made recommendations for changing 8 of the 11 HOs.

Surveys were conducted over a number of years that were focused on identified problems or populations, such as the migrant and seasonal farm workers, selected farm operations, and racial minority farm operators. One follow-up study was conducted when injuries occurred on a farm using a national representative

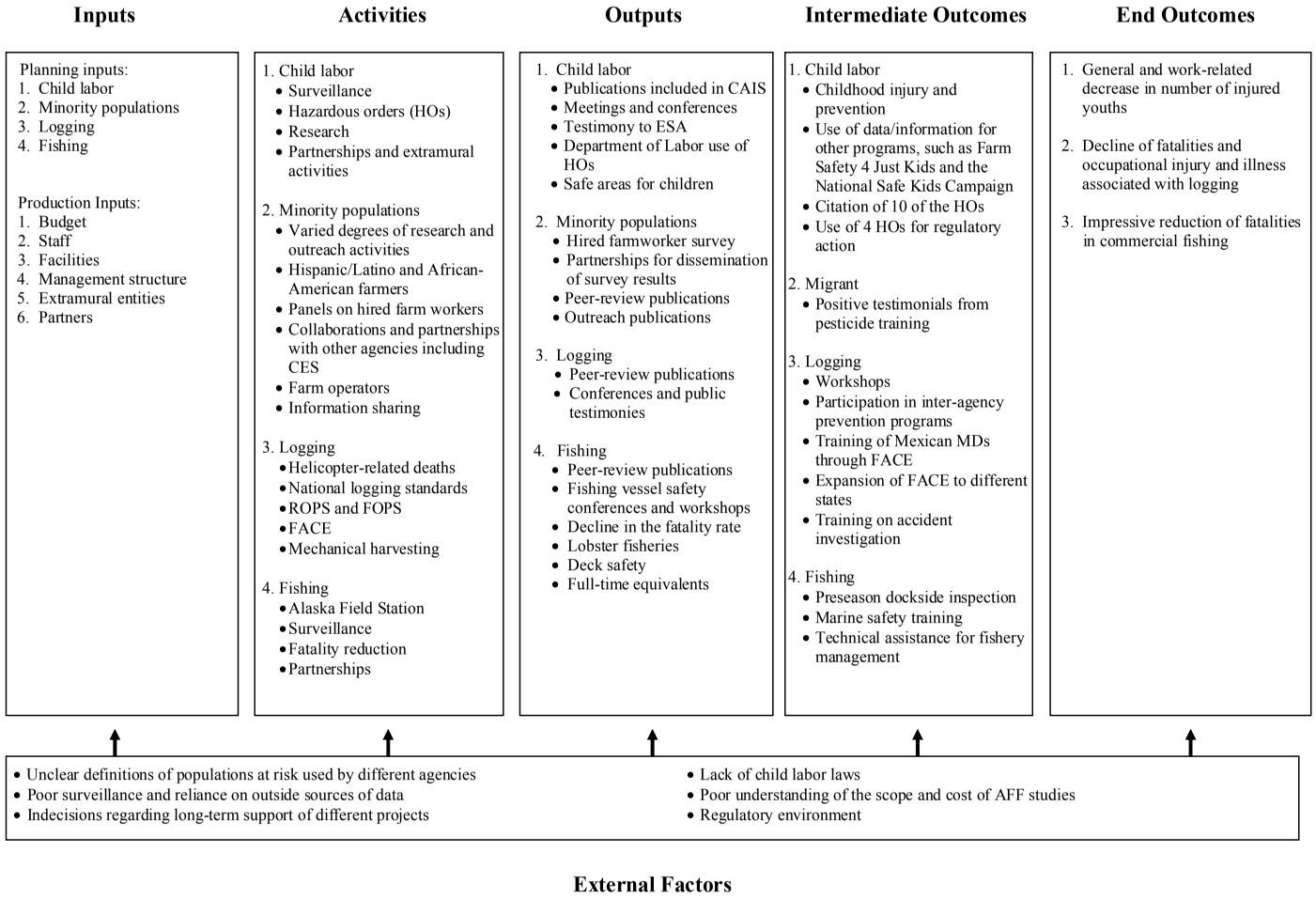

FIGURE 5-1 Priority populations at risk research logic submodel.
CAIS = Child Agricultural Injury Survey, CES = Cooperative Extension Service, ESA = Employment Standards Administration, FACE = Fatality Assessment and Control Evaluation, FOPS = falling object protective structure, ROPS = rollover protective structure.

sample of emergency department records. Important data were collected in the surveys. However, comparison of results across the surveys has been hampered by differences in data collection procedures, in definitions of target populations, and in denominators. MSD studies were more comprehensive and included plans for dissemination of information and for community involvement.

A majority of the activities conducted in the extramural programs and partnerships were investigator-initiated research project grants (R01 grants) and included support for conferences and interactions with extramural partners. The R01 component was strong and involved different centers, such as the National Children's Center for Rural and Agricultural Health and Safety (NCCRAHS), a center that conducts research on children's agricultural injury prevention. Research in the center has produced measurable results in the form of qualitative and quantitative outcomes. The materials produced from the childhood agricultural initiative have been referenced and used in outreach activities. Conferences were useful for sharing experiences and ideas among the different centers and extramural participants.

Minority Populations

Under the assumption that different minority farmworker groups face different hazards, the AFF Program has studied American Indians, Hispanic and Latino hired laborers and orchard workers, and minority farm operators, including Hispanics and African Americans. Cultural factors and conceptions of health and disease in minority group workers have been proposed as affecting the underreporting of various conditions. Further, different agricultural activities have been associated with different hazards. For example, the variety of jobs that orchard workers perform at different times of the year, the long working hours involved in these jobs, and the strenuous working conditions (such as carrying heavy containers up and down ladders) are some of the possible causes cited for high rates of illness and injury. In addition, changes in agricultural practices among certain populations may also lead to changes in the hazards in a specific population. An example of this is the move among Navajo from subsistence farming to cattle ranching. These types of changes require monitoring and quick response to reduce the risks among the worker populations involved.

In 1995, NIOSH convened a panel of experts on hired farm workers. Three years later, the panel issued its report and made recommendations for surveillance. Several high-priority subjects were identified, including MSDs, pesticide-related conditions, traumatic injuries, respiratory conditions, dermatitis, infectious diseases, cancer, eye conditions, and mental health. In 1998, an Occupational Health Supplement was developed to be included in the National Agricultural Workers Survey (NAWS) in collaboration with government organizations including DOL,

the U.S. Environmental Protection Agency, the U.S. Food and Drug Administration, the National Cancer Institute, the Health Resources and Services Administration (HRSA), and the Occupational Safety and Health Administration (OSHA); and with researchers from community organizations, universities, industry, advocacy groups and extension. The questionnaire was translated into Spanish, pilot tested, and revised. The survey results indicated that hired farm workers and migrant workers were younger than other workers. The results also indicated low English literacy, which has implications for health because of the inability to understand job-related instructions in English. The current survey focuses on mental health and psychological factors, but the continuation of this survey is uncertain because of funding issues.

As part of the AFF Program, the U.S. Department of Agriculture (USDA) conducted a Minority Farm Operators Occupational Health Survey in 2000. Several other organizations took part at different stages during the project, including academic institutions and research organizations. The response rate was low, and additional sampling was required; at that point, the method was changed, and data were collected using face-to-face interviews. The prevalence of various health and related conditions, including hearing loss, access to medical care, and mental health symptoms were estimated. This work highlights the importance of adapting methods to meet the needs of special populations in order to obtain health- and injury-related data for occupational health.

Several extramural studies have been conducted in conjunction with the Cooperative Extension Service (CES) assigned to the Navajo Nation to assess Navajo occupational safety and health needs. Projects included cattle handling and safety equipment, development of a training video, a loan program to purchase safety equipment, and development of an education program related to flash flooding. These projects were conducted with cultural sensitivity of the target population using stakeholder involvement and provided an important example of how to use CES, extramural researchers, and AFF Program staff to conduct needs assessment to develop educational and hazard reduction interventions.

Participatory research has been used in several other extramural studies funded by the AFF Program in several states involving Hispanic and Latino workers. Use of a participatory approach has resulted in improved success with interventions in relation to pesticide exposures and ergonomics.

Logging

Logging is historically one of the most hazardous industries in the United States. Logging fatality and injury rates have slowly declined since the mid-1950s; injury rates are twice the rate of all U.S. workers. In 1994, NIOSH published re-

search indicating the differences in logging-related fatality rates across the country; the highest fatality rate was associated with manual harvesting of saw timber, for which there was no logging safety standard.

Several logging-related activities have been conducted by NIOSH, including support of OSHA's adoption of a national standard for the logging industry, coordination of a statewide injury and helicopter-fatality intervention in Alaska, targeting logging fatalities in Fatality Assessment and Control Evaluation (FACE) investigations, and evaluation of mechanical logging methods.

In 1989, OSHA proposed a new standard in logging, which was largely based on standards developed in the 1976 NIOSH document titled "Criteria for a Recommended Standard: Logging from Felling a First Haul." From 1989 to 1990, NIOSH continued to offer comments to OSHA, provided data from the National Traumatic Occupational Fatality (NTOF) Surveillance System of the AFF Program, and made several important recommendations related to safety equipment, snakebite protection, work organization and communications, and safe felling techniques. These efforts culminated in the adoption of standards by OSHA in 1994, which included many of the recommendations made by the AFF Program.

Helicopter logging emerged in the late 1980s as a form of transportation mainly because of restrictions on road-building in Alaska's national forests. Investigations conducted by NIOSH staff showed that improper operation and maintenance were the main problems associated with the crashes. In 1993, a prevention matrix was developed by the Alaska Interagency Working Group for the Prevention of Occupational Injuries, which included representatives from the Federal Aviation Administration, the National Transportation Safety Board, the U.S. Coast Guard, the USDA Forest Service, OSHA, the Alaska Department of Labor, the Alaska Department of Social Services, and the AFF Program to identify risk factors for helicopter crashes. The result was a reduction in helicopter crashes: only one helicopter crash has occurred since 1993. Clearly the active involvement of other organizations in cooperation with NIOSH provides an example of successful partnering resulting in direct benefits for loggers in Alaska.

The programs in logging have focused on acute traumatic injuries and have not addressed other hazard and illnesses that might be related to logging. There has been a lack of work on the cultural and social issues that influence work-related illnesses and injuries among loggers.

Fishing

In 1990, the AFF Program goal was to reduce the number and rate of commercial fishing fatalities by 50 percent by 2005. In 1991-1992, data sharing agreements with the U.S. Coast Guard (USCG) and Alaska state troopers were established and

a comprehensive surveillance system for occupational fatalities, the Alaska Occupational Injury Surveillance System (AOISS), were established. High-risk groups and types of gear were identified as deserving of attention for interventions. An interagency effort was created that included the participation of many organizations. Many intervention programs have been implemented since then, and assistance has been offered on prevention of vessel-related fatalities, nonfatal work-related injuries, and fatalities due to loss of vessels. The program provides a model for building collaborative working relationships with other agencies to provide surveillance data from which to design intervention programs. However, the work focused on traumatic injuries and neglected other health hazards associated with fishing.

OUTPUTS

Child Labor

Numerous peer-reviewed publications were part of the Childhood Agricultural Injury Survey (CAIS), as were presentations in scientific conferences and professional meetings and NIOSH internal documents that were published and disseminated through a variety of media outlets. The overall citation index of the peer-reviewed papers is high. Although a vast number of publications are available through the NIOSH Web site, documents are not cataloged, and searches are cumbersome and time consuming.

In 2004, the AFF Program provided testimony on child labor regulations to the Employment Standards Administration (ESA). The DOL used NIOSH recommendations regarding the HOs covering youths of all ages and farms of all types. The AFF Program HO report was presented to the International Labour Organization (ILO). No evidence was provided on the impact of the presentations. NCCRAHS documents were used to design safe areas for children on farms. Although the idea for safe play areas was well received, the impact of the program is unknown because there is no information available on how many safe areas for children have been built on the farms as a result of the study. Three prominent outcomes are highlighted in the NIOSH evidence package (NIOSH, 2006a). One is a paper showing that motor vehicles and intentional causes of death are major issues for youths living on farms (Goldencamp et al., 2004). Another is a conference report that influenced the AFF Program in 2002, in reference to childhood agricultural injury prevention and modifications that were made in NORA priorities (Lee et al., 2002). The third is a 1996 report on children in agriculture (National Committee for Childhood Agricultural Injury Prevention, 1996). It is not clear why those items were highlighted, inasmuch as no policy change or intervention program development is cited or connected to them. No comparative study is offered to show that motor vehicle issues, for example, are different for youths not living on farms.

Furthermore, we cannot determine whether the results of the report on children in agriculture were used as the basis of intervention programs.

The CAIS database on youth farm injuries contains data from surveys conducted in 1998, 2001, and 2004. Only basic information with regard to traumatic injuries is available. Children are particularly vulnerable to risks and hazards when performing complex agricultural tasks, considering their age, sociological and developmental status, and body size. These types of sociological and psychological factors, among others, are rarely considered and would be important to understand. Thus a more integrated and interdisciplinary approach is needed when dealing with children in agriculture.

Migrants

The National Agricultural Workers Survey Occupational Health supplement is currently under review. The document summarizes results of the survey, will be shared with researchers and the ten Centers for Agricultural Disease and Injury Research, Education, and Prevention, and will be available on NIOSH and DOL Web sites. The National Center for Farmworker Health will assist in the dissemination of survey results by sharing data with migrant worker health clinics, HRSA, the DOL, Migrant Health Promotion, the National Institutes of Health, and other organizations. The document may be essential for disseminating the results of the survey, but the survey was conducted in 1999, and the information will be dated when it is published. No specific date for the completion of the document and dissemination of the results was provided.

Educational materials for migrants and minority groups have been included in the National Agriculture Safety Database (NASD) for the agriculture community and for adaptation by agricultural safety specialists. The NASD contains many cataloged educational materials and resources in English and Spanish from different sources. Particularly highlighted is the inclusion in the database of a bilingual NIOSH document: *Simple Solutions: Ergonomics for Farm Workers*. The accessibility of this document for workers was not addressed, as many agricultural workers do not read English or Spanish. Use of the standard approaches to dissemination of information for agricultural workers is evident throughout the AFF Program and neglects social and cultural differences in terms of preferred modes of communication, as well as literacy and language barriers.

Logging

Outputs related to logging include peer-reviewed publications, conferences, testimony, government publications, and NIOSH Web sites. Three workshops with proceedings were held between 1993 and 1997 to address helicopter logging

crashes. NIOSH testimony that influenced OSHA's logging standards is cited. Three government publications on prevention of logging injury and death prevention were produced in 1976, 1994, and 1998.

NIOSH seems to have reached a plateau in relation to logging research and programs in 2002. The issues or challenges for the logging industry seem to be specific to that sector, and the industry has been responsive to proposed improvements. However, there are significant changes in logging procedures and practices that need to be addressed in the future.

Fishing

A number of articles have been published in a variety of media and range from scientific publications to industry trade articles. Five conferences centering on fishing vessel safety have been sponsored by the AFF Program. Seven selected outputs are highlighted by NIOSH with various levels of development, completion, and impact:

Fishing Industry Safety and Health Workshop

In 1992, a conference was held to raise awareness and promote injury and disease prevention programs, and resulted in workshop proceedings. There were 77 attendees from Alaska and the West Coast.

NIOSH Current Intelligence Bulletin

A decline in the fatality rate in commercial fishermen has been noted since 1998, when the Commercial Fishing Industry Vessel Safety Act was passed. The implication is that NIOSH work in this matter has contributed to the decline in fatalities. However, the number of vessel sinkings has not decreased. The AFF Program made 11 recommendations regarding improvements in vessel stability, training, avoidance of harsh weather, falls overboard, and other issues associated with deck safety. The document has been used as a resource by six states and by federal, academic, and private organizations. Eight of the 11 recommendations were adopted by USCG.

FISH Workshop

The Second National Fishing Industry Safety and Health Workshop (FISH II) was sponsored and organized by the AFF Program in 1997; the proceedings became available in 2000. Attendance at the workshop is not given, but attendees

were divided into working groups and developed recommendations on prevention of vessel-related fatalities, man-overboard fatalities, diving fatalities, and nonfatal work-related injuries. Three interventions were implemented on the basis of the recommendations; the success of the recommendations cannot be determined from the information provided.

Line Entanglement in the Lobster Fishery

Lobster fishermen experience a fatality rate 2.5 times the national average for all industries (NIOSH, 2005b). Recommendations were developed with regard to work practices and engineering controls to reduce the risk of entrapment injuries, an industry-related publication was produced and distributed, and two peer-reviewed articles and one NIOSH document were issued. No data were provided on the long-term effect of the project on reduction of injuries among lobstermen.

Deck Safety Products

The Deck Safety Project started in 2000 with a clear plan that included the development of a program for crab fishermen. Focus groups and tours of vessels to identify safety problems were conducted, and the resulting information was published in a handbook in 2002. The second focus of the project was the Southeast Alaska fishermen. The emergency-stop system (e-stop) was developed for use in the event that a fisherman is entangled around a winch and was tested in 2005 and 2006. Work on the distribution and impact of the e-stop continues, but it seems that it is being installed in many vessels. No data on how many e-stops have been installed were provided, so the impact is yet to be determined.

IFISH I, II, and III

Three International Fishing Industry Safety and Health (IFISH) conferences have been held in conjunction with academic, industry, and international partners. The AFF Program has been a sponsor and major collaborator for these three conferences.

Full-time Equivalent Estimates

Given the nature of the industry, counting fishermen to obtain injury or illness rates is problematic. The AFF Program has developed a procedure to estimate the number of "full-time equivalent fishermen" for Alaska fisheries to compare fatalities and injuries to other Alaskan workers. No data are provided on how good the estimation is or has been, and no comparative study is shown or referenced

to evaluate it. If this approach can be used in other studies of fisheries in other regions of the country it will provide an important advance in comparative risk and in focusing interventions.

INTERMEDIATE OUTCOMES

Child Labor

Surveillance activities have been influential in defining what types of outreach and research programs on childhood injury and prevention were needed. The data generated have been used by NCCRAHS and other programs, such as Farm Safety 4 Just Kids and the National Safe Kids Campaign. The data have been cited in proposed congressional legislation, and the Children's Act for Responsible Employment (CARE) Act (HR 3482).

The AFF Program has been actively involved with child labor HOs and the dissemination of information about the HOs. A number of stakeholder groups including government agencies, the Young Worker Health and Safety Network, the Farmworker Justice Fund, and the ILO have used data and recommendations on the HOs to support recommendations to reduce the risk of injury to young workers in agriculture.

Migrants

Five testimonials given after a 2006 pesticide training workshop are offered as examples of the intended use of extramural AFF Program efforts. All the testimonials are complimentary, but they do not constitute program evaluation results, and they constitute merely a collection of comments made by participants in a training workshop. These intermediate outcomes address a small percentage of the overall activities involving migrant workers that have been conducted by the AFF Program.

Logging

Results of investigations of helicopter logging fatalities offered sound information that was used by an interagency group in Alaska and other agencies, including the Future Farmers of America, the USDA Forest Service, and the Alaska Department of Labor. Three workshops were held in 1995, 1996, and 1997 by the Alaska Interagency Working Group for the Prevention of Occupational Injuries and the AFF Program. A Helicopter Logging Safety Committee was formed in 1997 with support from the Helicopter Association International (HAI) and has established

its own helicopter logging guidelines. NIOSH reports that owing to its involvement in HAI activities, the insurance industry has also become involved and has substantially discounted helicopter insurance costs for operators. Reports from the AFF Program and FACE have been adapted and distributed by Forest Research Association (FRA) and its members.

The AFF Program and FACE participated in an evaluation of logging and wood-processing plants in Mexico and in the training of 35 Mexican occupational medicine residents. In 14 years, 65 logging-related fatalities have been investigated through FACE programs; the highest numbers were in Alaska, Kentucky, and West Virginia. The distribution of NIOSH findings from different studies is done by FRA. On the basis of results related to the reduction of injury rates with use of mechanized logging systems, the West Virginia Workers Compensation Board is holding meetings on incentives for logging companies and may establish lower rates for mechanized logging companies. These activities demonstrate significant involvement of stakeholders in use of data generated through the AFF Program.

Fishing

Preseason Dockside Inspection Program

As a result of working group activities in the 1997 FISH Workshop, USCG designed and implemented a preseason dockside inspection program for vessel safety in the Bering Sea crab fisheries. The industry supports the initiative, and in an evaluation conducted by USCG with assistance from the AFF Program, there was only one fatality between 1999-2005, whereas seven had occurred in the preceding 5 years. This collaborative effort provides evidence of a successful program which involves stakeholders from industry, USCG, and the AFF Program.

Marine Safety Training

The AFF Program funded the Alaska Marine Safety Education Association (AMSEA) to develop the training project for certified drill conductors who observe required monthly emergency drills. The AFF Program conducted an evaluation for AMSEA of the effectiveness of the training program for prevention of commercial fishing fatalities. In an evaluation of the training program, there was a small non-significant increase in the likelihood that victims had not received training, but victims were significantly less likely to have worn an immersion suit and more likely to have not used a life raft. AFF Program data have provided AMSEA with information that can be used to focus training efforts and to justify increasing the number of trained workers.

Technical Assistance for Fishery Management

NIOSH has been involved in assisting various groups or programs since 1992. In 1995, individual fishing quotas (IFQs) were implemented. NIOSH analyzed USCG data and showed that search-and-rescue missions declined by 63 percent after the implementations of the IFQs. There was also a decline in deaths among halibut fishermen from eight in 1992-1994 to zero since implementation of the IFQs. Another quota-based system was implemented for the Bering Sea crab fisheries. NIOSH data were used, and its work was mentioned in the materials developed and distributed when the quota system was debated. Therefore AFF Program activities have been used to increase safety through administrative control approaches to fishing.

END OUTCOMES

Child Labor

Data provided by NIOSH show a decrease in the number of youth injuries in general and in work-related youth injuries. For example, a 51 percent reduction in work-related youth injuries is reported as a direct effect of NIOSH programs. It is not easy to establish a direct association with the AFF programs that produced these results.

Logging

NIOSH reports that AFF Program activities and outputs have contributed to the declines in fatalities and occupational injury and illness associated with logging since the proposed OSHA logging standard of 1989. For example, from 1989 to 2003, the number of cases of logging-related occupational injury or illness per 100 full-time workers decreased by 13.1. The American Pulpwood Association distributed the summaries and recommendations from the AFF FACE investigations targeting the leading causes of deaths in logging nationally. The rates of injuries and leading causes of deaths in logging, such as being struck by falling objects, decreased by 38 percent and machinery-related deaths by 48 percent between 1984-1989 to 1996-2001. AFF Program activities likely had an impact on these reductions.

Fishing

Fatalities in commercial fishing have been reduced dramatically; there has been a 74 percent decline since 1990 in Alaska and a 51 percent annual decline in the

fatality rate in Alaska. The NIOSH AFF Program involvement in various programs and projects has likely contributed, in part, to those declines. Its contribution includes offering assessments, analyzing injury data, identifying high-risk groups, estimating denominators and rates, offering support for interventions, and assessing the success of the interventions.

EXTERNAL FACTORS

Changes in national leadership, including changes in DOL and ESA, have affected the NIOSH AFF Program. Federal agencies are required to evaluate the economic impact of proposals, and this may be difficult to estimate when the proposals are for exploratory or qualitative studies.

Child Labor

The absence of adequate child labor laws, as applied to youth on family farms, may increase the risk of injury and exposure to hazards to young workers.

Migrants

A series of events are cited as external factors that affected the completion of surveys or programs. Among them are the hiring of contractors to conduct surveys, collaborations with other federal organizations, and DOL's indecision regarding support of the NAWS. Continued support of this program is warranted.

6

Review of Health Effects Research

The National Institute for Occupational Safety and Health (NIOSH) Agriculture, Forestry, and Fishing Program (AFF Program) has been an important and effective program that has addressed health effects in a practical and responsible manner. The major portion of the budget has been allocated for agriculture, and the results of NIOSH investment are most visible in that sector although some notable achievements in commercial fishing are evident; the attention to forestry has been more limited. Because of the historic funding placed in agriculture, the committee focused to a considerable extent on the agriculture sector and on the health effects research conducted intramurally by NIOSH scientists and extramurally through research development and support in university-based Centers for Agricultural Disease and Injury Research, Education, and Prevention (Ag Centers) and among researchers in the broader community; the committee also evaluated health effects research in forestry and fishing to the extent that the available information permitted.

STRATEGIC GOALS AND OBJECTIVES

Goal 3: Health Effects of Agricultural Agent Exposures—Reduce injuries and illnesses by understanding the long-term, chronic effects of exposure from agriculture-related chemical or physical agents to farmers, their families, and applicators so as to implement controls that prevent harmful exposures.

The AFF Program appears to have commenced with a somewhat narrow focus in health effects research. Despite its stated goal, the AFF Program, particularly the extramural component, came to encompass a wide array of exposures and their effects that contribute to the risk of injury and illness in AFF workers. However, it is possible that NIOSH, because of the discrepancy between the stated goal and program inputs, failed to exert the kind of focused leadership that would be necessary for a cohesive national research agenda. Production inputs reflect the fact that many AFF researchers have understood that, but the AFF Program would have benefited from stronger direction in evolving goals and greater communication, both between the intramural and extramural components and among the university-based NIOSH Ag Centers. The extramurally funded Ag Centers routinely compiled detailed annual reports and generated specific planning documents, but it is difficult to ascertain evidence that the information was used in a constructive manner. An apparent managerial deficiency of the program was the lack of resources allocated by NIOSH to archive documentation and organize such materials for strategic and planning purposes. In fact, one of the challenges that the committee faced was obtaining program information and documentation from the intramural AFF Program or extramural Ag Centers. The apparent lack of resources and staff to adequately catalogue a history of funded projects and their products has lead to an institutional memory deficit that is a major deficiency of the overall AFF Program. Given the size of the task, addressing the needs of the entire AFF worker population is difficult. The requirement for prudent allocation of resources underscores the need for strong leadership.

LOGIC SUBMODEL

Information received from the NIOSH AFF Program (NIOSH, 2006a) related to inputs, activities, outputs, intermediate outcomes, and end outcomes in health effects research is summarized in the health effects research logic submodel (Figure 6-1).

INPUTS

Planning, production, and other input data were assessed and found to be adequate in part; however, it was not clear that the data were gathered by NIOSH in an organized manner. Staffing appears to have been adequate in some well-defined subprograms, but resources in many other parts of the AFF Program did not appear to permit adequate staffing. Surveillance data were gathered by intramural and extramural investigators; however, an overall surveillance scheme was not apparent in the evidence. Stakeholder needs of various sectors were taken into consideration

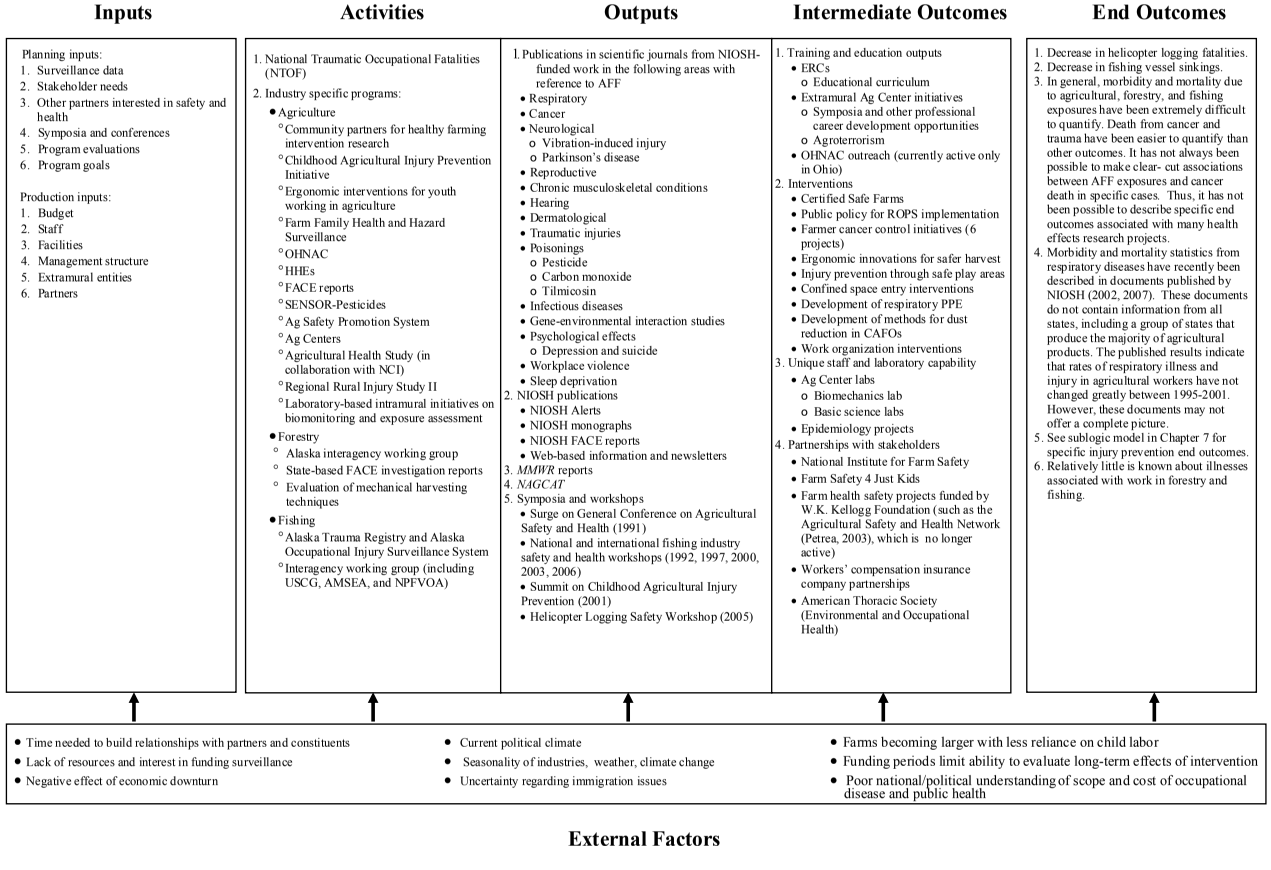

FIGURE 6-1 Health effects research logic submodel.
AMSEA = Alaska Marine Safety Education Association, CAFO = concentrated animal feeding operation, CES = Cooperative Extension Service, ERC = Education and Research Centers, FACE = Fatality Assessment and Control Evaluation , FOPS = falling object protective structure, HHE = Health Hazard Evaluation, *MMWR* = *Morbidity and Mortality Weekly Report,* NCI = National Cancer Institute, NPFVOA = North Pacific Fishing Vessel Owner's Association, NTOF = National Traumatic Occupational Fatality, OHNAC = Occupational Health Nurses in Agricultural Communities, PPE = personal protective equipment, ROPS = rollover protective structure, SENSOR = Sentinel Event Notification of Occupational Risk , USCG = U.S. Coast Guard.

to various extents over the life of the AFF Program. Stakeholders with whom it was more difficult to hold a discussion, such as farm workers and forestry workers, did not appear to be consulted during planning. The array of other partners was large, and some were not consulted by AFF Program staff during planning. The Alaska fishing safety program has been quite successful, because it began with good surveillance and progressed to the design and implementation of research in an organized way, which contributed greatly to its efficacy.

A pivotal NIOSH-sponsored symposium on agriculture was the 1991 Surgeon General's Conference on Agricultural Safety and Health. It came at a critical point in the history of the discipline and had far-reaching favorable consequences for the agriculture component of the AFF Program. The national and international workshops on commercial fishing safety also came at a critical point in establishing plans for the Alaska Field Station. While local and regional impact has clearly been made, it is not clear that NIOSH has had a similar impact on a national level in forestry or other aspects of fishing.

Planning, production, and other inputs were used effectively to promote the major activities in the Alaska fishing program. It is a well-defined program with a small scope that effectively addresses risk of death by drowning, hypothermia, or traumatic injury in a small number of workers. In contrast, the forestry component attempts to address the safety and health needs of a larger number of workers without the benefit of surveillance or well-articulated planning. Agriculture is a vast topic with diverse worker populations and exposures; surveillance has been fragmented in agriculture. It has at times been effective but not consistently. Inputs, including surveillance, were used effectively to plan and implement some projects, such as the Childhood Agricultural Injury Prevention initiative. For projects targeting adult workers, the benefits gained from planning and production resources have been less obvious because outcome measures are not available.

Some sources of inputs were adequate. For example, inputs from the Alaska fishing program were excellent. Other AFF projects had less adequate inputs, partially because of cultural, geographic, financial, and other types of barriers; the paucity of interventions aimed directly at farm workers is evidence of the limitation. Overall, a lack of evidence of strategic planning and coordination was apparent and may explain some of the variability in the quality of inputs.

There is little evidence that input was obtained from vulnerable working populations, such as farm or forestry workers, owners of small farms or forestry enterprises, the elderly, and non-English speaking workers.

ACTIVITIES

Activities are defined as the effort and work of the AFF Program, its staff, and its extramural partners. The committee has defined health effects research activi-

ties as surveillance of injuries and illness; identification and characterization of the unique health and safety risks faced by special populations; identification and characterization of health effects associated with chemical, physical, and biological agents encountered in AFF occupations; development of methods to characterize and measure potentially hazardous substances and exposures; and development of methods and strategies for the transfer of health effects knowledge to others who design and evaluate interventions and outreach mechanisms.

The AFF Program has at best modest reach into some AFF sectors. For example, geographic dispersion of AFF worksites, rural isolation, non-English dialects, social dynamics, access to workers at occupational sites, the undocumented status of some exposed AFF workers, and patterns of worksite task organization may militate against effective penetration. Nevertheless, Congress's intent was clear: to safeguard and promote the safety and health of AFF worker populations in the nation's fundamental interest.

The committee separated its assessment of the health effects research portion of the AFF Program into review of National Traumatic Occupational Fatality (NTOF) Surveillance System activities and industry-specific activities. NTOF is an intramural effort that relies on state-level death certification programs and, for the purposes of the AFF Program, appears to have focused largely on agricultural events with a secondary emphasis on forestry-related fatalities. The limitations of the system are openly acknowledged and include the lack of program-related comprehensiveness given the gaps in industry and occupation coding in state vital-statistics programs. States with some of the nation's leading agricultural and forestry production do not code their death certificates for industry or occupation. In addition, because data are provided by key informants, such as family members of the deceased or local coroners, key occupational features and exposures may be missing. The use of NTOF data to target Fatality Assessment and Control Evaluation (FACE) program initiatives and portions of the Occupational Health Nurses in Agricultural Communities (OHNAC) program appears problematic because the methods used by NTOF were flawed.

Industry-specific health effects programs encompassed both intramural and extramural activity and were highly varied. In forestry, there were activities involving interagency working groups, FACE investigation reports, and machine harvesting exposure assessment. In agriculture, some research programs focused on disease and injury surveillance, biomonitoring and exposure assessment, and hazard surveillance. In fishing, surveillance of worksite trauma and interagency policy working group activity occurred. Collectively, those activities expanded program effort well beyond the narrow goal specified by NIOSH for the AFF Program. In total, the industry-specific activities were much more congruent with congressional intent than with the narrow NIOSH-defined focus.

The activities addressed some of the most important exposures in AFF worksites. However, when reviewing the array of outputs described in the evidence package, the committee noted some gaps and uneven emphases. For example, sleep deprivation and the effects of nightshift work have not been extensively explored, workplace violence has received little attention, the health impact of volatile organic chemicals and solvents that are ubiquitous in AFF worksites remains unknown, infectious disease has received little exploration, and reproductive health effects have received only sporadic support in both the intramural and extramural parts of the AFF Program. The study of gene-environment interactions is a nascent program; it has become clear that research in this field requires large numbers of subjects to generate useful results, so there is a need to conduct well-organized multicenter studies with careful exposure assessment and characterization of disease phenotypes. The AFF Program has given substantial attention to respiratory disease and traumatic injury, some cancer end points, childhood exposure, hearing loss, selected dermatoses, and some neurological conditions. Program efforts have also been devoted, through the extramural Ag Centers, to employed workers (as distinct from owners or managers) in all three AFF sectors. The Agricultural Health Study is an important collaborative prospective cohort study—cosponsored with the National Cancer Institute (NCI), the National Institute of Environmental Health Sciences (NIEHS), and the U.S. Environmental Protection Agency (EPA)—of nearly 90,000 farmers and their wives to explore the potential causes of cancer and other diseases (National Cancer Institute, 2007). In addition, other epidemiological studies conducted through the Ag Centers serve as valuable program-wide resources. Emphases on AFF sex-specific exposure, common disease end points, and serious health consequences have been noted, but the evidence presented to the committee suggests limited reach.

Evidence of AFF stakeholder input into research activity varied. Beginning with the Surgeon General's Conference on Agricultural Safety and Health in 1991 (for the agricultural sector), the FACE-based logging initiative in five key industry states (for the forestry sector), and an interagency working group (for the Alaska fishing sector), stakeholder input appears to have been consistently sought by NIOSH scientists. Indeed, that may be one of the AFF Program's strengths. Some rural populations represented by, for example, voluntary agricultural organizations initially declined to participate in NIOSH initiatives, believing them to be programmatic extensions of the nation's occupational safety and health regulatory mechanism. Other populations, such as employed workers, appear to have been underrepresented in advisory structures convened by NIOSH to secure stakeholder input. To its credit, NIOSH has recently convened an AFF-sector advisory mechanism; it could profit from more thorough representation of AFF employed worker domains.

The participation of potential AFF partners has ebbed and flowed. When state-level agricultural safety specialist offices were receiving U.S. Department of Agriculture funding, numerous agricultural extension safety professionals were directly involved in research conducted by the extramurally funded Ag Centers. Organizations such as Farm Safety 4 Just Kids, the National Institute for Farm Safety, and the W. K. Kellogg Foundation have partnered with the AFF Program on strategic initiatives. Other professional organizations—such as the Environmental and Occupational Health Assembly (of the American Thoracic Society), the American Industrial Hygiene Association, and the American Society of Agricultural and Biological Engineers—have provided insight into and critiques of both planned and current activities. More recent stakeholder involvement has positioned workers' compensation insurance entities in roles complementary to research endeavors through their deployment of experimental translational programs.

The committee has noted that, in light of the plethora of potential AFF Program initiatives, prudent allocation of resources is required. Lacking formal continuing disease surveillance in agriculture, forestry, and fishing, NIOSH has crippled its capability for allocation of resources in a manner consistent with sound public health principles. Only top-level management in NIOSH can fix that dilemma; anything less than a fix would mean the loss of an irreplaceable opportunity to realign the sector initiatives in keeping with the original congressional intent.

As mentioned in Chapter 3, the regional focus of the Ag Centers has produced a diversity of approaches and issues and has been a strong suit of the AFF Program (see Table 6-1).

The committee reviewed copious documentation of peer-reviewed publications capable of rendering programmatic advice, and it is unclear whether such activity affected the direction of the AFF Program. NIOSH has used internal review mechanisms through the National Occupational Research Agenda that have resulted in program redirection. Other external reviews include a commission chaired by Susan Kennedy that issued a seminal report in 1995 calling for program adjustment in both the intramural and extramural venues (Kennedy, 1995). Cyclic review, through external peer-review mechanisms, has been applied repeatedly to the extramurally funded Ag Centers, childhood agricultural injury initiatives, other R01 initiatives, and the NIOSH Education and Research Centers (ERCs). Such review has resulted in some redirection of program effort, including discontinuation of funding of some extramural partners.

Evidence presented to the committee suggests that NIOSH-sponsored AFF research has typically used quality-assurance procedures for surveillance activity, basic laboratory science, and intervention research. The exception of which the committee is aware involved the six state-level Farm Family Health and Hazard Surveillance projects funded in the first 5 years of AFF Program effort. Created

TABLE 6-1 Research Emphases of Some NIOSH Ag Centers

Ag Center	Research Strength or Emphasis
Pacific Northwest Agricultural Safety and Health Center, Washington	Prevention of occupational disease and injury in farmers, fishermen, forestry operators through occupational medicine, epidemiology, industrial hygiene
Western Center for Agricultural Health and Safety, California	Health promotion and disease prevention, injury and ergonomics, neurotoxicity and pesticides, respiratory diseases, industrial hygiene and exposure assessment, evaluation, biostatistics
Southwest Center for Agricultural Health, Injury Prevention, and Education, Texas	Farm-family health and injury control, hired farmworker health and safety, animal-handling injuries, stress, health and safety training and education
Deep-South Center for Agricultural Disease and Injury Research, Education, and Prevention, Florida	Asthma, ergonomic injuries, heat stress in farm workers; prostatic cancer in licensed pesticide applicators; health, exposure assessment of poultry producers; incidence of logging-related injuries; safety of farm children
Southeast Center for Agricultural Health and Injury Prevention, Kentucky	Special populations, community-based interventions, engineering, ergonomics, green tobacco sickness, environmental health
Northeast Center for Agricultural and Occupational Health, New York	Hearing loss, arthritis, skin cancer, allergies, mechanical injuries, migrant farm workers, older farmers, women, children
Midwest Center for Agricultural Research, Education, and Disease and Injury Prevention, Wisconsin	Infectious pathogens, women, developing and evaluating health promotion and disease and injury prevention programs, engineering control technologies, injuries in children
High Plains Intermountain Center for Agricultural Health and Safety, Colorado	Engineering, industrial hygiene, education, toxicology, social work, epidemiology, environmental health, agricultural sciences
Great Plains Center for Agricultural Health, Iowa	Environmental health, health and safety of farmers, occupational health, injury prevention, rural health
National Children's Center for Rural and Agricultural Health and Safety, Wisconsin	Health and safety issues for farm children, guidelines for acceptable agricultural tasks

in response to an explicit directive of Congress, those surveillance efforts could have shaped the direction of the program for years to come. Instead, data remain unanalyzed in several of the states, and one state experienced such basic difficulty in planning, organizing, and directing the effort that little could be salvaged.

Transfer of research findings has been implemented through the OHNAC program; the Agricultural Safety Promotion System (direct funding of state-level agricultural safety specialists in land-grant institutions); fishing and forestry interagency working groups; explicit funding of such projects as ergonomic interventions for youth working in agricultural worksites and ergonomic designs for tools and work areas in nurseries, turf and garden entities, and orchards; and specific ERC-sponsored symposia and other training initiatives. The reach of those efforts has been nation-wide for the agricultural sector and largely regional for the forestry and fishing sectors. Stakeholders have been involved, particularly when the regional Ag Centers and the ERCs anchored the transfer activity. Research and educational capability were enhanced extramurally, and intramural capability in NIOSH also expanded. Numerous basic scientists, clinicians, engineers, and other researchers now active in the AFF arena received their original impetus from those efforts.

OUTPUTS

Major outputs of the AFF Program have been publications in scientific journals, fact sheets on the NIOSH Web site, summaries of disorder- or organ-system-focused epidemiological projects (for example, the documents *Epidemiology of Farm-Related Injuries: Bibliography with Abstracts* and *Injury and Asthma Among Youth Less Than 20 Years of Age on Minority Farm Operations in the United States, 2000*), and monographs (such as *Simple Solutions: Ergonomics for Farm Workers*, 2001; *Guide to Evaluating the Effectiveness of Strategies for Preventing Work Injuries*, 2001; and *Childhood Agricultural Injury Prevention: Issues and Interventions from Multiple Perspectives*, 1992) designed to serve as tools for translating research to practice. The degree to which those outputs addressed clinical problems varied greatly, so each category of output is discussed separately below.

Injury Research and Ergonomics

The AFF Program has stimulated extensive research across the nation on traumatic injuries; deaths and disabling injuries account for a considerable proportion of the intramural and extramural research. National Safety Council statistics indicate that agriculture continues to rank as one of the most dangerous industries. However, lack of a cohesive surveillance program makes it difficult to track the effectiveness of the programs. Nonetheless, the AFF Program has attempted to focus on some important subjects, such as tractor safety and rollover protection structures (ROPS), for which cause and effect have been demonstrated. Research in ergonomics seems to have been much more limited—despite its importance to health and safety and to the mission of NIOSH—with several notable exceptions,

such as the development of handles for flower pots in the greenhouse industry, smaller fruit containers that result in lighter loads, and longer rake handles.

Respiratory Disorders

NIOSH AFF staff and the leadership of the NIOSH Ag Centers gave respiratory disorders high priority. They have been leaders in characterizing respiratory exposures to organic dust by using modern industrial hygiene methods. They have also helped to describe disease phenotypes associated with those exposures and to define the epidemiology of the respiratory disorders of interest. The AFF Program was one of the first to fund a study of gene-environment interactions in the farm setting. Work in respiratory disorders has been done by intramural researchers and NIOSH-funded extramural researchers that generally have worked well together. Overall, the publications have had a large impact on the national and international scientific community. That impact was amplified through funding of well-attended national and international conferences on agricultural safety and health in which respiratory disease was one of the main themes. The impact of the output on farmers and farm workers is much more difficult to assess but does not appear to be as great as it could be. The AFF Program effort in respiratory disease appears to be limited almost completely to agriculture except for some work in asthma caused by exposure to snow crabs.

Cancer

The AFF Program has not had a major focus on research in occupational cancer detection or prevention since the 1990s except through its partnership with NCI and NIEHS in the Agricultural Health Study (AHS). That illustrates a reasonable approach to division of health effects research among partner agencies in theory, but it suffers from the lack of any reported intentional decisionmaking on the part of NIOSH. The AHS is a prospective study of pesticide health effects in over 88,000 people. Subjects include private and commercial pesticide applicators and their spouses living in Iowa and North Carolina, most of whom are farmers. The major focus has been on defining associations between pesticide exposure and cancer. To date, much less effort has been devoted to creating recommendations, devising interventions, and building capacity.

Neurological Disease

The AFF Program has not had a major focus on research on occupational neurological disease detection or prevention. NIOSH has had some activity in this

field primarily through its partnership with NCI and NIEHS—a reasonable division of labor. As noted above, the major focus of the joint effort through the AHS has been on defining associations between pesticide exposure and cancer; research on neurological disease outcomes related to pesticide exposure, such as Parkinson's disease, has been a secondary interest. Much less effort has been devoted to creating recommendations, devising interventions, and building capacity in this field as well. However, the effort in general is an excellent example of NIOSH collaboration with other government agencies interested in the health and well-being of AFF workers. The AHS has collected a wealth of data that can ultimately be used to address clinically important questions. The information generated would then be used to create recommendations for dissemination to farm communities. Little work has been done through the AFF Program to assess workers in forestry or fishing for evidence of neurological disease. Revisiting vibration-induced neurological disease may be appropriate.

Reproductive Health

Modest AFF Program funding has been devoted to studying reproductive outcomes in farm families. No firm conclusions have been drawn from the work, and no recommendations have been formulated by NIOSH. The committee is not aware of any NIOSH-funded work in this field in forestry and fishing.

Chronic Musculoskeletal Conditions

Osteoarthritis of weight-bearing joints is an important problem in farmers. Scientific work on it has been done mostly in Europe. There is no NIOSH-funded work in this field in forestry or fishing.

Noise-Induced Hearing Loss

The epidemiology of hearing loss and strategies for hearing conservation are important topics for the AFF sector. NIOSH has a separate Hearing Loss Program, which underwent program review in 2006 (IOM and NRC, 2006). Within the AFF Program, there has been a relatively small but steady stream of projects characterizing hearing loss and use of personal protective devices, mostly conducted through the Ag Centers. Research outputs—which include published reports, scientific manuscripts, training materials, and dissemination of these products—address hearing conservation, hearing loss as a risk factor for injury, comparisons of self-reported hearing to audiometric testing, prevalence of noise-induced hearing loss, and task-based and animal-based exposure assessment. While the majority of activ-

ity has been in agriculture, a few studies have looked at noise in forest harvesting and aboard catcher-processor fishing vessels.

Dermatological Disorders

Dermatological disorders are known to be an important problem in production agriculture. Less is known about their impact on the health of workers in forestry and fishing. The AFF Program does not appear to have generated major outputs in this field.

Traumatic Injury

The epidemiology of traumatic injury and death on farms and in the Alaska fishery has received a great deal of emphasis in the AFF Program. Much less information was available about this topic with reference to forestry. Important contributions to the understanding of the problem have been made by intramural and extramural NIOSH investigators, particular those working in the fishing industry in Alaska. In that arena, the research has led to the development of solutions for the problem and to a large reduction in death rates. Finding a way to reduce injury and death from trauma on farms has proved more difficult except for injury to children and tractor rollovers, in which considerable progress has been made. Much work remains to be done to extend the fishery work to other regions; to devise effective ways of reducing injuries in all farm populations, including farm workers; and to address the large problem of traumatic injury in forestry workers.

Poisonings

Poisoning from exposure to high concentrations of toxicants remains an important problem in AFF workers, primarily related to exposure to pesticides. NIOSH has funded extensive work in agricultural pesticide poisoning, including epidemiology, identifying clinically relevant biomarkers, and training workers to avoid causative pesticide exposure. Some of the work has been done in effective interagency collaborative relationships, particularly through the AHS. NIOSH has also helped to raise awareness of the problem of carbon monoxide poisoning in production agriculture through the publication of a NIOSH Alert on the topic. There has also been an effort to educate fishermen about it. NIOSH's response to emerging problems regarding poisonings in the AFF sector has not always been rapid. For example, several years elapsed between the deaths of two farmers from unintentional injection of tilmicosin, a veterinary antibiotic, and the publication of a NIOSH Update report containing recommendations to prevent poisoning with it.

Infectious Diseases

The output of the NIOSH AFF Program with respect to infectious diseases has been modest. NIOSH did sponsor one conference on agroterrorism. There may have been unexplored potential to partner with the Department of Homeland Security in additional work on the topic. The growing concern about avian influenza and the extensive planning already in progress for dealing with it in a possible pandemic may provide NIOSH with additional opportunities for collaboration.

Gene-Environment Interaction

NIOSH funded early investigations in gene-environment interactions as they pertain to work in production agriculture. In doing so, it demonstrated its ability to take advantage of opportunities created by an increase in knowledge about agricultural exposures gained through the AFF Program and new technologies in genetics. The next challenge is to conduct scientifically important studies on gene-environment interactions with larger populations of AFF workers. Doing so would require collecting data from multiple sites and demonstrating a level of cooperation and coordination that has not been evident in some of the other research funded through the AFF Program.

Psychological Effects

The effects of psychological stressors on the AFF workforce have not been extensively explored with NIOSH AFF Program resources. It is known that farmers have a high rate of suicide, and a link to pesticide exposure has been proposed. The AFF Program has the potential to explore the effect of occupational exposures and psychological stressors on health outcomes in the AFF workforce.

Workplace Violence

NIOSH has made recommendations in an effort to reduce the impact of workplace violence. Workplace violence occurs occasionally among hired farm laborers, but there is very little evidence in literature regarding prevalence and reports are anecdotal. In the California Agricultural Worker Health Survey, only 0.7 percent of male workers reported ever having been a victim of workplace violence (Brammeier et al., *in press*; Villarejo and McCurdy, *in press*). Data similarly shows that there were no reported cases of workplace violence for fishermen from 2001-2007 nor does it occur enough to be included as a question in the U.S. Coast Guard's accident investigation forms or databases (Lieutenant Commander Vasquez, U.S. Coast Guard

Commercial Fishing Vessel Safety Office, personal communication, November 1, 2007). The AFF sector is not currently viewed as one in which workplace violence is a large concern.

Sleep Deprivation

There is a growing understanding of the health effects of sleep deprivation, from trauma (Stallones et al., 2006) to obesity. It is known that workers in specific industries in which long hours and shift work are common, including healthcare, are at increased risk for adverse health outcomes directly associated with sleep deprivation. NIOSH has not extensively addressed the issue in the AFF sector, even though accounts of long workdays and workweeks are noted in employee activity logs and are legion in the sector.

Aging

The AFF workforce is aging; a disproportionate number of the workers actively employed in this sector are in their 50s or older. Aging contributes to the risk of poor outcomes because of work exposures in a variety of ways, from increased risk of traumatic injury to higher morbidity from sleep disorders. Age-related health risks in AFF workers and possible solutions are topics that merit more attention.

Children and Adolescents

Infants and toddlers are not workers, but may be brought into work environments and may also incur exposures at home, particularly if living in housing adjacent to areas of aerial spraying. They are also vulnerable to inadvertent exposures to chemicals stored and utilized in the agricultural workplace. Small children incur differential exposures due to their physiology, metabolism, and diet (NRC, 1993). Their increased respiratory rates relative to adults have implications for respiratory exposures, and oral behaviors of the young increase their risk of ingestion of any hazardous materials in their environment. Concerns have been raised that these findings have applicability to agricultural work settings that include children. Children as young as preschoolers may work with crops or animals, and the issues of differential risk may apply to these children. Risk due to a child operating adult-sized machinery or with large animals may outweigh exposure risks.

Adolescents are also considered vulnerable to occupational exposures. A National Research Council report (1998a) noted the lack of definitive research on the difference between adolescent and adult immune and other systems that would lead to increased vulnerabilities in adolescents, and subsequently suggested that research

be conducted on exposures to substances associated with latent diseases (such as cancer, hearing loss, repetitive motion injuries, and back injury) at a time of rapid growth and cell turnover, and also on endocrine disruptors at a time of puberty.

INTERMEDIATE OUTCOMES

The intermediate outcomes span unique staff and laboratory capability for AFF worksite exposure assessment, explicit worksite interventions and fruitful partnerships with AFF stakeholders, professional and clinical training at academic health centers, and symposia and other professional career-development opportunities. Prevention or mitigation of exposure is reflected in a hierarchy that begins with AFF worksite exposure assessment, moves to testable interventions, continues with stakeholder partnerships if interventions are effective, and culminates in training of and clinical awareness in rural practitioners, agricultural extension leadership and staff, local public health nurses, agricultural engineers, and voluntary agriculture and forestry association staff and general membership. NIOSH public affairs staff repeatedly rejected advice from Ag Center scientists encouraging intramural staff to produce materials that farmers could relate to and understand.

AFF worksite exposure assessment needs to involve unique biomechanics, basic science, and epidemiological assessment. NIOSH and the extramurally funded Ag Centers have developed and deployed biomechanics and basic science capability. Substantial activity has also occurred in design of rural epidemiological surveillance, sometimes without NIOSH assistance or support but still able to elucidate the epidemiology of disease states and injury of disabling conditions of interest in agriculture and forestry populations.

NIOSH funding has been invested in AFF worksite interventions, such as design of a Certified Safe Farms initiative, tractor ROPS public policy development, rural cancer control intervention development, ergonomic tool design, development of respiratory and hearing personal protective equipment, organic dust reduction in AFF worksites through animal housing engineering, injury prevention through redesign of worksite facilities and methods of work, design of safe play areas for children in agricultural worksites, design of helicopter logging injury countermeasures, and use of enhanced deck safety technologies for fishermen. Those initiatives have generally been scientifically robust and clinically relevant and have reflected input of AFF stakeholders whose perspective governed identification and priority-setting of interventions and the actual deployment process. Feedback from AFF stakeholders as varied as the National Institute for Farm Safety and the U.S. Coast Guard about the utility of the interventions has generally been favorable. Other AFF stakeholders—including agricultural engineers, rural clinicians,

public health and clinical nurses, extension safety personnel, and voluntary and professional organization staff—have professed encouragement of the efforts and suggested more rapid deployment and greater penetration in AFF worksites.

Of particular interest to the committee were instances in which engineering standards, regulations, and other guidelines were developed and deployed across time in all three AFF sectors. The most robust activity occurred in the fishing sector, and activity was somewhat more limited in the logging sector, but in both instances the NIOSH intramural program led the way. Most AFF resources allocated by Congress were directed toward the agricultural sector; however, this sector has been the most timid in these matters. Clearly, agricultural worksites are complex, and liability concerns of agricultural technology developers and machinery manufacturers are ever present and the failure to unify the communities of science and agriculture, forestry, and fishing for the common good has hindered new initiatives and the flow of information and technology at institutional, local, state, and national levels.

END OUTCOMES

In general, trends in morbidity and mortality related to AFF exposures have been difficult to quantify. However, mortality due to cancer and trauma has been more readily quantified than other outcomes, even though it has not always been possible to identify clear-cut associations between AFF exposures and cancer death. Trends in other disease end points resulting from occupational exposures remain elusive, including neurological, reproductive, musculoskeletal, dermatological, infectious, psychological, and physiological (sleep-deprivation) outcomes.

Trends in mortality and morbidity resulting from worksite injury have been documented in the Alaska commercial fishing industry and the West Virginia logging industry. Evidence provided by NIOSH confirmed that interventions designed and field-tested by the AFF Program have reduced mortality and morbidity there. The challenge is to amplify that impact by expanding the interventions into other geographic regions in those sectors.

Trends in morbidity and mortality resulting from respiratory diseases have recently been described in NIOSH documents (2000b, 2007c). The documents do not contain data from all states (including a group of states that produce the majority of agricultural and forestry products), but the data indicate that rates of respiratory illness and injury in agricultural workers did not change appreciably from 1995 to 2001. Given the data limitations, the analyses do not offer a comprehensive review of outcomes in the AFF workforce.

Mortality resulting from cancer is generally lower in AFF populations than in the overall American population (Hanrahan et al., 1996). That may be due in part to greater use of preventive measures and clinical screening in some AFF worker populations than in other working populations. It could also be due to the protective effect of some AFF exposures—a phenomenon that deserves further exploration (NIOSH, 2007c). The higher incidence of primary intracranial glioma among male farmers compared to the general population led to the design and implementation of a case-control study conducted jointly by NIOSH and two extramurally funded Ag Centers (Great Plains Center for Agricultural Health in Iowa and the National Farm Medicine Center in Wisconsin). Results of the effort are emerging. In general, cancer mortality in American males has declined (American Cancer Society, 2007), so any decline attributed to occupational exposure needs to exceed historically observed declines.

7

Review of Intervention Research

The National Institute for Occupational Safety and Health (NIOSH) Agriculture, Forestry, and Fishing Program (AFF Program) has devoted significant resources toward developing and evaluating interventions focusing on the agriculture, fishing, and forestry industries. Review of the program indicates that intervention research-related projects span several of the AFF Program defined goals including those focusing on Priority Populations at Risk (Goal 2), Health Effects of Agricultural Agent Exposures (Goal 3), and Hazard-Control Systems (Goal 4). Given the fundamental importance of intervention research and the noted overlap of activities, the committee decided that it would be appropriate to consider intervention research as a whole, and to collectively evaluate these activities.

STRATEGIC GOALS AND OBJECTIVES

Goal 2: Priority Populations at Risk—Reduce injuries and fatalities among subgroups of the working population determined to be at high risk or underserved by traditional occupational health approaches.

Goal 3: Health Effects of Agricultural Agent Exposures—Determine the chronic effects of agricultural exposures/health outcomes from toxic exposures and develop appropriate interventions to reduce the incidence of disease.

Goal 4: Hazard-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.

The intervention-research aspects of the AFF Program's goals align well with high-priority research subjects identified in the National Occupational Research Agenda (NORA), including control technology and personal protective equipment and intervention effectiveness in the category of research tools and approaches. The research goals are general and do not include specific measurable objectives or stated strategies for accomplishing the goals. NIOSH relies largely on NORA and the peer-review process to ensure the relevance of funded intramural and extramural projects. However, the process lacks formal mechanisms for coordinating research efforts in a scientific community that includes NIOSH scientists and engineers and extramural investigators in the NIOSH Centers for Agricultural Disease and Injury Research, Education, and Prevention (Ag Centers) and other research institutions and centers. The current NORA-2 process for establishing the goals and objectives of the AFF Program needs to ensure relevance. The current strategic goals of the AFF sector defined under NORA-2 are in development. In addition, the process through which the NORA sector councils are being developed needs to ensure that emerging problems are identified through interaction and communication with stakeholders. It seems likely that the establishment of an AFF sector in NORA will ensure that the research programs align with priorities established through the NORA-2 development process.

LOGIC SUBMODEL

Information received from the NIOSH AFF Program (NIOSH, 2006a) related to inputs, activities, outputs, intermediate outcomes, and end outcomes in intervention research is summarized in the intervention research logic submodel (Figure 7-1).

INPUTS

Funding for intervention research has been provided through cooperative agreements, extramural grants, and internal funding of specific projects.

ACTIVITIES

The major subprograms related to intervention research are listed in Table 7-1 with approximate dates and funding levels. The Ag Centers are listed as a whole, because detailed project information was not available by individual center. The activities are consistent with intervention research, which is an element of several AFF Program goals, including those related to high-priority populations, chemical exposure, hazard control, and outreach.

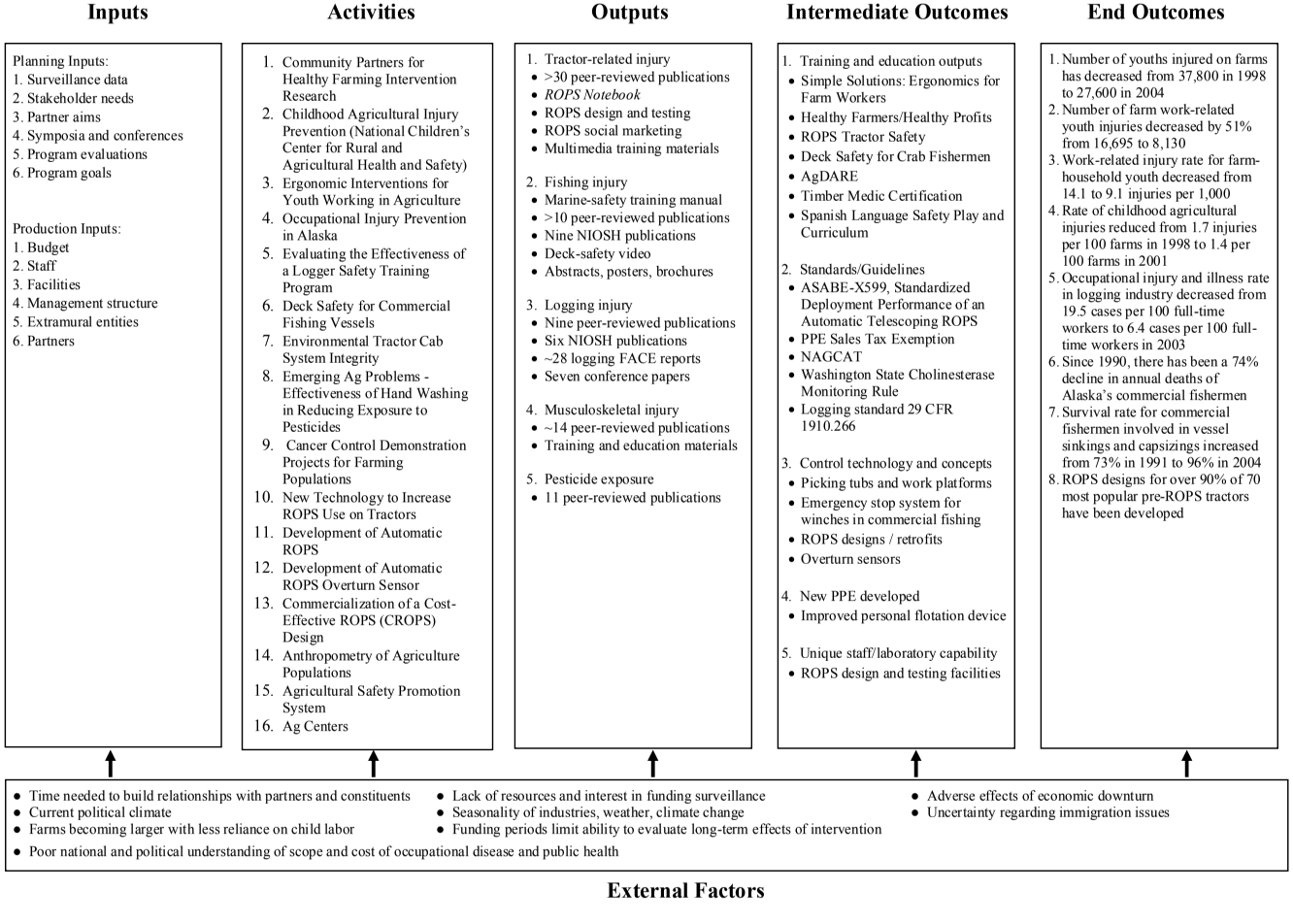

FIGURE 7-1 Intervention research logic submodel.
AgDARE = Agricultural Disability Awareness and Risk Education, ASABE = American Society of Agricultural and Biological Engineers, FACE = Fatality Assessment and Control Evaluation , NAGCAT = North American Guidelines for Children's Agricultural Tasks, PPE = personal protective equipment, ROPS = rollover protective structure.

TABLE 7-1 Programs with Intervention Research Activities

Program or Project	NIOSH Division	Dates	Funding ($)
Community Partners for Healthy Farming Intervention Research	DSHEFS	1996-2007	6,550,341
Childhood Agricultural Injury Prevention, National Children's Center for Rural and Agricultural Health and Safety (NCCRAHS)	DSR	1996-2010	1,107,379
Occupational Injury Prevention in Alaska—Commercial Fishing, Helicopter Logging	AFS	1990-2010	3,388,092
Ergonomic Interventions for Youth Working in Agriculture	DART	2000-2006	370,104
Evaluating the Effectiveness of a Logger Safety Training Program	DSR	2000-2004	205,403
Deck Safety for Commercial Fishing Vessels	AFS	2004-2006	198,424
Environmental Tractor Cab System Integrity	DRDS	2001-2005	778,570
Emerging Agricultural Problems—Effectiveness of Hand Washing in Reducing Agricultural Worker Exposure to Pesticides	DSHEFS	1996-2004	1,078,076
Cancer Control Demonstration Projects for Farming Populations	DSHEFS	1990-1997	>46,304
New Technology to Increase ROPS Use on Tractors	DSR	2000-2006	1,222,948
Development of Automatic ROPS	DSR	1992-1999	392,545
Development of Automatic ROPS Overturn Sensor	DSR	1994-1999	484,492
Commercialization of a Cost-Effective ROPS (CROPS) Design	DSR	2003-2004	122,825
Anthropometry of Agriculture Populations	DSR	1996-2003	718,369
Agricultural Safety Promotion System	DSR	1995-1997	1,000,000
Ag Centers	OEP	1997-2006	74,885,568

NOTE: AFS = Alaska Field Station, DART = Division of Applied Research and Technology, DRDS = Division of Respiratory Disease Studies, DSHEFS = Division of Surveillance, Hazard Evaluations, and Field Studies, DSR = Division of Safety Research, OEP = Office of Extramural Programs.

Relevance to Most Serious Outcomes

The intervention research activities generally focus on the most serious outcomes. According to the *Worker Health Chartbook*, the five leading sources of occupational fatalities in AFF in 1992-2001 were farm tractors (2,165), trucks (795), fishing boats (434), ground (403), and trees and logs (357) (evidence package Table 2-3, NIOSH, 2004). A large portion of AFF Program activities was devoted to intervention research designed to address the most serious outcomes.

Tractor Fatalities

In the case of tractor fatalities, primary research emphasis has been on the development and evaluation of rollover protection structures (ROPS). Intramural projects focusing on ROPS were conducted by personnel in the Division of Safety Research, including New Technology to Increase ROPS Use on Tractors, Development of Automatic ROPS, Development of Automatic ROPS Overturn Sensor, and Commercialization of a Cost-Effective ROPS (CROPS) Design. Cooperative agreement research focusing on tractor interventions was conducted through the Community Partners for Healthy Farming Intervention Research, which supported such projects as the Kentucky ROPS programs (I and II) and Electronic Tractor and Machinery Safety Training Material for Youth. The Ag Centers also contributed resources to the development of interventions to prevent tractor and equipment injuries; projects included ROPS Design and Testing for Agricultural Vehicles (High Plains Intermountain Center for Agricultural Safety and Health), Cost-Effectiveness of Promoting Rollover Protective Structures (ROPS) and Seat Belts on Family Farm Tractors (Southeast Center for Agricultural Health and Injury Prevention), Tractor Safety Program (The Northeast Center for Agricultural and Occupational Health), an Audiovisual Approach to Train WV Farmers on Prevention Effectiveness of ROPS in Reducing Traumatic Injury (Great Lakes Center for Agricultural Safety and Health), Tractor Risk Abatement and Control (TRAC-SAFE) (Great Plains Center for Agricultural Health), and Youth, Tractors, and Policy (National Children's Center for Rural and Agricultural Health and Safety). In addition, a National Agricultural Tractor Initiative involving a collaboration of all the Ag Centers and the National Children's Center began in 2005; its goals are to establish incentives to retire older tractors or retrofit them with ROPS, increase the use and maintenance of preventive and protective technologies, mount a social marketing campaign aimed at safer tractor use, and build private-sector and legislative support.

Fishing Vessel Fatalities

Intervention research related to fishing vessel fatalities has been the focus of several intramural and extramural projects, including Commercial Fishing Safety Training in Alaska: 1993-2006, Injury Prevention in the Commercial Fishing Industry (at the Alaska Field Station, AFS), Deck Safety for Commercial Fishing Vessels (AFS), and Occupational Injury Prevention in Alaska (AFS).

Logging Fatalities

The AFF Program has adopted a multipronged approach to control injuries in logging, consisting of support for development of an Occupational Safety and Health Administration (OSHA) standard for the logging industry, coordination of an Alaskan intervention program to address injuries associated with helicopter operations, conduct of investigations of selected logging fatalities with the Fatality Assessment and Control Evaluation (FACE) program, and assessment of mechanical logging methods as a means of reducing injuries.

Relevance to Most Frequent Outcomes

The 2004 *Worker Health Chartbook* indicates that the number of nonfatal agricultural injuries has been increasing; they totaled 104,400 in 2001. On the basis of data gathered from 1993 to 1995, the leading sources of injury were machinery and livestock, with roughly equal numbers attributed to each (about 99,000). The largest number of injuries occurred in cattle, hog, or sheep operations, followed by cash-crop and dairy farms. The *Chartbook* also presents nonfatal injury data from the 11 NIOSH surveillance and research areas. Results show that relative to other industries, the AFF sector had relatively high rates in the surveillance categories of fatal injuries, nonfatal injuries (particularly amputations, back injuries, bruises and contusions, cuts and lacerations, fractures, and strains, sprains, and tears), poisoning (with pesticides), respiratory disease (especially hypersensitivity pneumonitis), and dermatitis. It is noted that surveillance data on many of these categories are quite sparse.

The AFF Program has supported numerous intervention research activities directed toward the most common outcomes. The projects reflect diverse targeted outcomes that in general are relevant to the most common outcomes identified in the *Worker Health Chartbook* or through surveillance activities conducted as part of other Ag Center activities.

Relevance to Needs of Special Populations

Gender is often included in examinations of risk factors for injury and illness, but no evidence was found to suggest that it was being specifically considered in the intervention research projects examined. Vulnerable working populations were often the focus of AFF Program intervention projects, including the extensive emphasis on childhood agricultural injury prevention, migrant and minority populations, loggers, and fishermen.

Partnerships in Research Activities

The AFF Program partners extensively with numerous organizations at the national and local levels in conducting intervention research. There are numerous examples of diversity in partnerships in terms of the size of the organizations involved and the nature and scope of the projects. A detailed list of federal agency partnerships established for high-priority populations at risk is found in Table 7-2.

On the basis of the extensive partnerships described, it is clear that this aspect of the AFF Program is one of its strengths and that it probably results in numerous synergies that increase overall effectiveness.

TABLE 7-2 Federal Agencies Partnering with the NIOSH AFF Program on High-Priority Populations at Risk

CHILDHOOD AGRICULTURAL INJURY PREVENTION
Centers for Disease Control and Prevention, Division of Community and Migrant Health Centers
Consumer Product Safety Commission
Health Resources and Services Administration (HRSA), Maternal Child Health Bureau
Indian Health Service
National Center for Injury Prevention and Control
National Institute of Child Health and Human Development
U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)
USDA, Cooperative State Research, Education, and Extension Service
U.S. Department of Education, National FFA Adviser
U.S. Department of Education, Office of Migrant Education
U.S. Department of Labor (DOL), OSHA
DOL, Employment Standards Administration
DOL, Employment and Training Administration
MINORITY-POPULATION PROGRAMS
DOL, OSHA
Food and Drug Administration
HRSA
Navajo Chapter Houses
National Cancer Institute
USDA-NASS
U.S. Environmental Protection Agency (EPA)
FISHING SAFETY RESEARCH
Alaska Marine Safety Education Association (AMSEA)
Harvard School of Public Health
North Pacific Fishing Vessel Owners' Association
U.S. Coast Guard

SOURCE: NIOSH, 2006a.

Appropriateness of Resource Allocations

It is difficult to find a coherent theme in some of the projects that have been funded over the period examined. Historically, some Ag Centers seem to have taken on a large number of varied projects that do not necessarily represent a subject of focus. The most recent request for applications for Ag Centers is structured in such a way as to ensure that center programs have a focus or theme, that intervention projects are fully developed, and that process and outcome measures are included. Furthermore, the requirement that at least 20 percent of Ag Center direct costs be devoted to prevention and intervention research ensures a substantial commitment to this kind of research in the future.

Planned Program of Transfer Activities

There is not a single, coherent, AFF Program-wide plan for intervention research transfer. Plans for transfer activities may be included in individual projects, and in some cases the projects themselves may focus entirely on transfer activities, but there is no unified strategy for transfer of AFF Program intervention research.

OUTPUTS

The major outputs from intervention research activities are publications, reports, conferences, databases, engineering designs, guidelines, recommendations, education and training materials, scientific manuscripts, and product dissemination. Intervention research outputs addressed a variety of outcomes, including such high-priority subjects as tractor-related, fishing, and logging fatalities. In addition, many outputs were developed to reduce injury and illness related to tractors and equipment, livestock, musculoskeletal disorders, and pesticide exposure.

High-Priority Subjects

Tractor-Related Injury Intervention Research

This research has produced numerous outputs aimed at reducing tractor-related fatalities through the Community Partners for Healthy Farming Intervention. It supported the Kentucky ROPS project, which produced a notebook "toolkit" for promoting ROPS-equipped tractors (Ehlers and Palermo, 2005). The project led to more than 10 peer-reviewed publications and electronic and paper versions of training materials in different languages. Several Ag Centers have also focused intervention research efforts in tractor-related injury.

Fishing Vessel Fatalities

Intervention research outputs related to reducing fishing fatalities were produced primarily through the AFS (Injury Prevention in the Commercial Fishing Industry, Deck Safety for Commercial Fishing Vessels, and Occupational Injury Prevention in Alaska—Commercial Fishing), Ag Centers (Skin Disorders in Commercial Fishermen and Understudied/Under-Represented Populations—Vietnamese Shrimpers), and an extramural project (Commercial Fishing Safety Training in Alaska: 1993-2006). Outputs included abstracts, posters, brochures, patents, peer-reviewed publications, a 450-page marine safety training manual, and multilingual DVD and videotaped training materials.

Logging Fatalities

Intervention-research outputs directed at reducing fatalities in logging included peer-reviewed publications; NIOSH publications, including FACE reports; criteria for a recommended standard; and conference papers and presentations.

Musculoskeletal Disorders and Ergonomics

Many intervention-research outputs focusing on ergonomics and musculoskeletal disorders (MSDs) have resulted from the AFF Program, including the following:

1. Community Partners for Healthy Farming Intervention Research:
   - Ergonomic Interventions in Wine Grape and Tree Fruit Production
   - Healthy Farmers-Healthy Profits—direct-market vegetable producers
   - Healthy Farmers-Healthy Profits—tame berry producers in six upper Midwest states
2. Ergonomic Interventions for Youth Working in Agriculture
3. Agricultural Safety Promotion System: effectiveness of ergonomic interventions in nursery operations
4. Western Center for Agricultural Safety and Health:
   - Improving Health and Safety of Field Workers by Redesigning Tools
   - Prevention of Musculoskeletal Disorders in Hand Harvest of Vegetable Crops
   - Evaluation of the Ergonomics of an Alternative System for Harvesting Pears
   - Efficacy of Weight Transfer Devices in Reducing Low Back Pain in Stoop Labor

5. Southern Coastal Agromedicine Center: Ergonomic Interventions in the Agriculture Industry
6. The Northeast Center for Agricultural Health: Musculoskeletal/Ergonomic Program
7. Pacific Northwest Agricultural Safety and Health Center: musculoskeletal disorders

In addition, a conference focused on stooped and squatting postures in the workplace was jointly sponsored by the University of California Center for Occupational and Environmental Health, the University of California Agricultural Ergonomics Research Center, NIOSH, the California State Compensation Insurance Fund, and the Center to Protect Workers' Rights (Stooped and Squatting Postures in the Workplace, Oakland, CA, July 29-30, 2004).

Pesticide Exposure

Intervention research outputs related to pesticide exposure were produced by such projects as Interventions To Reduce Pesticide Exposures Among Agricultural Workers and Their Families (Pacific Northwest Agricultural Safety and Health Center) and Emerging Agricultural Problems—Effectiveness of Hand Washing in Reducing Agricultural Worker Exposure to Pesticides (Division of Surveillance, Hazard Evaluations, and Field Studies).

Generation and Dissemination of New Knowledge

Considered as a whole, the AFF Program has generated considerable amounts of new technology and knowledge related to interventions, although the quantity and quality of the outputs are highly variable.

Numerous peer-reviewed publications have been produced, and many have been presented in flagship journals and widely cited. The diverse nature of the journals suggests that outputs reach a wide and varied audience and that investigators are choosing publications believed to be best aligned with the content of and relevant stakeholders for the projects described.

Relevance of Outputs to Both Sexes, Vulnerable Populations, and Health Disparities

Intervention research outputs included publications that were relevant to both sexes, vulnerable populations (children, fishermen, loggers, and orchard workers), and health disparities (skin cancer).

Relevance of Outputs to Small Businesses

Outputs are relevant to small businesses. It is well recognized that two of the most important challenges in developing interventions for agriculture, forestry, and fishing is that most operations are small and that effective regulation and comprehensive surveillance programs do not exist. Most of the outputs produced are relevant to or specifically produced for small operators.

Readability, Simplicity, and Design of Outputs

Intervention research outputs intended to be delivered to AFF workers have generally been designed with the end user in mind. Materials examined were appropriately readable and user-friendly.

The North American Guidelines for Children's Agricultural Tasks (NAGCAT) was developed to guide parents in assigning farm jobs to children 7-16 years old. The guidelines are targeted for use by parents, agricultural safety specialists, educators, youth groups, health professionals, farm organizations, public health professionals, and the mass media. The guideline booklets are user-friendly with respect to readability, simplicity, and design.

Materials developed for migrant and minority-group orchard workers have been included in the National Agriculture Safety Database, such as educational and informational resources organized by topic, language, and format (for example, fact sheet, news releases, and script). Whether this is the most effective manner to reach these workers is not clear.

These examples make up only a small portion of the intervention research outputs produced, but they demonstrate an awareness of the need to prepare materials in a user-friendly manner that is appropriate for the intended audience with some exceptions such as the migrant workers who do not use computers as a source of information and may have low English or Spanish literacy.

INTERMEDIATE OUTCOMES

AFF Program intervention research activities have resulted in numerous training and education outputs that are being used in the workplace or in school or apprentice programs. They have also led to the development of standards, regulations, public policy, and voluntary guidelines that have been transferred to or created by the workplace in response to NIOSH outputs. Furthermore, new control technology, personal protective equipment, and administrative control concepts that are feasible for use have been adopted in the workplace to reduce risk factors. Although objective data are difficult to obtain, results generally indicate that stakeholders find value in AFF Program intervention research products, as indicated by

document requests, Web hits, conference attendance, and anecdotal reports and feedback. Evidence suggests that program activities have resulted in many research partnerships with stakeholders that have led to changes in the workplace and that interventions that protect both sexes and vulnerable workers and that address the needs of small businesses have been developed.

Standards, Regulations, Public Policy, and Voluntary Guidelines

The AFF Program has produced several examples of standards, regulations, public policy, and voluntary guidelines related to intervention research. Those outputs include revised or proposed standards related to ROPS for tractors, legislation providing rebates for ROPS retrofits, sales tax exemptions for purchase of personal protective equipment, guidelines for children's agricultural tasks, and support for development of a statewide cholinesterase-monitoring program and a federal logging standard.

New Personal Protective Equipment Developed

The AFF Program has developed a prototype improved personal flotation device that has thin, flexible patches that become illuminated once the personal flotation device or jacket is submerged and allow quick location and recovery of victims.

Unique Staff and Laboratory Capability

The High Plains Intermountain Center for Agricultural Health and Safety and the NIOSH Pittsburgh Laboratory for designing and testing engineering control strategies for tractors and other agricultural equipment house unique capabilities among the Ag Centers and other institute and agency resources.

END OUTCOMES

Demonstrating the impact of intervention research is challenging and complex given the considerable time often required for a measurable impact on population illness and injury rates to occur. Furthermore, most diseases and injuries have multiple causes, and the adequacy of surveillance varies with changes in access to healthcare and economic disincentives to report. For those reasons it is difficult to attribute end outcomes directly to specific intervention research projects. However, there are some encouraging trends in injury and illness data that are consistent with a favorable impact. For example, since the release of NAGCAT in 1999, the work-

related injury rate in farm household youth decreased from 14.1 to 9.1 injuries per 1,000 working household youth from 1998 to 2004.

After the release of a proposed OSHA logging standard in 1989, the national occupational injury and illness rate in the logging industry decreased from 19.5 to 6.4 cases per 100 full-time workers in 2003. NIOSH also played a lead role in developing the Alaska Working Group's July 1993 recommendations to prevent helicopter logging crashes. Since that time, there has been only one helicopter logging crash in Alaska (it occurred in 1996).

Although it is recognized that the work-related fatality rate in commercial fishing in Alaska remains unacceptably high, historical data show that fatalities are decreasing. NIOSH reports that since 1990 there has been a 74 percent decline in annual deaths in Alaska's commercial fishermen. Extensive collaboration with U.S. Coast Guard and numerous other partners in Alaska to implement new safety requirements probably contributed substantially to the 96 percent survival rate of commercial fishermen involved in vessel sinkings and capsizings in 2004; the survival rate was only 73 percent in 1991.

NIOSH also reports that a pilot eye injury prevention project funded by the AFF Program in Florida helped to reduce eye injuries (by 75 percent) in 500 workers from 2003 to now. The project also found that the rate of acceptance of safety glasses increased to 65-75 percent from 5 percent before intervention.

Those end outcomes are only a sample of the outcomes attributed to AFF Program intervention research.

EXTERNAL FACTORS

Programs engaged in intervention research have described various external factors relevant to the AFF sector. These external factors include: the seasonality of work tasks which often provides only short windows of time for data collection; multiple years that are needed to demonstrate effective intervention results; weather variations that influence activities across years; and workers that are willing to take risks and lack awareness of the preventability of illnesses and injuries. Other variables include: rapid changes in the work practices under study; time needed to build relationships with partners and constituents; market conditions; current political climate and uncertainty regarding immigration issues; and a poor national and political understanding of the scope of and costs related to occupational disease and public health.

8

Review of Outreach Activities: Knowledge Diffusion and Technology Transfer

STRATEGIC GOALS AND OBJECTIVES

Goal 5: Outreach—Reduce injuries and illnesses by informing and educating employers and employees in agriculture, forestry, and fishing (AFF) about occupational safety and health hazards and control systems.

In the evidence package (NIOSH, 2006a), the AFF Program provides examples of activities, outputs, intermediate outcomes, and impacts that reflect the results of the translation of knowledge and its transfer to diverse audiences and the implementation of recommendations. Some of the examples involve important interventions to support the adoption of safety innovations and included evaluations of their success and their impacts. The knowledge diffusion and technology transfer occurred through legislation, improved technology, protective equipment and clothing, and effective communication and education programming.

LOGIC SUBMODEL

Goal 5 incorporates a logic model directly associated with the "supply chain of knowledge". The concept of a supply chain of knowledge is related to the inputs needed for the development of knowledge, the transfer and communication of knowledge, as well as the surveillance and evaluation of and feedback about the impacts of these delivery mechanisms such as websites, conferences, and training programs. In the concept of a supply chain, links at each stage need to be strong

and connected to move the results of surveillance, research, and intervention to the appropriate target populations at risk, whether employees or employers. The logic submodel (Figure 8-1) identifies inputs, activities, outputs, and intermediate and end outcomes.

INPUTS

On the basis of the materials in the evidence package, the committee concluded that about 17 percent of the National Institute for Occupational Safety and Health (NIOSH) budget was devoted to Goal 5 over the period 1997-2006. That translates to about $800,000 per year for the intramural programs and $2.1 million per year for the extramural programs. The work involved about six full-time equivalents (FTEs) at NIOSH per year. The committee was unable to break out the funding or FTEs associated with Goal 5 at the NIOSH Centers for Agricultural Disease and Injury Research, Education, and Prevention (Ag Centers) but summarizes here the activities, outputs, and outcomes from the evidence package.

Planning inputs included the National Occupational Research Agenda (NORA, 2000), the National Coalition on Occupational Safety and Health (NCASH) report, and congressional directives. Many of the conferences, workshops, and symposia cited in Chapter 10 may also have helped to set priorities for this goal and other AFF efforts, but they are not so referenced. The logic model starts with the identification of the problems, knowledge gaps, and documentation of areas of severe or significant mortality, morbidity, and injuries. NIOSH identifies them in the opening chapters of the evidence package, but the evidence package often does not connect the materials to the goal of knowledge diffusion and technology transfer.

The second input required is a planning and priority-setting process communicated to NIOSH through the NORA process or from stakeholders. This process is currently underway.

The third stage is the application of priorities to intramural or extramural research through requests for proposals and principal-investigator initiatives. Surveillance projects and research conducted at this stage are expected to provide results for dissemination and improved processes, equipment, personal protective gear, and behavioral changes. The mechanisms for improvement include identifiable actions and proposed solutions, but these still need implementation through engineering, behavioral, or regulatory actions. The engineering solutions require diffusion of knowledge and implementation at the level of the manufacturer or employer and occasionally the worker. Behavioral changes require a mechanism for knowledge diffusion and attitude, motivational, and behavioral changes in practices associated with the workplace. Regulatory changes require a process to pass laws, write regulations or rules associated with the workplace, and have them

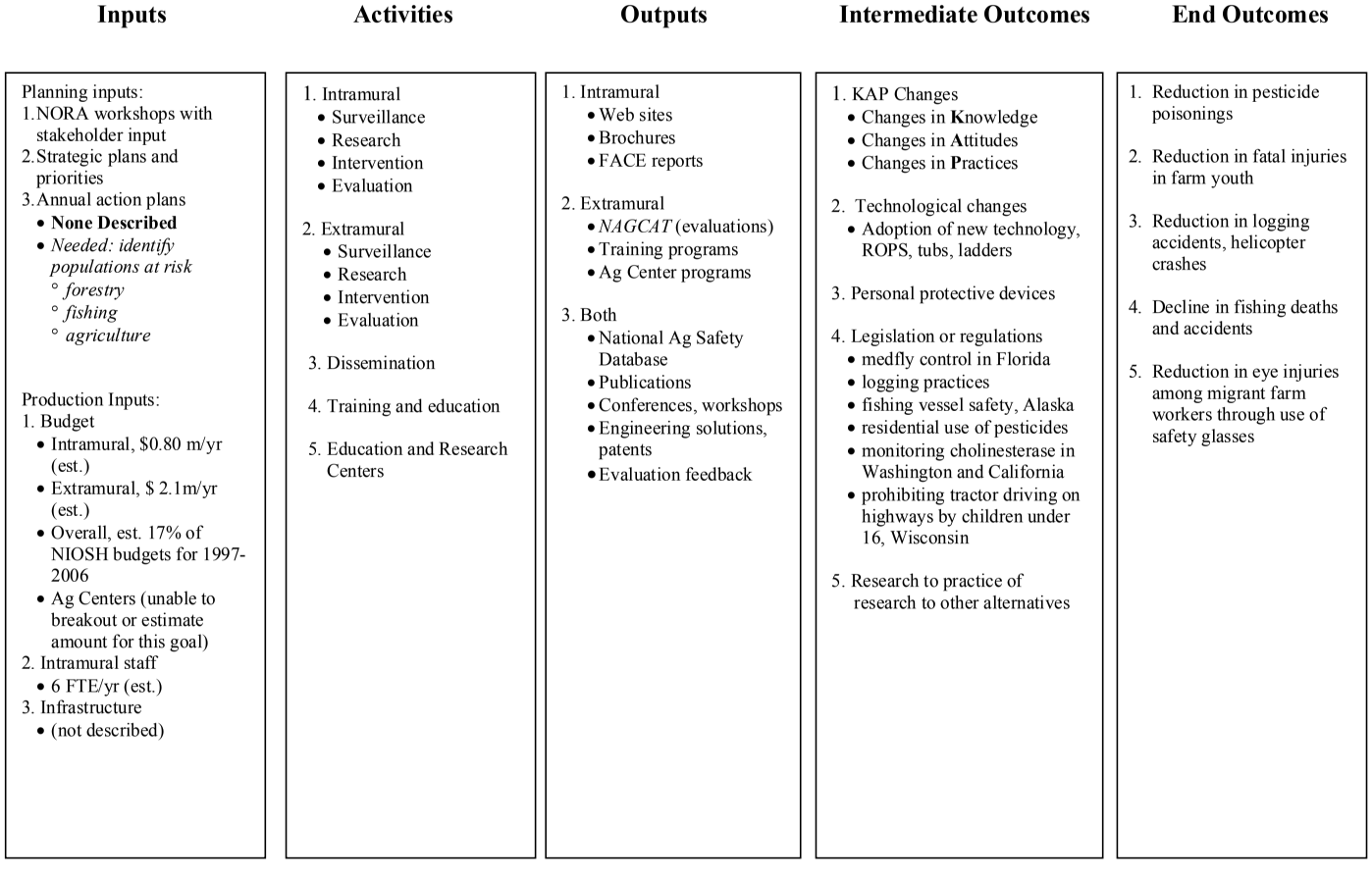

FIGURE 8-1 Knowledge diffusion and technology transfer logic submodel.
FACE = Fatality Assessment and Control Evaluation, FTE = full-time equivalent, NAGCAT = North American Guidelines for Children's Agricultural Tasks, ROPS = rollover protective structure.

implemented by employers and employees. Where those mechanisms for improvement have been undertaken, the logic model calls for evaluation of the impact and feedback to NIOSH staff to determine whether the changes have filled the knowledge gaps and reduced mortality, morbidity, or injuries associated with the workplace and the populations at risk.

An excellent example from the evidence package is the safety inspection and training associated with the fisheries program, in which the application of all three mechanisms to the fisheries industry led to a substantial reduction in boating accidents and loss of fishermen. Another excellent example of such a logic model is exhibited in the Pacific Northwest Agricultural Safety and Health (PNASH) Center report (Figure 8-2), which incorporates all the elements of inputs from diverse

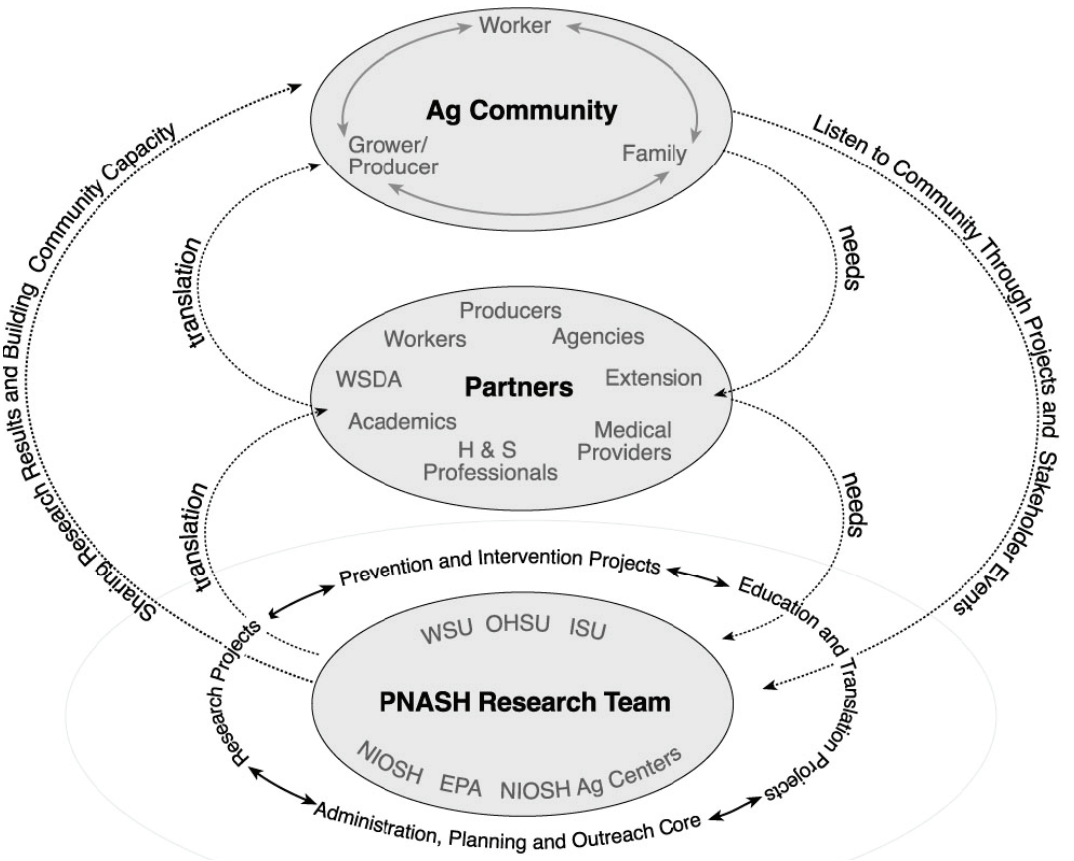

FIGURE 8-2 The PNASH Center partnership model.
SOURCE: Appendix 2-10 in NIOSH, 2006a.

stakeholders, feedback mechanisms, and evaluation. In this case, the research team from Washington State University, Oregon Health Science University, and Idaho State University collaborate with NIOSH and the U.S. Environmental Protection Agency (EPA), and other NIOSH Ag Centers as they listen to the needs of the partners including other health and safety workers (H&S) and the diverse agricultural community to identify the needs and share results of research.

ACTIVITIES

The activities that contribute to Goal 5 are summarized extensively in Chapters 7-10. This section summarizes the activities of the Ag Centers that are related specifically to knowledge diffusion and technology transfer.

Although the committee did not receive materials describing the NIOSH Education and Research Centers (ERCs), a review of their Web sites showed at least some research and educational activity devoted to agricultural issues by the ERCs at the University of California, Davis, University of Iowa, University of Texas, and University of South Florida. The others may have been active in the general training of practitioners in health and occupational safety.

In the evidence package, NIOSH reviewed the following major interventions:

- Agricultural health and agricultural safety promotion systems (1990-1993)
- Occupational Health Nurses in Agricultural Communities (1990-1996)
- Community Partners for Healthy Farming Intervention Research (1996-2003)
- Diffusion of safety innovations (1997-2005)
- Safe Communities coalitions (1998-2000)
- Certified Safe Farm (1998-present)
- Other outreach programs

Those programs are discussed in the evidence package, and it is not necessary to describe them here except to note that they are all completed. The documentation demonstrates numerous efforts from 1990-2005 to extend the results of research into the respective communities. No new programs were proposed.

OUTPUTS

The outputs listed constitute a mixture of publications, abstracts, CD-ROMs, booklets, pamphlets and fact sheets, training curricula, books, Web sites, and presentations, but internal NIOSH staff are not differentiated from external AFF

Program participants. Over 18 conferences, workshops, and symposia have been held since 1991 to address childhood agricultural injury, minority-group populations, logging, and safety in the fishing industry.

The outputs from Goal 5 also include extensive partnerships with other organizations to communicate and transfer knowledge to employers and employees.

Although researchers have long recognized the lack of correspondence between knowledge, on the one hand, and attitudes and behaviors related to safety and health practices in farm populations, on the other (Murphy, 1992; Elkind, 1993; Freeman et al., 2003), a great deal of NIOSH staff effort has gone into providing educational materials. There are many other products of the NIOSH research activities and uses as evidenced in Box 8-1, Research to Practice.

The evidence package provides examples of program efforts over the last 15 years and, most recently, new intervention research associated with the rollover protective structure (ROPS) program in 23 states. Other examples cited include the reduction in dairy injuries, the youth safety training program, the reduction in green tobacco sickness, and the use of appropriate eyewear in Illinois and Michigan.

AFF Program staff collected case reports of rollovers to use in developing realistic stories. These were used to develop a ROPS notebook for farmers and to assess its effectiveness. The involvement of NIOSH AFF staff is not clearly described.

INTERMEDIATE OUTCOMES

The National Agriculture Safety Database (NASD) Web site was created at the request of NIOSH agricultural extension agreement participants to provide a national information resource for the purposes of dissemination, leveraging resources, and avoiding duplication of efforts. "It is widely recognized and heavily used by the diverse community involved in agriculture (farmers, agribusinesses, universities, and government agencies)." The Web site receives over 500,000 hits per month from 75,000 unique users. It contains over 3,000 publications and links to other organizations. However, only 34 states are listed as contributing to the NASD. That is odd inasmuch as all the Ag Centers are contributing, and they cover all the states. In fact, although recent reports from Washington state had been submitted by the PNASH Center, Washington is not listed among the states for which one can get information. Recent examples of new materials include the ATV Safety Packet from the Children's Safety Network, submitted in 2006. The NASD may need better funding or a mechanism to incorporate all the states into the database via the Ag Centers.

The National Ag Safety Disc, a PC-based CD-ROM that contains a compendium of educational and information resources, was released in 1994 and after

BOX 8-1
Research to Practice (r2p)

In the recent *Evaluation of the Agricultural Safety Centers* (2006), NIOSH staff worked with the Agricultural Centers Evaluation team to define categories of "research to practice" (r2p) to illustrate various methods of moving results of projects into use by others. *Research to practice* was defined as research findings or products that are accepted and used by target audiences. The eight categories that were represented were research to intervention and education, research to research, research to field use, research to evaluation, research to academe, research to policy, research to surveillance, and research to technical assistance.

An interesting result of this study was the distribution of r2p activities. First, 71 percent, or 94 of 133 projects, evaluated were in the r2p realm, and the 94 were classified in the eight r2p categories:

%	Research to Practice
57	R to intervention and education
13	R to research
10	R to field use
6	R to evaluation
4	R to teaching
4	R to policy
3	R to surveillance
2	R to technical assistance
99	Total

One might interpret the classification scheme broadly and combine all categories except research to research; all the other categories involve research to some form of practice. Uses in the field, for evaluation, for policy purposes, in the classroom, and for technical assistance are all related to practice in different contexts. If we omit research to research, 86-87 percent of research went to practice in some form, and 13 percent was used as an input for further research.

That approach, however, was not used in the evidence documents that were provided. This may be a useful categorization; but no one seems to have asked the question of why NIOSH came up with this set of categories and what NIOSH is doing with it. Is it meaningful in some administrative way? Does it help understand the flow of knowledge from research through other indirect routes to final use in education and intervention?

SOURCE: Buchan and Holmquist-Johnson, 2007.

beta testing was scheduled to be released in final form in 1995 (Jones et al., 1995). This project is not mentioned in the materials provided by NIOSH. The database described above may be the expanded phase of this dissemination activity.

END OUTCOMES

The following are specific examples of outcomes that NIOSH identified as a result of its programs:

- A reduction, as a result of surveillance and research activities, in acute pesticide poisoning from 13.1 to 8.9 cases per 100,000.
- A reduction in youth injuries, in terms of both actual numbers and rates.
- Reductions in logging accidents and helicopter crashes.
- A substantial decline, as a result of safety training and inspections, in fishery accidents and deaths.
- A reduction in eye injuries in migrant and seasonal farm workers through the use of safety glasses.

Cited examples that result from the development of legislation include the management of pesticides at both the federal and state level, specifically in California, and Wisconsin legislation prohibiting driving of a tractor on a highway by people under 16 years old unless they have successfully completed a tractor certification course. An interesting evaluation analysis, however, showed that the Wisconsin law did not affect injury rates.

The transfer of knowledge into regulations is seen in Mediterranean fruit fly (medfly) control in Florida, logging practices in the Northwest, and vessel safety in Alaska. Other regulations are related to the residential use of pesticides, the monitoring of cholinesterase in California, and rules associated with the application of and new standards for ROPS.

The transfer of knowledge through improved technology is shown by the new ROPS technology and seatbelts on tractors, the winch shutoff on fishing boats, and monitoring sensors.

Examples of improvements by engineering include machine guards on hay balers and the ergonomic apple bag; by administrative intervention, the requirement that fishermen wear personal flotation devices; and by protective equipment and clothing, the use of safety glasses.

Examples of effective communication in education include day camps and safety programs for young people, the report on leading causes of death in logging, and the social marketing efforts in California.

Those examples are cited in the Executive Summary of the evidence package and further elaborated on in the various sections of the evidence package (NIOSH, 2006a). The examples reflect the effort to identify impacts of all programs but most specifically Goal 5 and the outreach, education, and communication programs.

The evidence document concludes with a statement that NIOSH was unable to link intermediate outcomes causally with occupational injury, illness, fatality,

or hazard exposure data; nevertheless, these many examples provide ample documentation of intermediate and end outcomes.

REVIEW OF THE NIOSH CENTERS FOR AGRICULTURAL DISEASE AND INJURY RESEARCH, EDUCATION, AND PREVENTION (AG CENTERS)

The programs of the NIOSH Centers for Agricultural Disease and Injury Research, Education, and Prevention (Ag Centers) were reviewed from the perspective of the diffusion of knowledge and the incorporation of research results in outreach programs.

Western Center for Agricultural Health and Safety

The Western Center for Agricultural Health and Safety (*http://agcenter.ucdavis.edu*) serves California, Hawaii, Nevada, and Arizona. The Western Center demonstrated substantial research and extension partnerships with state agencies in pesticide exposure and illnesses and incorporated a major r2p effort. As part of the r2p program, the center used social marketing approaches, increased electronic communication, and supplied some funding for the AgSafe conference to provide education, train the trainers, and educate agriculture workers. There is no evidence of an evaluation of the impact and outcomes of the effort, but several long-term evaluation studies are proposed or under way.

Pacific Northwest Agricultural Safety and Health Center

The Pacific Northwest Agricultural Safety and Health Center (PNASH, *http://depts.washington.edu/pnash/*) works with employers, workers, health professionals, and government agencies to identify hazards and implement solutions that will prevent or reduce workplace injuries and illnesses in northwestern farming, forestry, and fishing. The center operates in Washington, Oregon, Idaho, and Alaska. Through its Advisory Board and using a priority-setting process in which stakeholders provided input, it initiated forums for outreach and extension to workers, employers, and health professionals. The focus was on pesticide exposure and the use of technology, intervention measures, and training to reduce exposure. The research program also addressed ergonomics and injuries in vineyards, orchards, packing sheds, and forests—specifically, traumatic injuries, musculoskeletal disorders, noise, and vibration exposure. Special populations at risk were hired farm workers, family workers, and family members; a goal was to prevent pesticides from being carried home in vehicles and on clothes. The center has also undertaken a capacity-building effort in the Hispanic communities, with agricultural employers,

and with health professionals. An important study of protective clothing and its performance resulted in changes in use patterns and reduced exposure of workers to pesticides and in the design of effective protective clothing. A demonstrated effective training technique is the fluorescent-tracer technique to identify exposure. The center used diverse communication methods to reach specific audiences: Hispanic children, parents, and farm workers (page 537 of Appendix 2-10 in NIOSH, 2006a).

Southwest Center for Agricultural Health, Injury Prevention, and Education

The Southwest Center for Agricultural Health, Injury Prevention and Education (SW Center, *http://swcenter.uthct.edu*) is at the University of Texas Health Center at Tyler, Texas (UTHCT), and funds projects in three core categories: research, intervention and prevention, and outreach and education. Project directors are based in various institutions in the five states served by the SW Center: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas. In partnership with clinics, the SW Center tried to build capacity and prevent animal-caused injuries. It focused on cattle handling among tribal members, as well as the general farm population. Special populations included farm women, children, and the Navajo. It also looked at injuries of Vietnamese shrimpers. The diffusion process focused on social marketing techniques.

Midwest Center for Agricultural Disease and Injury Research, Education, and Prevention

The Midwest Center for Agricultural Disease and Injury Research, Education, and Prevention (*http://www.marshfieldclinic.org/nfmc/projects/*) is housed in the National Farm Medicine Center at Marshfield Clinic, in Wisconsin. The center has conducted research on back pain, fatality risks from livestock manure storage facilities, safety guidelines for children's agricultural tasks, women's reproductive health, and agricultural zoonoses and various evaluation studies. It serves a region that includes Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin. NIOSH funding for the Midwest Center ended in 2002, and information about the center was not provided in the evidence package.

Great Lakes Center for Agricultural Safety and Health

The Great Lakes Center for Agricultural Safety and Health (*http://www.ag.ohio-state.edu/~agsafety/*) serves Illinois, Indiana, Kentucky, Michigan, Ohio, Pennsylvania, West Virginia, and Wisconsin. The center is based at Ohio State Uni-

versity. It focuses on ergonomics, pesticide exposure and health effects assessment, acute unintentional injury, virtual-reality simulation of hazardous agricultural jobs, and agricultural safety and health education and outreach. Although it is only 5 years old, the center focused heavily on ROPS, protection from sun and heat, and grain engulfment. It has provided some training, a ROPS video, fact sheets, hazard alerts, and grain-bin safety standards but little r2p programming. An interesting research project, related to the New York Study described in the next section, is evaluating the use of hazard audits for insurance companies; there are no results yet.

Northeast Center for Agricultural and Occupational Health

The Northeast Center for Agricultural and Occupational Health (NEC, *http://www.nycamh.com*) is at the New York Center for Agricultural Medicine and Health (NYCAMH) in Fly Creek, NY. NEC serves a 13-state region from Maine to Virginia. The center focused on tractor accidents and injuries to migrants and children, with Advisory Board input in selecting high-priority issues. The focus was primarily on musculoskeletal injuries, hearing loss, and other ergonomic injuries. The center provided considerable outreach and knowledge transfer, including the newly developed ergonomic apple bag for migrant workers, the ROPS program, and extensive safety training and health screening. But about 52 percent of tractors on the farms that produce the top five New York commodities have no ROPS.

The committee noted Goal 5 of NEC: "Carefully evaluate all education and prevention projects." However, evaluation seems to focus on the use of materials rather than outcomes in reduction in injuries and mortality (page 391 of Appendix 2-10 in NIOSH, 2006a).

Although most evaluation studies focus on use of materials rather than outcomes, one exception is the North American Guidelines for Children's Agricultural Tasks (NAGCAT) interventions study. In this project, the valuation compared intervention versus control farms and demonstrated a significantly longer time to occurrence of injuries after the intervention was provided (pages 407-501 in NIOSH, 2006a). Another discovery is that only about half the recorded injuries were in NAGCAT-covered categories; this result was explained by the fact that about half the accidents involving children occurred on farms but not during work, and it has resulted in NAGCAT reports on safe play areas on farms.

A second successful program is the Agricultural Hazard Assessment and Training program, in which insurance claims declined from 90 to 50; losses in costs were also reduced over the 4 years of intervention on the 50 farms in the NY Study. The severity of injuries was also lower than on the control farms. The insurance company now uses risk assessment instruments in three other states (pages 410-501 in NIOSH, 2006a).

Southern Coastal Agromedicine Center

The Southern Coastal Agromedicine Center (*http://www.ncagromedicine.org/scac.htm*) is at the North Carolina Agromedicine Institute and serves Alabama, Florida, Georgia, Mississippi, North Carolina, Puerto Rico, South Carolina, Virginia, and the Virgin Islands. The institute, based at East Carolina University, is a collaborative institute of that university, North Carolina Agriculture and Technical State University, and North Carolina State University. The center's high priorities are ergonomic research, vehicle safety, heat-related disorders and dehydration, and skin disorders of fishermen. The center looked at selected agricultural injury surveillance activities among African-American farmers and ranchers and among agricultural workers with work permits, arthropod allergens in large-scale swine production, and development of farm safety teams composed of high school students. It put in place a timber-medic training program to assist emergency medical technicians working with injuries in the forests and on Christmas-tree farms. It also established a network with healthcare providers to address issues associated with safety and the use of pesticides by migrant workers and greenhouse workers and with farm vehicle safety. Little evaluative research has been completed on the outcomes with respect to health and mortality.

Southeast Center for Agricultural Health and Injury Prevention

The Southeast Center for Agricultural Health and Injury Prevention (*http://www.mc.uky.edu/scahi/*) serves Georgia, Kentucky, North Carolina, South Carolina, Tennessee, and Virginia. The center focused on ROPS, family and child health on beef-cattle farms, and youth education. It concentrates on underserved populations of women, children, migrants, and older farmers. Its projects for dissemination and diffusion include the Agricultural Disability Awareness and Risk Education (AgDARE), the Kentucky ROPS project, Farm Safety 4 Just Kids, and the Kentucky Women in Agriculture Conference. The ROPS project was the most comprehensive, with pre-intervention and post-intervention evaluation. No evaluation of health or injury outcomes was provided except for the ROPS project, which demonstrated both cost effectiveness of dissemination and intervention and the value of community-university partnerships in such efforts.

Great Plains Center for Agricultural Health

The Great Plains Center for Agricultural Health (*http://www.public-health.uiowa.edu/GPCAH/*) is at the University of Iowa's Institute for Rural and Environmental Health in Iowa City, Iowa, and serves Iowa, Kansas, Missouri, and Nebraska.

Focused on exposure to agricultural chemicals and health, it conducts basic research, houses major surveillance efforts, and collaborates with Farm Safety 4 Just Kids. Its studies were primarily on toxicant inhalants and respiratory problems associated with swine. Center staff conducted multiple interventions, including a 700-farm family and community partnership for a health training (Keokuk County) program that was a successful intensive educational training and support model. Evaluation has shown that agricultural health and safety training correlated with a reduction in fatalities. (The authors, however, are cautious about claiming credit.) The AgriSafe Network provided ongoing agricultural occupational safety and health education for health professionals. Great Plains Center reports are clearly presented using the logic model.

High Plains Intermountain Center for Agricultural Health and Safety

The High Plains Intermountain Center for Agricultural Health and Safety (HICAHS, *http://www.hicahs.colostate.edu*) serves the residents of Colorado, the High Plains, and the Rocky Mountain Region. It is on the Colorado State University campus in Fort Collins and is a multidisciplinary organization with input from such fields as engineering, industrial hygiene, education, toxicology, social work, epidemiology, environmental health, and agricultural sciences. HICAHS conducted outreach (training and education) primarily through Cooperative Extension and in partnership with public health professionals in the schools. It undertook hazard-evaluation site visits and surveys and extensive outreach to the migrant community. The model it used was a regional multistate effort in coordination with extension specialists at universities. It used a participatory learning model for technology transfer and knowledge diffusion. It seems to have neglected the American Indian population. Its focus is on exposure to pesticides, lung diseases, and engineering controls, education, and training in regional projects. Considerable evaluation of projects is an integral part of center work.

Rather than relying only on cooperative extension for r2p, the program established new partnerships with agricultural associations, equipment and service companies, insurance carriers, dairy owners, community health clinics, and other organizations, such as Easter Seals. That broadened the range of distribution and contacts. As a result of the broad-based participatory approach, the center provided many "customized" training programs. This approach allows greater input on research needs from end users, provides more effective documentation, and affords greater attention to regional needs of agricultural partners that have direct access to end users (farmers, ranchers, farm facilities, and migrant and seasonal workers) (page 99 of Appendix 2-10 in NIOSH, 2006a).

Evaluation of the ROPS design for pre-ROPS tractors (page 109 of Appendix 2-10 in NIOSH, 2006a) indicated that all stages of activity—including design, testing, and selling commercially—were accomplished for Ford and selected other small tractors. Commercial tests before sales are still under way for John Deere and Allis Chalmers models.

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

The National Children's Center for Rural and Agricultural Health and Safety (*http://research.marshfieldclinic.org/children/*)—located at the National Farm Medicine Center in Marshfield, Wisconsin—strives to enhance the health and safety of all children exposed to hazards associated with agricultural work and rural environments. The center is a model for inputs and priority identification and funding. It developed a newsletter, the NAGCAT, networks of advocates, and workshops, and it incorporated a small grant model to move research results to educational programs and practices. An important element in the National Children's Center program is evaluation of dissemination processes.

Deep-South Center for Agricultural Disease and Injury Research, Education, and Prevention

The Deep-South Center for Agricultural Disease and Injury Research, Education, and Prevention—located at the University of South Florida in Tampa—served the target populations of Alabama, Florida, and Mississippi. The Deep-South Center focused research on safety and health problems of special agricultural populations in the region including minority, migrant, and low-income farmers and farm workers. Its activities included the design of educational and health promotion interventions for farmers and farm workers; archive of educational and disease prevention/health promotion materials designed for use by agricultural safety and health specialists, clinicians, and health educators; design of models for use of rural public health and clinical nurses when engaged in problem identification and delivery of interventions; and design of aids to assist in hand-arm movement during planting, weeding, or harvesting. Funding for the center ended in 2001.

Assessment of Comparative Strengths and Weaknesses of the NIOSH Ag Centers

NEC provided a thoughtful assessment of the diverse approaches to knowledge diffusion and transfer (page 160 of Appendix 2-10 in NIOSH, 2006a). First, enforcement is difficult to accomplish. Second, engineering may be a preferred

approach, and the best example is ROPS in which the universal application and use of the technology have not occurred, and tractor deaths occur at a greater rate than one might expect if the technology were fully adopted. With respect to education, one study reviewed 25 farm safety intervention education programs and found some changes in knowledge, attitudes, and behaviors, but "none showed sustained decrease in injuries or illnesses." However, "multi-faceted programs appear most successful" (DeRoo and Rautiainen, 2000).

Research on intervention over 20 years has found that no one theory or method is likely to create an effective, sustainable, and transferable program. Therefore, in the Great Plains Center, the Certified Safe Farm (CSF) model incorporated several theories and principles of intervention and health promotion from past research and experience (page 161 of Appendix 2-10 in NIOSH, 2006a). The CSF project included intervention and control farms and a triad of services: clinical services, education, and on-farm safety reviews. Demonstrable outcomes included increased use of personal protective equipment and reductions in respiratory problems, injury costs, and insurance claims.

Another example of research with multiple interventions and evaluation of outcomes is the National Childhood Agricultural Injury Initiative. Although many alternative explanations may be offered for the results, there were clear declines in the number of injuries in children (from 32,800 to 22,600 from 1998 to 2001) and their rate from 1.7 to 1.4 per 100 farms in the same period. A similar drop in deaths and death rates occurred during the periods 1978-1983 and 1990-1993 (page 211 of Appendix 2-10 in NIOSH, 2006a).

As part of r2p, many of the Ag Centers used social marketing, increased electronic communication, and networking to provide education, train the trainers, and communicate with agricultural workers. They used diverse communication methods specific to audiences—Hispanic children, parents, farm workers. A major success story is the Keokuk County project, in which Center staff conducted multiple interventions including a 700-farm family and community partnership for a health training (Keokuk County) program. This was a successful intensive educational training and support model. Evaluation studies have shown that agricultural health and safety training was correlated with a reduction in fatalities. (The authors, however, are cautious about claiming credit.)

HICAHS conducted outreach (training and education) primarily through Cooperative Extension and in partnership with public health in K-12 schools. HICAHS researchers undertook hazard-evaluation site visits and surveys, and extensive outreach to the migrant community. The model it used was a regional multi-state effort in coordination with extension specialists at the universities. It used a participatory learning model for its technology transfer and knowledge diffusion efforts.

EVALUATION

The AFF Program created a separate goal for its educational, knowledge diffusion, and technology transfer activities, which has created a separation of research from the dissemination functions. These dissemination activities would be integrated in all of the research priorities. In discussing the ideal AFF research program in Chapter 2, the committee recognized the needed role of research in knowledge diffusion and technology transfer to reach the at-risk populations. However, the separate goal continues to compartmentalize this outreach interaction as distinct from the processes used to inform the research questions, methods, and analyses. In part, this is a reflection of the logic model that guides the review. The concept of broader deliberation and decisionmaking among researchers and populations-at-risk from the inception of research ideas to their diffusion to the vulnerable populations is not explored in depth.

Although there are substantial efforts to reach working populations, most NIOSH materials were provided through Web sites or written materials. This reflects a lack of understanding of the worker populations in agriculture. Some researchers have addressed the need to modify messages for farming populations (Grieshop et al., 1995; Cole, 2000, 2002; Morgan et al., 2002). The changing profile of the working populations involved in agriculture, forestry, and fishing needs to be taken into account in the development of programs designed to reach workers. Immigrant workers clearly have different cultural views of safety and disease that need to be assessed if culturally relevant information is to be provided. Farmers, ranchers, fishermen, and loggers similarly have specialized cultural contexts related to perceptions of risk and safety practices that influence adoption of new practices (Morgan et al., 2002; Freeman et al., 2003; Helmkamp et al., 2004; Effland, 2005). Incorporating representatives of target populations into the priority-setting process and actual dissemination processes would increase the likelihood of successful outreach and impacts.

Much of the legislation that addresses worker health and safety is not applicable to farmers and ranchers, and many of the relevant regulations are not enforced (Murphy, 1992; Cole, 2002). Therefore, the effectiveness of legislation in reaching AFF working populations is questionable, yet legislation remains an important tool in the diffusion and implementation of new knowledge and technologies.

Most education programs ignore the role of well-established habits in maintaining behavior and preventing the adoption of new behaviors (Murphy, 1992; Cole, 2002; Freeman et al., 2003). Failing to take habits and culture into account limits the ability of programs to modify behavior so as to increase safety and improve health. As noted above, multifaceted programs appear most successful and provide a rationale for using social marketing techniques.

The recommendations in Chapter 12 will address these issues, especially the need for an integrated model of NIOSH research and diffusion programs.

9

Other Programmatic Elements Identified by the Committee

In following the components of the committee's ideal Agriculture, Forestry, and Fishing (AFF) Program, the committee identified other elements that the program has been involved in and provides here a review of engagement with stakeholder constituents, health services research and training, public policy and regulatory advice, and program evaluation initiatives.

STAKEHOLDERS

The AFF Program seeks to engage stakeholders in its work, and the challenges in engaging such a large and diverse workforce are obviously great. Other National Institute for Occupational Safety and Health (NIOSH) programs also have an array of stakeholders, but AFF stakeholders—the program's ultimate beneficiaries—are an extraordinarily diverse constituency. Most of the 2 million-plus AFF businesses are small and are operated by self-employed persons assisted by family members, including children. Increasing numbers are immigrants from Mexico and Southeast Asia who produce specialty crops on small-scale farms. Self-employed workers who provide the majority of the labor in their operation seek to earn their families' livelihoods in outdoor environments, sometimes enduring hardships that few U.S.-born workers would tolerate.

AFF Workers

The AFF workforce consists of those earning their livelihood in the AFF sector and is diverse in race, ethnicity, language, culture, class, and social norms. The bulk of the workforce is made up of hired workers, and many are employed only on a seasonal basis. Large portions of AFF hired and contract workers are low-literacy, non-English speaking immigrants, many of whom are not authorized to work in the United States: in fisheries, increasing numbers are of West African or East Asian origin; in agriculture, the vast majority are from Mexico or Central America. Language barriers are becoming greater as more and more hired and contract workers speak languages lesser known in the United States, such as Triqui, Mixtec, Zapotec, Maya, Purépecha, and Quechua; at least a dozen languages are spoken daily on U.S. farms, and most do not have a written form. Efforts to engage these populations must overcome barriers of language, culture, race, ethnicity, and class.

Underlying the challenges of engaging AFF workers is the deep-seated division between those who seek immediate practical solutions to their problems and those in the research community who prefer to engage in contemplation or laboratory experimentation. The historical foundation of that divide in our society has been well described by Hofstadter in *Anti-intellectualism in American Life* (1963). Compounding the barrier is the low level of scientific literacy among workers that the AFF Program seeks to engage. One might say that the reverse is also true: that the schism between the intellectuals and the workforce is perpetuated by a failure of the intellectuals to communicate effectively on workers' terms, taking into account different work circumstances and cultural attitudes. Finding common ground or even a meeting space comfortable for all parties may be difficult.

The following pages describe four instances in which efforts to overcome barriers were successful to the benefit of all parties. The examples illustrate approaches, not recipes, that AFF projects could adopt or adapt.

Engaging Hired Farm Laborers

In 1988, the Ford Foundation challenged the California Institute for Rural Studies (CIRS) to undertake research in the subject of farm labor and rural poverty in California. The challenge included a requirement that academics, laborers, and community leaders meet and develop a collaborative agenda. A meeting place had to be found in which all parties would be comfortable. The bias of the CIRS staff in selecting a meeting space was that a university or college setting would probably be inappropriate because relatively few farm laborers had ever attended college or felt comfortable among highly articulate experts. In the end, a modest motel with suitable meeting rooms near downtown Fresno was selected. That choice was made because Fresno is in the center of the San Joaquin Valley, the most productive agri-

cultural region in the United States, employing over 200,000 farm laborers during spring and summer. Fresno is a community that many farm laborers visit and in which they were likely to feel comfortable. Some academics were uncomfortable with the choice because it meant leaving the familiar confines of their campuses, such as Berkeley, Santa Cruz, and San Diego. However, when the reason for the choice was carefully explained, nearly all 60 faculty members invited to participate expressed appreciation for the thought that had gone into the selection process. For the 60-odd farm labor representatives or rural community leaders, who included industry representatives, the choice of Fresno made sense from the beginning.

Next, the conference discussion process involved carefully choosing eight academics to prepare research papers on specific topics: housing, voting rights, labor relations, the California farm labor market, measuring rural poverty, indigenous migrants, the changing structure of agriculture, and pesticide policy.

At the conference, the presentation of papers was structured so that a panel of three would comment on each paper—typically an academic, a farm labor representative or rural community leader, and an industry representative. Papers were provided to panel members at least a week in advance of the conference. Time was allotted for comments or questions to any of the panelists. A panel facilitator and note-taker kept the entire process running smoothly, and simultaneous translation into Spanish and English was made available to all who needed such assistance.

Among the outcomes of the conference were eight conference proceedings papers, with synopses of panelists' or conference participants' comments, and the formation of a project advisory committee to provide general guidance to the CIRS staff in its work. All the labor and community participants found the format to be welcoming and to have enhanced participation.

Engaging Hired Forestry Services Workers

The second example involved the U.S. Department of Agriculture (USDA) Forest Service, which in California had found that its staff was relatively uninformed about Hispanic immigrant workers, many of whom were showing up as contract laborers for planting or other work on federal land. In 1995, CIRS was contacted by a representative of the Forest Service who asked whether it might be possible to set up a workshop to enable staff members to learn more about the newest components of the forest labor force.

In the view of CIRS staff, it was essential that Forest Service personnel encounter Spanish-speaking immigrant workers directly, not just hear a description of them in English. CIRS staff arranged for a busload of about 50 Forest Service employees to visit a public farm labor camp near Stockton. The meeting was held in the evening, after the workday, after the workers had a chance to change from

work clothes into more comfortable attire, and after everyone had a chance to get an evening meal. A local Spanish-English interpreter was recruited, and four current farm laborers volunteered to participate in a panel presentation for the Forest Service employees. The gathering was held outdoors under a rooftop mat with benches arranged in a semicircle facing the panel of workers. Several dozen other farm laborers and family members also attended, mostly out of curiosity.

The panel presentation was enlightening. The four workers described their home villages, how they came to the United States to find work, how many years they had been coming to the United States to work in the fields, how much they earned, how much money they sent back home each week to support their families, and what they thought about while doing heavy manual labor in the baking hot fields of the San Joaquin Valley. One worker said that he wanted to learn more about the potential impacts of the newly approved North American Free Trade Agreement on employment in his region of Mexico.

Forest Service employees asked many eye-opening questions. One worker described how he had been coming to the Stockton area for over 45 years, doing the same kind of work year after year, and how his grandson had just graduated from California State University, Stanislaus, with an honors degree in computer sciences. He said he was proud that his labor had helped to make it possible for his grandson to realize his dream. After he spoke, there were several moments of silence among all participants in the evening's event and then a crescendo of respectful applause.

Engaging Northern High Plains Growers

The third example involved growers on the northern high plains. In 1998, organic growers in central North Dakota requested a meeting with scientists of the National Farm Medicine Center (NFMC) so that they could explore concerns about personal health and about potential contamination of their organic farm products resulting from the use of pesticides on adjacent acreage that had been purchased or rented by potato growers of the Red River Valley in the North. The organic growers could smell the pesticides used by potato growers and wondered about exposure of themselves or their households. The use of the products is not permitted on organic acreage, and the organic growers were concerned that pesticide drift would contaminate growing crops, the soil in which the crops are grown, or worse, the hands, feet, face, and other body parts of people working on organic acreage.

North Dakota is administratively in federal HHS Region IV, so NFMC contacted the High Plains Intermountain Center for Agricultural Health and Safety (HICAHS) at Colorado State University, Fort Collins; the two centers worked together to structure a 2-year study of the issue. Once institutional review board

approval was secured, scientists of both centers requested face-to-face meetings in the separate household living rooms of organic growers and potato growers so that basic study outlines could be reviewed and both communities might experience buy-in. Each group was wary of the other (and the local county agricultural extension agent warned explicitly against any form of study), so engaging both on their individual turf was the first step in a long process of gaining mutual credibility. The participatory research provided greater buy-in to the proposed study and its potential findings (McCauley et al., 2001; Quandt et al., 2001; O'Fallon and Dearry, 2002).

Scientists of both agricultural centers listened intently on site to group descriptions of agricultural operations and tasks performed by workers; wore the requisite plastic booties while on the "walk-abouts"; walked farmsteads and fields; had coffee and home-baked delicacies in farm kitchens, living rooms, and local restaurants; and ended several rounds of meetings by noting the availability of a federal partner who had the field-collection instruments and advanced laboratory capability that a study of this type demanded. Neither protagonist was enthusiastic about inviting a federal partner, but both reluctantly agreed to permit NIOSH to enter the proposed study as a partner and to accompany NFMC and HICAHS scientists when study procedures were launched. Private resources from NFMC were used to fund the study, inasmuch as both agricultural groups were suspicious of any form of federal funding involvement.

Numerous meetings and less formal interactions with both groups of growers ensued on their premises, always in the local community. At no time was it expected that either group would travel to Marshfield, Wisconsin, or Fort Collins, Colorado; rather, scientists and technicians from the agencies went to the study areas. And no one from either agricultural group travelled to Cincinnati, Ohio, or Morgantown, West Virginia, to engage scientists at NIOSH directly.

The study was launched with perimeter air sampling around organic crop acreage, the farmsteads of organic growers, and selected "control" areas elsewhere. As data collection proceeded, technical staff were invited to provide study updates and transmit educational information about the study, pesticide products used on potato crops and their potential human health effects, types and hydrological characteristics of soil overlying aquifers in central North Dakota, and the use of personal protective equipment. NFMC scientists and technical staff invested additional effort to educate potato growers about preventing nontarget exposure, applying pesticide with "best management practices", and planning for the future use of integrated pest management strategies.

In less than a year, NIOSH staff members were viewed as legitimate participants on the study team and were included in all activities when on site. Initial study results were presented to both agricultural groups in fall 1999 (Gunderson

et al., 1999). The settings for these disclosures were the living room of an organic grower, a local meeting room for potato growers, and a local hunting lodge for study staff of all three agencies. Study results were surprising to both groups of growers (Gunderson et al., *in review*), but both indicated that they were impressed by the fairness with which they were treated; by the tenacity of both technicians and scientists in attempting to learn what happens in production agriculture settings, why it happens, and who is potentially affected; and by the lack of arrogance and "pretty urban talk" on the part of staff and scientists.

Engaging Alaska Commercial Fishermen

The fourth example, from commercial fishing, can be found in the work leading to the publication and distribution of the booklet *Deck Safety for Crab Fishermen* (Jensen Maritime Consultants, 2002), a publication that is in its third printing since its release in 2002. The NIOSH Alaska Field Station had determined that crab fishing in Alaska was an extremely high-risk industry. By reviewing the injury data available, NIOSH researchers found that most injuries aboard crab vessels were associated with the pot launcher, the bait chopper, and slips and falls. The researchers then sought out and interviewed a group of crab fishermen for ideas on safety improvements.

Once the NIOSH team had formulated a list of safety improvement suggestions, it vetted them by surveying 89 crab fishermen associated with 75 boats of different types and sizes in Dutch Harbor, Alaska. By getting their boots wet and actively seeking to engage the stakeholders in the targeted industry, NIOSH vastly improved the validity of its proposed interventions. By also having contacted about 36 percent of the crab-fishing fleet, NIOSH laid the foundation for buy-in by a very individualistic population. The product that it developed generated so much interest that some of the stakeholders published the booklet themselves instead of waiting for NIOSH's long internal review process.

A consistent and often-repeated theme throughout the committee's information-gathering meetings was that NIOSH serves its stakeholders best when it follows a "boots on the ground, get dirty" approach to research and reaches out to its constituents. NIOSH has enjoyed its greatest successes through nimble, targeted, and adaptive efforts that are conducted in a timely manner.

Non-Workers as Stakeholders

Another category of stakeholders consists of those who interact with and serve AFF worker populations. These stakeholders provide support services and include equipment manufacturers, various government agencies (USDA, the Na-

tional Cancer Institute, the National Institutes of Health, the National Institute of Environmental Health Sciences, state departments of agriculture, the Cooperative Extension Service, and state and local health agencies), veterinarians, agricultural engineers, and state and local agencies that provide essential services, such as healthcare providers and forest firefighters. But engaging those additional stakeholders would supplement, not substitute for or in any sense replace, the engagement of directly affected workers. The committee here distinguishes between the working population directly engaged in AFF production and people engaged in support activities, including research.

As mentioned in Chapter 2, NIOSH needs to consider five types of directly affected stakeholders in each of the agriculture, forestry, and fishing sectors: self-employed workers, unpaid family workers, direct-hire workers, contract-hire workers, and workers employed by larger-scale businesses. Other persons may be at risk owing to their living on or adjacent to worksites because AFF workplaces are, by their relationship to natural resources, extensive as opposed to localized. The additional persons may include children, spouses, or other relatives of AFF workers. The National Children's Center for Rural and Agricultural Health and Safety has been effective in reaching out to and engaging all five categories of workers, albeit with considerably greater success among some categories than others. The fishing program in Alaska has been particularly effective in directly involving various categories of workers in addressing occupational safety in a localized fishery industry; however, some categories of workers may have been underrepresented.

Organizations representing self-employed and unpaid family workers in agriculture are relatively highly developed, especially nowadays with the proliferation of commodity-based groups; there is relatively effective involvement of some of these groups in the AFF Program, as was clear at the Seattle National Occupational Research Agenda (NORA) session in January 2006. Despite those successes, both hired and contract workers have been underrepresented throughout the brief history of the AFF Program. The fault is by no means to be placed only on the program, as there are substantial barriers to engaging hired and contract workers, including language and cultural gaps. Compounding the problem is the relative absence of involvement of most hired and contract workers in any organization that directly represents workers. Labor unions represent only a very small fraction of hired and contract farm workers—no more than 30,000 of a national hired workforce estimated to be of 1.3-2.25 million workers (Villarejo and Baron, 1999). The record of labor unions in the AFF sector is spotty: some have had a strong commitment to making the workplace safer, but others have demonstrated little interest in this issue. The American Federation of Labor and Congress of Industrial Organizations' Department of Occupational Safety and Health has recognized that "NIOSH is valuable in that it can address new, unregulated hazards such as ergonomic problems" (Factor and Uehlein, 1990).

Nonprofit advocacy groups and government-funded service agencies have occupied the front lines in seeking to represent hired and contract workers. Although some efforts have been helpful, few of the spokespeople who speak on behalf of hired and contract workers have any direct experience as AFF workers themselves or, in some cases, only slight direct contact with these workers. Direct worker involvement as stakeholders is essential if their views are to be adequately represented. Stipends need to be considered to compensate workers for time off of work and travel expenses.

HEALTH SERVICES RESEARCH AND TRAINING

Health services research is defined as the multidisciplinary field of scientific investigation that studies how social factors, financing systems, organizational structural processes, health technologies, and personal behaviors affect access to healthcare, the quality and cost of healthcare, and ultimately health and well-being. The research domains of this field are individuals, families, organizations, institutions, communities, and populations. Health services research examines how people obtain access to healthcare, how much healthcare costs, and what happens to patients as a result of this care. The goals of health services research are to identify the most effective ways to organize, manage, finance, and deliver high-quality care and improve patient safety (Academy Health, 2000). This research has been conducted to study a variety of healthcare aspects, including those pertaining directly to occupational health. Health services research has not been conducted in as much detail in agricultural, forestry, and fishing workers as in other occupational groups.

The term *training* refers to the education of professionals in specific topics directly related to safety and health. It may target people working as or training to become nurses (including advanced practice nurses), physicians, physician's assistants, physical therapists, occupational therapists, mental health counselors, emergency medicine technicians, lay health workers, safety professionals, engineers, and industrial hygienists. At times, the training has been specific to clinical problems that are directly relevant to AFF workforce safety and health issues and has been conducted with a public health approach; however, at other times, it has been a general approach to occupational safety and health without emphasis on problems seen in AFF workers. There has been a consistent approach to educating healthcare professionals about AFF occupational issues.

Strategic Goals and Objectives

The briefing information provided by NIOSH did not contain goals pertaining directly to health services research and training. However, NIOSH funds several

extramural projects that revolve around health services research or training and numerous extramural projects of which health services research or training is an important part. From 1990-2006, NIOSH funded up to 16 Education and Research Centers (ERCs) across the United States. Many ERCs offer education and training for medical providers, safety professionals, and others who work with agricultural health and safety issues. NIOSH describes the emphasis as follows: "The core areas of programming are industrial hygiene, occupational health nursing, occupational medicine, and occupational safety. Programs are developed to meet the educational needs of these groups as well as other professionals working in the field of occupational safety and health" (ERC, 2007). In addition, NIOSH has funded at least one program to train lay health advisers, also called promotoras. The ERCs provide training programs in agriculture, forestry, and fishing.

Inputs

The main inputs to health services research, education, and training have been NIOSH funds distributed to the agricultural research centers (ARCs) and the ERCs, although the committee is aware that NIOSH clinicians and scientists have provided faculty expertise to the centers. University-affiliated centers have also been major contributors to the programs that have been developed with faculty and staff outside the centers as well as those hired with ERC funds. The documentation provided by NIOSH is unclear on the role of the private sector. For example, the Mary Imogene Bassett Hospital—affiliated with the New York Center for Agricultural Medicine and Health—has been instrumental in launching studies of respiratory, auditory, and musculoskeletal problems faced by farmers; the study results have been used in the design of new outreach capacity and in clinical training. The Marshfield Clinic of Wisconsin fielded similar outreach and training activity. NIOSH documentation, however, does not mention such efforts. Collaborations with and contributions from other local and regional community medical facilities are likely to have been critical for the success of such initiatives. Documentation of them was difficult to find in the materials provided by NIOSH for use by the committee.

Activities

Most of the health services research and training activities were reported for the agricultural sector; very few could be found for forestry and fishing. A number of the health services research and training programs in agriculture are specifically designed to offer health or safety training directly to farmers or farm workers in addition to educating medical or safety professionals. That dual approach to education is desirable for the entire sector.

Agriculture

The NIOSH-funded ERCs at selected academic institutions (some of which also have Ag Centers) have funded projects related to production agriculture, including training in industrial hygiene, occupational health nursing, occupational medicine, and occupational safety. For example, the ERC at the University of Iowa has funded postdoctoral fellows who engage in training in a wide variety of topics. It is less clear whether there is a formal relationship between the NIOSH Ag Centers and the ERCs or whether collaborations evolved through opportunity. It is also not clear how much emphasis is placed on agricultural health in each ERC program. However, the committee has observed that numerous professionals have been encouraged to explore occupational health issues—explorations that probably would not have taken place without the presence of ERC initiatives. Quantifying the training might be useful to measure the adequacy of preparation for practice and as a means of determining whether NIOSH funds are well spent. Examples of health services training in agriculture are summarized below.

Promotores de Salud From 1999 to 2003, AFF Program researchers at the University of Illinois at Chicago developed and evaluated an intervention to reduce the number and severity of eye injuries in Latino farm workers through collaboration with peer health advisers (*promotores de salud*) in Illinois and Michigan. The *promotores de salud* were trained in eye injury and first aid by AFF Program staff. Contacts with workers focused on distributing protective eyewear and on training in the importance of wearing appropriate eyewear. Data were collected on the effectiveness of the intervention and showed that use of appropriate protective eyewear by Hispanic farm workers can be increased by training lay health advisers to select and custom-fit protective eyewear acceptable to workers and by providing the eyewear for distribution by the *promotores* (Migrant Health Promotion, 2005). The research group established an eye health and safety Web site in collaboration with the Rural Women's Health Project to disseminate information about eye injury prevention and the project nationally.

Certified Safe Farms The Certified Safe Farms program (funded largely by NIOSH) has been active at the University of Iowa for about 12 years. Collaborating academic institutions have included the University of Nebraska Medical Center. The project is designed to determine whether farm safety inspections and resulting changes in safety practices, with health screening of farmers, will reduce injuries and costs of farm families' healthcare. Participants receive occupational health screenings, health and wellness education, on-farm safety reviews, and incentives for adopting safer farming processes. Willing farmers work with a nurse trained in farm safety and health and a person trained in inspecting farms for safety hazards.

Variations of the health screening and farm inspection process have been developed for different forms of production agriculture in the Midwest. Self-reported data pertaining to the costs of occupational injury and illness paid by participants and their insurers were collected.

Healthcare Provider Training Several universities that have medical schools—such as the University of Illinois, the University of Iowa, and the University of Minnesota—have received funding from NIOSH to design and implement occupational health training programs for physicians, nurses, and other healthcare providers and persons who do not have a healthcare background in agricultural health. The programs are well established and use AFF Program resources to extend work to neighboring states. Although the programs have responded to the obvious need for training, the committee notes that the programs would benefit from greater physician input in course content and clinical approach.

Occupational Health Nurses in Agricultural Communities (OHNAC) From 1990 through 1996, the AFF Program funded 31 public health nurses in rural communities in 10 states (California, Georgia, Iowa, Kentucky, Maine, Minnesota, New York, North Carolina, North Dakota, and Ohio) to conduct case-based, and sometimes rate-based, surveillance. In 1995, the program funded continued surveillance under the banner of Community Partners for Healthy Farming Surveillance. States that were funded under the original OHNAC project and later funded by Community Partners for Healthy Farming Surveillance usually retained OHNAC in the titles of their programs. The surveillance projects addressed multiple agricultural subsectors. For simplicity, both surveillance projects will usually be referred to hereinafter as OHNAC.

Northwest Community Health Worker Network Extramural AFF Program researchers engaged the Hispanic farmworker community through two community-based participatory research projects in Washington and Idaho. Together with the Washington Association of Community and Migrant Health Centers, researchers established the Northwest Community Health Worker Network and listserv, and they provided professional education to clinicians and trained community health workers in prevention and diagnosis of and treatment for pesticide poisoning.

Take-home Pesticide Exposure Study The primary purpose of the take-home pesticide exposure study conducted by the University of Washington was to describe the sources of pesticide contamination in farm homes and investigate the relationship between clinically documented contamination and pesticide exposure of family members in the home. A combination of environmental and biological

sampling was used. Questionnaires and on-site observation were used to determine practices and behaviors that may contribute to exposure and thereby to provide content for future professional education venues.

Forestry

Before formal implementation of the AFF Program in 1990 but concurrently with congressional adoption of appropriations legislation establishing the program in NIOSH, NIOSH provided National Traumatic Occupational Fatality Surveillance System data to support development of an Occupational Safety and Health Administration (OSHA) forestry standard. It also gave OSHA recommendations about including multiple safe felling techniques, making changes in the snakebite section of the standard, improving work-area organization and communication, using rollover protective structures (ROPS) and falling-object protective structures (FOPS), and prohibiting some unsafe harvesting techniques. In 1994, OSHA adopted the final standard, which incorporated most of the recommendations made by NIOSH; the recommendations spanned several of the research domains of the health services research arena.

Fishing

NIOSH conducted an early assessment of the decline in commercial fishing deaths on the Alaskan shelf after implementation of the Fishing Vessel Safety Act in 1991. It found that although deaths had decreased, vessel sinkings had not. In addition, NIOSH identified the fishery in which each fatal event had occurred. The crab fishery in the Bering Sea was shown as the most hazardous fishery in Alaska and the problem was the loss of fishing vessels, which meant loss of life. In 1997, NIOSH convened other partners at the second national Fishing Industry Safety and Health (FISH II) Workshop in Seattle to develop practical recommendations that would prevent vessels from sinking. It resulted in the Preseason Dockside Inspection Program, implemented by the U.S. Coast Guard beginning in 1999. That program appears to be highly effective in reducing deaths, thereby probably reducing the use of clinical care, but at this time it is limited to the Gulf of Alaska and the Bering Sea.

Outputs

The AFF Program has produced numerous projects related to health services that would probably not have existed without the program. The OHNAC program, initially funded by NIOSH in 1991-1996, has generated noteworthy findings and

publications, which are all the more remarkable because NIOSH did not formulate epidemiologically derived guidance for nurses "in the field" that might have resulted in more precise targeting of efforts to the highest-risk agricultural worksite exposures in the 10 funded states. Outputs of the OHNAC program included peer-reviewed publications targeting clinicians and others, which form the backbone of formal instructional materials (including clinical texts); continuing education updates; self-study courses; simulations; and seminar content.

Overall, the output of the AFF Program has been substantial in health services research and training, although less than output of other kinds, such as information aimed directly at workers. At times, a lack of planning and organization has hampered progress. It is not always clear how conducting health services research and training fits with the other missions of the NIOSH AFF Program.

Other Outcomes

There is evidence that some NIOSH-funded health services research projects may be influencing industries tangentially related to the AFF sector and to the topic of occupational safety and health. Those industries span a continuum from liability insurance carriers to equipment manufacturers—such as those producing tractors or fishing vessel cable winching devices—to health and safety product vendors. The influence of NIOSH can be detected in the marketplace: from the presence of safety-enhanced end-user products to the belief by the insurance industry that use of these products reduces occupational injury and illness. The reductions may occur because of the effect on worker social factors, sector development of financing incentives, changes in organizational work-setting procedures and supervision, introduction of new and improved technologies for prevention of ill effects or their timely clinical detection, or adjustments in how basic medical care is deployed. And the projects have enhanced the professional development of classically trained agricultural engineers, industrial hygienists, safety professionals, industrial nurses, and so on whose career trajectories evolved from full-time employment in sector-related industry to university-based Ag Centers, occupational health clinics, and other private venues, such as the National Safety Council. Examples of these outcomes include the following:

- The Certified Safe Farms project has received funding from the health insurance industry in Iowa. This may be an important first step in reaching the ultimate goal of making preventive health services available to farmers.
- In 1997, extramural AFF Program staff at the University of Iowa sponsored consensus-building activity, including a capstone conference to develop an approach to implementing a nation-wide tractor-related injury and death prevention

program. That initiative has spawned other activity in several communities—the farming, engineering, clinical, and occupational health research communities; federal agencies; and state legislatures. These communities have addressed tractor-related issues through the use of ROPS on tractors through public incentives; improving lighting and marking to reduce injuries and deaths due to collisions between tractors and motor vehicles on public roadways; enhancing the training of basic and advanced emergency medical technicians in clinically efficacious methods of victim extraction and scene stabilization; exploration of emergency machine-stopping mechanisms; and promulgation of designs for safe play areas for children and adolescents near or in agricultural work zones.

PUBLIC POLICY AND REGULATORY ADVICE

At its formation, OSHA was designated to be the federal agency with primary responsibility for regulation and enforcement of workplace safety. NIOSH was created as an independent, scientific research organization to inform the public, including governmental agencies, about occupational health and safety, and to play an advisory role in recommending ways to reduce risk of injury or illness in the workplace. However, NIOSH has regulatory authority for respirator certification in agricultural environments for confined spaces and for dust and pesticide exposure (42 CFR Part 84). Those are the only direct regulatory roles of NIOSH.

The Crucial Role of NIOSH

The committee finds that the AFF Program has played a central role in improving public oversight of occupational safety for the AFF workforce at both the federal and state levels. The committee also finds that the NIOSH Ag Centers, owing to their specific regional focus, have made important contributions to informing public policy discourse.

The AFF Program has provided both research findings and advice for a number of substantial modifications of workplace safety regulation. It has also initiated several important partnerships to develop improvements in occupational safety. The two most notable partnerships have been with the Alaska commercial fishing industry, where NIOSH engaged the industry workforce directly, and with the Childhood Agricultural Safety Network, where a brilliant example of coalition building was successfully undertaken and realized over a period of years.

The AFF Program has conducted 16 investigations as part of the agency-wide Fatality Assessment and Control Evaluation (FACE) program. Those efforts were not regulatory, but they identified deaths of young workers who were assigned tasks prohibited by hazardous order regulations and incidents in which non-English

speaking workers were not provided with appropriate training. Such scientific, non-regulatory studies contribute knowledge that underpins regulatory advice.

Less visible but important have been the efforts of some of the separately funded regional NIOSH Ag Centers. For example, Pacific Northwest Agricultural Safety and Health (PNASH) Center research efforts have led to invitations to center faculty to participate in national policymaking discourse. The Western Center for Agricultural Health and Safety has engaged county health departments in Merced and Fresno Counties, California, regarding current research initiatives of interest. Several researchers presented policy briefings at the California state capitol to a large audience of legislative staff and advocacy groups (Villarejo and Schenker, 2005). Other centers similarly have engaged local and regional agencies and private organizations and trade groups in policy discussions.

NIOSH core staff continuously engaged federal agencies in policy discourse. For example, NIOSH staff met with USDA Forest Service representatives concerning issues ranging from the use of insect repellents by Forest Service staff to cleanup policies regarding the use of safe cleaning agents. Also notable are the multiple research contributions that inform proposed new hazardous orders for child workers in agriculture and ergonomics standards to address repetitive-stress disorders.

Barriers to Effective Use of NIOSH Policy and Regulatory Expertise

Although NIOSH is uniquely positioned to provide independent, scientifically founded information and advice to inform public policy and regulatory discourse, several barriers may severely limit its contributions. First, as the NIOSH evidence package notes, the AFF workforce is to a great degree unregulated. The various statutory exemptions from the Fair Labor Standards Act and the Occupational Safety and Health Act, noted in Appendix F, severely limit the purview of NIOSH research activities; OSHA, for example, excludes all farms with 10 or fewer employees.

Second, and perhaps decisive in the current regulatory regime, there is a strong preference in some agencies for allowing market forces to shape the workplace environment. That preference is reflected in the sharp decline in federal occupational safety regulatory activity in recent years.

Third, Congress itself has been an important barrier even to the consideration of regulatory change. As the NIOSH AFF evidence package points out, "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, EPA's promulgation and enforcement of the pesticide Worker Protection Standard, and Department of Labor revi-

sions to child labor hazardous orders. But there has been little regulatory activity in agriculture safety and health."

Legislative actions have eliminated or repealed regulations that could significantly reduce and prevent workplace injuries and illnesses in the workplace. The committee finds that congressional interventions, such as its repeal of the ergonomics standard adopted by OSHA (OMB Watch, 2001), appear to have been based on controversial political considerations and to have ignored compelling scientific assessments and evidence of probable adverse long-term safety and health effects on the labor force. By ignoring the best scientific advice (NRC, 1998b, 1999; NRC and IOM, 2001), such ill-advised maneuvers have resulted in missed opportunities to reduce important occupational musculoskeletal risk factors. Despite the fact that musculoskeletal injuries and illnesses are the leading cause of work limitations (Liberty Mutual, 2006), it may take years to resurrect the ergonomics standard. To further complicate matters, the repealed OSHA ergonomics standard had already excluded agriculture.

Fourth, some scientists publish research findings but fail to follow through with the same urgency to seek needed improvements that their research suggested. Moreover, research scientists may lack the necessary communication skills to engage affected communities effectively.

It is useful in this context to consider how private sector and state agency partnerships can undertake activities that are not subject to federal constraints. Private foundations, non-government organizations, industry trade groups, and others can join state agencies in undertaking initiatives to address workplace safety and health in the AFF sector, and there are numerous examples of the support of research activities by the private sector.

PROGRAM EVALUATION INITIATIVES

NIOSH established an Operational Logic Model with the mission "To provide national and world leadership to prevent work-related illness and injuries." As part of this model, the goal of the AFF Program is prevention through effective research, transfer, and evaluation. Evaluation has been defined as systematic investigation of the merit, worth, or significance of the object (CDC, 1999b). This section of the report comments on the AFF Program's evaluation initiatives as presented in the evidence package (NIOSH, 2006a) and other evaluation activities discovered during the program review.

Program evaluation is extremely important for determining whether NIOSH activity has had a favorable impact on safety and health. To maximize the impact, the evaluation needs to include an analysis of the quality of the research or program. The evidence package includes a variety of evaluation activities. The research

conducted by the Alaska Field Station provides a good example of continuous program evaluation consistent with the NIOSH logic model: research on commercial fishing safety is well defined and was designed by using surveillance data, which can also be used to track the outcomes of the project. Those data were also used to make changes in project activities to improve safety. The end outcome of the program is a reduction in deaths associated with fishing activities in Alaska. The Agricultural Center Evaluation Project is also a good example of a NIOSH evaluation initiative. The report published in January 2007 provided recommendations to NIOSH. The one overarching recommendation was to continue to support this collaborative evaluation effort.

There does not appear to be a similar strategy or conceptual framework for evaluation of most AFF activities. The briefing document made it difficult to sort the information into appropriate sections in any coherent way. For example, surveillance discussions were scattered throughout the document, making it difficult to determine what was considered surveillance, hazard assessment, and so on.

Most important, it seems that no infrastructure has been developed in NIOSH for consistently capturing the activities of AFF projects that can be used for efficient, effective evaluation. The briefing book contains NIOSH's best effort to go back and find needed information, but much of the information that must reside somewhere at NIOSH is not included; for example, the original requests for applications (RFAs) for the programs launched in 1990 are not in the packet although the later RFAs calling for Ag Center applications are.

The NIOSH Operational Logic Model described in the evidence package indicates that evaluation would occur during most of the steps of the model (Figure 1-3 on page 28 of NIOSH, 2006a). Although the evidence package does report outputs, intermediate outputs, and outcomes in many cases, there is little information on evaluating the effectiveness of the reported items. The one exception, as mentioned earlier, is the Alaska commercial-fishing project, which seems to provide evidence of effective evaluation.

NIOSH staff readily admitted the difficulty of measuring outcomes. This is demonstrated in the evidence package by NIOSH stating that "in many instances it is difficult to effectively trace the contribution of NIOSH to the end outcomes. Many groups contribute to reducing occupational injuries and illnesses and to creating safer places to work. Still, NIOSH is strongly committed to developing objective measures of its real-world performance. If the best measures of performance relate to motivating and enabling others to work safer, this in no way diminishes the importance of the accomplishment (NIOSH, 2006a)." Under "End Outcomes," the evidence package notes that "evidence of reductions in occupational hazard exposures, illnesses, and/or injuries as a result of the AFF Program research is elusive at best" (page 101 in NIOSH, 2006a).

Many similar comments appear throughout the evidence package. One could and logically would surmise that many projects have had a favorable impact on improving the safety and health of the AFF workforce. However, the evidence package, while providing significant evidence regarding programs in place, did not document an evaluation process that could provide evidence of the overall effectiveness of the AFF Program.

There is some evidence that program evaluations are conducted, but validation of program effectiveness in reducing injuries and illnesses is not robust and needs substantial improvement. A process for quantifying end outcomes and their impact on reductions in injuries and illnesses and the evaluation of programs from a qualitative perspective needs to be established for all AFF projects. The process would be linked to surveillance and designed to provide feedback that can be used to change program priorities or activities if the present course of action is not having a substantial impact. NIOSH would use a standard best-practices approach. An evaluation model such as the Centers for Disease Control and Prevention's "Framework for Program Evaluation in Public Health" would be adopted and used consistently to quantitatively and qualitatively evaluate all projects and programs.

10

Program Scoring and Rationale

The committee was charged with evaluating the relevance and impact of the National Institute for Occupational Safety and Health (NIOSH) Agriculture, Forestry, and Fishing Research Program (AFF Program) on an integer scale of 1-5. Following the guidelines and questions provided in the Framework Document (Appendix A), the committee used its expert judgment to rate the relevance and impact of the overall research program by summarizing its assessment of the major subprograms before arriving at overall scores for relevance and impact.

The Framework Document does not prescribe a method for arriving at an overall quantitative score on the basis of qualitative evaluations of separate subprogram areas; it allows individual evaluation committees to tailor the scoring process. The present committee considered many ways of determining a single score to convey the relevance and impact of the program in its entirety. It originally considered assigning numeric scores to each of the three sectors but decided, because the AFF Program devoted most of its efforts to agricultural safety and health, that individual scores for forestry and fishing safety and health would be difficult to interpret. The committee decided to reach a single score that included consideration of the successes of the forestry and fishing safety and health subprograms in spite of the much smaller amount of funds and personnel committed to them. The assessment of those subprograms was based primarily on input received from experts on safety and health in the forestry and fishing sectors, as well as its review of the documentation on the subprograms and the NIOSH Centers for Agricultural Disease and Injury Research, Education, and Prevention (Ag Centers).

The committee also considered external factors outlined in Chapter 3 in scoring for program relevance and program impact.

ASSESSMENT OF AGRICULTURE, FORESTRY, AND FISHING RESEARCH PROGRAM RELEVANCE AND IMPACT

Score for Relevance

On the basis of information provided by NIOSH and others and its own experience and expertise, the committee assessed the degree to which the AFF Program has led and carried out research most relevant to improvements in workplace protection in agriculture, forestry, and fishing. The committee converted that assessment into a **score of 4** for relevance, based on a 5-point scale described in the Framework Document (Box 10-1).

The committee arrived at this score for the program as a whole after considerable deliberation. As one would expect for any research program as diverse as the AFF Program, the research carried out in some subprograms was more relevant than in others, as shown in the detailed evaluations presented in Chapters 4-9. In addition, the rating scale for relevance provided in Box 10-1 required the committee to consider more than one characteristic of relevance (e.g., priority of research, level of engagement in transfer activities), and the committee's evaluation of these different characteristics did not always fit neatly into a single score. For example,

BOX 10-1
Scale for Rating Program Relevance

5 = Research is in highest-priority subject areas and highly relevant to improvements in workplace protection; research results in, and NIOSH is engaged in, transfer activities at a significant level (highest rating).
4 = Research is in high-priority subject area and adequately connected to improvements in workplace protection; research results in, and NIOSH is engaged in, transfer activities.
3 = Research focuses on lesser priorities and is loosely or only indirectly connected to workplace protection; NIOSH is not significantly involved in transfer activities.
2 = Research program is not well integrated or well focused on priorities and is not clearly connected to workplace protection and inadequately connected to transfer activities.
1 = Research in the research program is an ad hoc collection of projects, is not integrated into a program, and is not likely to improve workplace safety or health.

according to the Framework scale, a score of 4 should be assigned if the research is in high-priority subject areas and is adequately connected to improvements in workplace protection, and the program is engaged in transfer activities. The committee concluded that some, but not all, research in the AFF Program has been in high-priority subject areas, and that the program has somewhat been engaged in transfer activities, but not always the most appropriate. In contrast, assigning a score of 3 would indicate that the research focuses on lesser priorities and is not significantly involved in transfer activities, and this also was not entirely accurate for the AFF Program. Had the committee been given the option of providing non-integer scores, the score for program relevance most likely would have been between 3 and 4.

To arrive at a single integer score for relevance, the committee examined separately the two main components of the relevance score: the priority of research and the level of engagement in transfer activities. For the former, the committee concluded that although not all research activities of the AFF Program fulfilled all the qualifications of a 4, it *more often than not* met the standard for engaging in high-priority research. In assessing the program's level of engagement in transfer activities, the committee focused on the *applicability* of transfer activities and concluded that the AFF Program was engaged in transfer activities and at least some transfer activities took place in appropriate areas. The committee therefore concluded that a score of 4 for relevance was more appropriate for the program overall.

Score for Impact

On the basis of the Framework Document's scoring criteria for program impact (Box 10-2), the committee assigned the AFF Program a **score of 3** out of a possible high score of 5.

DISCUSSION OF RATINGS FOR RELEVANCE AND IMPACT

As it thought about the relevance and impact of the AFF Program, the committee was influenced by general aspects of the program that contributed to its successes, some of which are described below. Further discussion of the conclusions that led to the committee's scores for relevance and impact, respectively, are described in subsequent sections of this chapter.

Breadth of the Program

Resources have been inadequate for the AFF Program to carry out its congressional mandate in the area of agriculture, let alone in the additional areas of

BOX 10-2
Scale for Rating Program Impact

5 = Research program has made a major contribution to worker health and safety on the basis of end outcomes or well-accepted intermediate outcomes.
4 = Research program has made a moderate contribution on the basis of end outcomes or well-accepted intermediate outcomes; research program generated important new knowledge and is engaged in transfer activities, but well-accepted intermediate outcomes or end outcomes have not been documented.
3 = Research program activities or outputs are going on and are likely to produce improvements in worker health and safety (with explanation of why not rated higher).
2 = Research program activities or outputs are going on and may result in new knowledge or technology, but only limited application is expected.
1 = Research activities and outputs are NOT likely to have any application.
NA = Impact cannot be assessed; program not mature enough.

forestry and fishing. In contrast with other NIOSH programs that focus research on narrow sectors and well-defined problems, the AFF Program has the task of addressing manifold issues that affect the occupational safety and health of nearly all natural resource workers on land and sea. That task touches on more than a million businesses, a huge array of products, and multiple workplace exposure. NIOSH non-sector based programs address extremely narrow topics and can focus good science on well-defined problems, whereas the AFF Program is expected to spread its resources to address broad issues, so it is difficult to conduct research on all of them. In agriculture, the AFF Program responded in a reasonably effective manner to the extreme diversity that characterizes agricultural production in the United States. The extensive sectoral, technical, and geographic diversity of the agricultural industry left NIOSH with no alternative but to focus on key subjects.

Focused Research Areas

Despite those enormous challenges, the AFF Program has proved that it is able to conduct sound research on focused areas when given the opportunity. That is the case with the Alaska commercial fishing program (see Box 10-3), which is an exemplary research program with concentrated research topics, clear goals, and adequate resources. Several factors contributed to the success of the well-executed program: research that was focused and targeted, use of clear and consistent sur-

BOX 10-3
An Exemplary AFF Program:
Commercial Fishing Injuries and Fatalities, NIOSH Alaska Field Station

While the committee evaluated several projects in the AFF Program and found many of them lacking relative to how a research program ought to conduct research, the work by the NIOSH Alaska Field Station on commercial fishing safety has proven to be effective, and the station has executed its research according to how an ideal program would operate.

NIOSH established the Alaska research field station in 1991 to address the high occupational fatality rate in Alaskan commercial fishermen. Members of the field station quickly identified the excessively high fatality rate in Alaskan commercial fishing of 200 per 100,000 per year for the 2-year period 1991-1992 (NIOSH, 2002). An epidemiologist was brought on to collect data on commercial fishing fatalities in Alaska and used the Alaska Occupational Injury Surveillance System database to focus on industries, workers, causes, and risk factors for injuries for priority setting and prevention research.

Members of the field station recognized that they did not have a good understanding of the commercial fishing industry. Therefore, in October 1992, NIOSH sponsored the first National Fishing Industry Safety and Health Workshop to

- Introduce members of the NIOSH Alaska research field station to the fishing industry.
- Identify players involved in commercial fishing safety.
- Learn about the fishing industry.
- Learn about existing regulations.
- Figure out how NIOSH could fit in and make a difference.

The meeting laid the foundation for how researchers would approach industry challenges, gave researchers insight into differences among the various industry segments, and illuminated the need for varied and flexible approaches to problems centering around people in the industry. Researchers developed peer relationships with industry stakeholders, and information was easily exchanged between the two; U.S. Coast Guard (USCG) has numerous copies of all publications written by the Alaska Field Station and refers to them often. NIOSH has been a resource for the USCG Commercial Fishing Industry Vessel Safety Advisory Committee. By walking the docks, talking to fishermen, and holding forums in numerous locations in Alaska with fishermen from various fisheries, the Alaska Field Station staff were able to outline four main categories of concern and set priorities for efforts according to magnitude of risk. In 1997, NIOSH published a bulletin indicating that the Commercial Fishing Industry Vessel Safety Act of 1988 had contributed to reducing deaths in the industry in Alaska, but the root issues that put people at risk persisted at the same level. It went on to recommend 11 focused improvements.

The second National Fishing Industry Safety and Health Workshop, held in 1997, drew international interest. Through forums and subcommittees, meeting participants outlined four main subjects of focus: vessel sinkings, man overboard, deck injuries, and diving deaths.

Vessel Sinkings—As a result of NIOSH Alaska Field Station research on fishing vessel sinkings, USCG in Seattle and Alaska initiated a standard practice of preseason boardings to conduct safety checks and advise vessel operators of issues that need to be addressed before departure. That activity led to the development of a voluntary commercial fishing vessel safety inspection and certification program that has now become

a requirement for any vessels carrying a National Marine Fisheries Service observer onboard. Another advance has been the recent USCG development of an alternative compliance safety agreement for a class of vessels operating in Alaska. NIOSH has had little direct involvement in the latest developments, but it appears that NIOSH efforts provided the necessary catalyst.

Man Overboard—Although time and resources have not allowed the Alaska Field Station to focus much effort on man overboard injuries and deaths, a National Occupational Research Agenda project is under way to gather the various devices, ideas, and practices used in man overboard prevention and recovery. The project will evaluate the effectiveness of the prevention and recovery methods, identify barriers to nation-wide implementation, and look at ways to improve.

Deck Injuries—After crab fishing was identified as the largest contributor to occupational injuries and deaths in Alaska, members of the field station sought out fishermen to discuss the issues. Their discussions and open-minded face-to-face approaches resulted in the publication of *Deck Safety for Crab Fishermen*, a 37-page practical guide to techniques and modifications to improve safety on crab vessels.

Additional forums and cooperative efforts with the NIOSH Spokane Research Laboratory identified entanglement as an issue for fishermen. That resulted in the development and successful testing of a unique emergency stop arrangement for capstan winches commonly used in purse seining. NIOSH took the capstan winch emergency stop to the Pacific Marine Expo and other events to share the invention with fishermen and has partnered with manufacturers to spread the use of the emergency stop on fishing vessels.

Watertight integrity and vessel stability are major causes of vessel losses and deaths, as demonstrated by the Arctic Rose sinking in 2001 that resulted in the loss of 15 lives—the largest loss of life in U.S. commercial fishing history. An engineering innovation now being tested is a fiber optics-based system for monitoring watertight hatches on fishing vessels to ensure watertight integrity. The system enables a captain to ascertain at a glance whether the important hatches are secured. Watertight hatches were not considered a viable option until recently because of the demanding vessel environment.

Diving Deaths—The 1997 Alaska Diving Safety Workshop (at which a member of the Alaska Field Station presented), sponsored by the Alaska Marine Safety Education Association (AMSEA) and Alaska Sea Grant, led to new diving regulations in Alaska and led NIOSH-supported AMSEA to develop an educational video about dive-harvest safety that introduces dive tenders to vessel safety, basic dive operations, and dive emergencies.

By highlighting those four issues, NIOSH confirmed USCG's belief that fishing safety was important, and the research data prompted action and showed USCG how to set priorities among its efforts.

Rather than measuring success by the number, volume, and weight of peer-reviewed articles and publications, the Alaska research field group has used practical methods to generate impact. Staff at the field station have used commercial fishing trade journals and newsletters, such as those of the North Pacific Fishing Vessel Owners' Association (NPFVOA) and AMSEA, to provide the latest safety information to commercial fishermen.

The research and outreach work in commercial fishing safety has had a great impact not only on local fisheries but on national and even international fisheries. This work and other publications have generated worldwide interest and resulted in NIOSH-sponsored international conferences on fishing industry safety and health: the first International Fishing Industry Safety and Health (IFISH) conference was held in Woods

continued

BOX 10-3
Continued

Hole, Massachusetts, in 2000; IFISH II was held in Sitka, Alaska, in 2003; and IFISH III was held in Mahabalipuram, India, in 2006. Those conferences have generated proceedings that are used around the world to help spur further conversations, research, and regulations on commercial fishing safety.

The NIOSH Alaska Field Station was able to show progress in many elements of commercial fishing through assorted cooperative efforts with USCG, NPFVOA, AMSEA, industry stakeholders, and other partners. Since the inception of the Alaska Field Station, there has been a 51 percent decline in the annual death rate in Alaskan commercial fishermen, active interagency cooperation is occurring, and, perhaps most important, NIOSH has achieved buy-in and respect from the commercial fishermen themselves.

The research methods and practices of the NIOSH Alaska Field Station are exemplary: they are focused, priorities have been set, they are timely, and they include stakeholder feedback. Through hands-on approaches to problem solving, determined efforts to gather and improve death and injury surveillance data, and a willingness to take the extra effort to assign high priority to face-to-face communication, the station has had incredible impacts on fishing safety. The main weaknesses of the program are attributed to external factors.

The committee applauds the work done by this small group of researchers. The Alaska Field Station has proved itself to be an effective program that has been relevant to the needs of commercial fishermen and has demonstrated that the outputs and intermediate outcomes of its effort have had a considerable impact in reducing injuries and deaths.

SOURCES: NIOSH, 1997a, 2002, 2006a; Chris Woodley and Michael Rosecrans, USCG, personal communication, August 31, 2007; Jennifer Lincoln, NIOSH, personal communication, August 31, 2007.

veillance methods, involvement of key stakeholders, and motivated core staff to ensure project continuity.

Examples of Cutting-Edge Research

Work on agricultural risks to respiratory health conducted by AFF Program staff in collaboration with other researchers has included cutting-edge research that has moved the field forward. Successes include significant contributions to the development of laboratory methods in studying respiratory risks, development of field methods for collecting dust samples, and etiological knowledge of hazards.

Hand-arm vibration syndrome (HAVS), or white finger syndrome, is a common problem among forestry workers. NIOSH studies demonstrated the strength of association between the use of chain saws and HAVS (NIOSH, 1997b), leading scientists and engineers in manufacturing companies to develop anti-vibration devices that could be mounted in chain saw engines to reduce vibration transference from engine to handle. NIOSH researchers also studied the problem on a global scale and saw a decreased prevalence of HAVS symptoms in Finnish and Japanese forestry workers following the introduction of light-weight, low-vibration chain saws (Futatsuka and Uneno, 1985a, 1985b; Koskimies et al., 1992; NIOSH, 1997b).

Contributions of Extramural Research

Information related to hazards encountered by AFF workers is of critical importance to efforts designed to protect those workers. With the support of AFF Program funding, the Farm Family Health and Hazard Surveillance (FFHHS) projects continue to expand the knowledge base about health and hazards associated with agriculture. Based on information from these projects, AFF Program staff systematically developed and widely disseminated training materials for conducting safety "walk-throughs." The Occupational Health Nurses in Agricultural Communities (OHNAC) program, another extramural program, developed important training for nurses in rural areas and provided many alerts to agricultural workers. A number of the Education and Research Centers (ERCs) continue to provide training in agricultural safety and health for occupational safety and health professionals.

Contributions of NIOSH Ag Centers

The NIOSH Ag Centers are an invaluable component of the AFF Program and have contributed to its successes. The Ag Centers serve as a national resource for addressing agricultural safety and health problems through research, education, prevention, and intervention. The regional nature of the centers allows research to be focused, targeted, and relevant to U.S. worker populations. The centers are based in university settings, enabling researchers to draw on university resources. Overall, the Ag Centers have methodically carried out and encompassed the necessary components of an occupational safety and health research program: surveillance, research in various subject areas, partnerships and collaborations with state and local stakeholders, and information dissemination. Nearly one-third of the research conducted by the AFF Program was conducted through the Ag Centers, and the centers have strategically addressed issues that affect various populations. Examples of these components include the following:

Involving Stakeholders

The Ag Centers use community-based approaches to identify issues deserving etiological or other exploratory research. These centers have established both community-based program advisory structures and technical working groups to enhance research, educational, and outreach efforts. Not surprisingly, some advisory structures have performed better than others.

By using community-based methods designed to engage workers, several Ag Centers have developed some successful programs to address occupational safety and health concerns of hired farm workers. For example, the Western Center for Agricultural Health and Safety (WCAHS), in collaboration with the California Institute for Rural Studies, held a conference in 1990 that included hired farm workers, farm labor advocates, and community-based medical providers (Villarejo, 1990). The success of this conference signaled the active and serious interest of university researchers in engaging workers and their representatives.

Outreach

Early in the development of its outreach activities, the WCAHS partnered with the Statewide Integrated Pest Management (IPM) Program staff of the University of California Division of Agriculture and Natural Resources to initiate a project to train workers in safe work practices in settings where restricted chemicals are used. The two-stage "Train the Trainers" program focused on bilingual (Spanish-English) training for supervisors, farmers, crew leaders, labor contractors, and other human resource specialists in the California agricultural workforce (O'Connor-Marer, 2000). Each participant who successfully completes this program becomes a certified pesticide safety trainer, meeting U.S. Environmental Protection Agency (EPA) guidelines. In turn, newly certified trainers provide training for hired farm laborers. Key to the process is the trainer-worker relationship in which individuals may raise questions or otherwise bring workplace safety issues to the fore. The most recent findings of the National Agricultural Workers Survey (NAWS) indicate that 86 percent of California's hired crop farm workers interviewed in 2003-2004 said they had received pesticide safety training from their current employer, up 8 percentage points from the 78 percent who similarly reported receiving such training in 1999-2000 (Aguirre International, 2005). There are no comparable data available for earlier years. The "Train the Trainers" model for pesticide safety training has been widely adopted elsewhere (Buhler et al., 2002), and the concept is encouraged by the EPA (EPA, 2007).

Influencing Policy

In California, current state law requires labor contractors to participate annually in continuing education intended to improve their personnel practices, and safety is a key component of the curriculum. That policy developed from the findings of a survey of the employment practices of California's farm labor contractors during the late 1980s and early 1990s, when many farm operators turned to labor contractors for their short-term labor needs. The WCAHS and the California Department of Employment Development supported the research, which included interviews of more than 180 farm labor contractors (California EDD, 1992) that eventually led the Agricultural Personnel Management Program (APMP) of UC Cooperative Extension and the California Institute for Rural Studies to initiate training workshops to address their needs.

The establishment of reliable standards and more accurate techniques for in-field measurement of acetylcholinesterase (AChE) depression in the blood serum of workers was a factor in encouraging the State of Washington to provisionally require analogous measurement of AChE depression among hired farm workers in that state. That decision was based in large part on the WCAHS research (Wilson, 1996). Measurement of this biomarker is in workers who may have been exposed to organophosphate pesticides and is required under California pesticide regulations, but techniques for in-field measurements had previously yielded statistically unstable results in many cases, so the improvements to the tests made results more reliable and credible.

Role of Occupational Safety and Health Journals

Scientists and practitioners need mechanisms for communicating, and support from the AFF Program for two journals that address agricultural safety and health have provided just that. The *Journal of Agromedicine* and the *Journal of Agricultural Safety and Health* serve as a central clearinghouse for the publication and dissemination of research findings. Clearly these journals serve the community in a fundamentally critical way and facilitate the work of scientists and practitioners.

ADDITIONAL COMMENTS ABOUT RELEVANCE

The committee assigned the AFF Program a score of 4 for relevance because it found that research has been in high-priority and priority subject areas, and research has resulted in some successful transfer activities. The following section elaborates on this finding.

The AFF Program has engaged in some high-priority research areas and has done an adequate job of addressing major problems. Several relevant, effective,

and important research and intervention pieces have resulted from the program. As previously mentioned, the work on Alaska commercial fishing has focused on highly important issues and has had an impact. The Childhood Agricultural Injury Prevention Initiative is extremely relevant, and some evaluations of the North American Guidelines for Children's Agricultural Tasks have shown reduced injuries when the guidelines were applied. The National Agricultural Tractor Safety Initiative is another example of a focused research effort that has been extremely relevant. Research on musculoskeletal disorders that assessed simple and direct solutions for agricultural worker populations is an important issue that was addressed and that had a direct impact on workers. The research conducted on injuries and respiratory diseases is notable, though efforts were somewhat disjointed at times. The AFF Program's current collaboration with other federal agencies on the Agricultural Health Study is a crucial endeavor that addresses the effects of environmental, occupational, dietary, and genetic factors on the health of the agricultural population.

Although the AFF Program has been engaged in some high-priority research, it has not balanced its research efforts to reflect areas that merit the highest priority. Forestry work remains one of the deadliest occupations in the United States, but the AFF Program has yet to demonstrate substantial effort in this area outside of Alaska and the southeastern United States. The committee is concerned that the AFF Program is not in tune with modern agricultural and forestry practices, lacks the ability to review efforts and know when to move on to other emerging issues, and consequently NIOSH does not have an accurate grasp of issues most pressing to agriculture and forestry workers. As seen in information provided to the committee, the AFF Program has struggled to conduct surveillance to identify subjects that warrant the highest priority for attention and has not been able to accurately define the populations that it serves. It has also struggled to effectively engage stakeholders to identify current issues and to disseminate its research findings to practice. Those are important matters that affect the kinds of research conducted; leaving them unaddressed will severely hinder the AFF Program's ability to conduct research relevant to worker safety and health.

The AFF Program is engaged in transfer activities, but it has not been entirely successful in developing integrated approaches to disseminating research findings so as to yield additional reductions in injuries and illnesses in the AFF sectors. The AFF Program does not appear to be as heavily involved in translational research activities as it needs to be. Where it is involved, it does not always appear to know how and to take credit for that involvement. The outreach approaches that do exist tended to have been developed in other industrial settings and have not been appropriate or effective in reaching most target AFF populations; industrial settings differ dramatically from AFF worksites and workforce, and different approaches are needed

to reach worker populations in the AFF sectors. Many examples of such models have been used by the Ag Centers and are described in Chapter 8. As previously mentioned, some projects have been successful in outreach because they first and foremost successfully engaged stakeholders and target populations and understood how to translate research results into workplace practices.

The AFF Program has been ill equipped, even among university-based and clinical researchers, to address cultural and language barriers. Bench scientists cannot be expected to become instant experts in unfamiliar cultures, foreign languages, and rural lifestyles and practices. Several first-rate scientists have courageously and frankly admitted their lack of expertise and experience in community outreach and have asked for assistance in public conferences that involved the AFF Program (Frank et al., 2004).

ADDITIONAL COMMENTS ABOUT IMPACT

The committee concluded that AFF Program activities or outputs are likely to produce improvements in worker health and safety, and gave the AFF Program an impact score of 3. That score was merited by the fact that the program has made some contributions to worker safety and health, as seen in the success of projects that have affected children, commercial fishermen, and tractor operators. But the committee had a difficult time establishing a clear record of positive impacts because the AFF Program itself has not given much priority to documenting the impact of its efforts. In some instances, the committee was aware of impacts that could be attributed to the AFF Program for which the program itself did not take credit. In other cases, however, it is clear that the contributions of the program have not been accepted by stakeholders nor has the research program engaged sufficiently in transfer activities. The committee concluded that the impact of the AFF Program's research has been hampered by a lack of leadership, stakeholder buy-in, and effective dissemination of knowledge and practices. The following section elaborates on these findings.

The committee finds that the NIOSH AFF Program has made important contributions that are likely to produce improvements in worker safety and health. The outputs of the AFF Program include a wealth of information that is still considered current and important by the scientific community. However, the information has not been organized in a manner that is understandable by or helpful to others and has not been accessible to its own researchers; the AFF Program holds great potential for impacting workers if it is able to organize information in an accessible, understandable, and helpful format. Research has informed public policy and regulatory initiatives at the federal level and in several states. It is vital that independent, scientifically based research continue to inform policy and regulatory discourse.

Many in the AFF industries are well aware that safety and health are woven into the fabric of successful businesses. As illustrated by the tragic loss of life associated with the recent sinkings of fishing vessels off New Bedford, important gaps still allow extremely dangerous conditions to continue.

NIOSH has a unique role as the only federal agency capable of convening all players dedicated to preventing workplace injury and disease, and it has deployed itself credibly on this task and funded other partners to function in consensus-building roles. NIOSH-sponsored symposia and workshops have had a great impact on the work of many occupational safety and health professionals and probably on the lives of AFF workers, but it is difficult to measure the direct impact of these indispensable capacity-building activities on worker safety and health.

The AFF Program has made important contributions to occupational health services and training endeavors across the nation. The committee members themselves have benefited from NIOSH-sponsored meetings and symposia, which have sparked the interest of occupational safety and health practitioners and provided others with valuable avenues for professional growth that would otherwise not have been available. It remains vital that NIOSH continue such support because it has singular influence in convening clinicians, scientists, and training institutions; conducting clinical research that produces occupational training insight; prescribing appropriate content for occupational training; and providing scientific and clinical evidence that informs practice standards. But there is room for improvement. For example, there is a need for physicians to become more involved in preparing training materials and to enroll in training courses. In light of the growing numbers of schools of public health, there is a need to prepare appropriate education and training curriculum materials for health professionals.

The AFF Program evidence package and supplemental materials lacked substantial data demonstrating changes in the annual number of occupational fatalities or disabling injuries in hired farm workers and several other populations. The lack of data may be attributed in part to the failure to conduct surveillance comprehensively and to poor data management and collection; it may also be attributed to external factors as previously discussed in Chapter 3. There was also a lack of evidence of concerted efforts to address hazards, safety, and health in forestry workers and in fishermen outside of Alaska.

Worker populations have not been adequately defined or tracked, therefore injuries and illnesses and changes in these populations have not been documented. The AFF Program's unfamiliarity with standard sources of data on hired farmworker employment, including the long-established U.S. Department of Agriculture (USDA) quarterly *Farm Labor*, is an indication of its inability to obtain accurate denominator data for its separate populations. The program has not used state-level data and data from other sources, such as workers' compensation insurance

coverage, that contain a rich body of information on hired farmworker morbidity and mortality that would be valuable in informing discussions of changes in rates of occupational injury or illness (Villarejo, 1998).

KEY PROGRAM LIMITATIONS

Although on the whole the AFF Program demonstrated success in addressing some relevant issues and showed that it had impacted some populations, the committee identified limitations that affected the program's progress and effectiveness. The committee observed several issues that affected both the AFF Program's ability to conduct research on issues relevant to AFF workers and its ability to conduct research that would have an impact on worker safety and health.

Leadership and Strategic Planning

The overarching concern about the AFF Program is the lack of a single cohesive vision to drive the research agenda. The lack of consistent leadership, long-term strategic planning, and periodic review of that course has led to a piecemeal approach to the research program, and the program appears disjointed more often than not. However, the patchwork approach has produced some successful efforts because of the efforts of talented and dedicated researchers. The committee understands that the AFF Program is currently undergoing changes in leadership and is seeking guidance from its National Occupational Research Agenda (NORA) AFF Sector Council. Current reports to the committee on these efforts show great promise, and the committee notes that effective leadership and stakeholder involvement will be essential in focusing the strategic plans of the AFF Program.

Surveillance

The AFF Program appears to have had considerable difficulty in applying the principles of and engaging in surveillance. Constraints to successfully implementing comprehensive surveillance may be due to external factors and funding. Basic demographic and health effects surveillance of each human population at risk of worksite exposure is essential because without it no effective targeting of other programmatic elements can occur, nor can one know when an intervention has been effective and move on to address other priorities. Surveillance needs to be broad-based in its population targets inasmuch as the sector is diverse in settings and employment practices and places that put populations at risk, such as children, spouses, and the elderly. Given the diversity of the target populations involved in the AFF sector, the focus on selected hazard surveillance (e.g., pesticides, rollover

protective structure [ROPS]) may have been the most efficient approach available, however creative partnering with other organizations, on items such as the NAWS survey might have provided additional information to guide program development. There are numerous examples beyond surveillance where NIOSH might reasonably let responsibility for an aspect of worker health and safety rest with another agency, but it was difficult to find that such a decision was arrived at after intentional consideration and decisionmaking.

In the 1990s, the AFF Program attempted to conduct surveillance through the FFHHS program and the OHNAC program. In addition, the AFF Program funded the National Farm Medicine Center in Wisconsin and the Great Plains Center for Agricultural Health in Iowa to conduct surveillance in two rural surveillance catchment areas. More recently, a second phase of the Regional Rural Injury Study has been funded.

The AFF Program needs to develop its surveillance program by using surveillance results in partnership with other organizations. Examples of some of these include the Centers for Disease Control and Prevention (CDC) National Center for Injury Prevention and Control, the National Center for Health Statistics (CDC), the National Animal Health Monitoring System (USDA), NIOSH Ag Centers, the National Children's Center for Rural and Agricultural Health and Safety, agricultural safety specialists at 1862 land-grant institutions, equipment manufacturers, and such informal groups as agricultural, fishing, and forestry workers and employer focus groups. NIOSH program directors and managers have not fully used CDC's surveillance findings for intervention targeting and development. Injury surveillance in the fishing industry appears to have been undertaken more expertly, at least for commercial systems of the far North, and health surveillance beyond hazard surveillance in the forestry industry is in programmatic infancy. Further, the use of hazard surveillance systems for nonfatal injuries and illnesses holds promise for being a more cost-effective model for identifying emerging issues. In addition, the use of sentinel monitoring of occupational illnesses and injuries, first proposed in 1983 (Rutstein et al., 1983) by NIOSH staff has not been actively pursued and may also be cost-effective.

Stakeholders

On the basis of the information provided by the AFF Program, remarks provided by stakeholders, and comments submitted by the public, the committee understands that the AFF Program has not fully engaged its stakeholders. It has had some remarkable partnerships to reach stakeholders, such as those with the commercial fishing industry in Alaska, but it has struggled to engage other stakeholders. The program has met the most success when it has understood stakeholder needs by asking for direct feedback from farm workers, loggers, and fishermen. It has also

garnered the most credibility when researchers have demonstrated that they are sensitive to stakeholder needs, which vary greatly among the three sectors.

A recurrent important impediment to NIOSH-sponsored programs has been lack of credibility among stakeholders. NIOSH has demonstrated that it can forge helpful linkages with segments of economic sectors, as in the mining and construction industries. However, such linkages to directly engage workers are not apparent between the AFF Program and two of its three target worker populations: in agriculture and forestry. Without a strong buy-in from its targeted populations, the program may appear to be out of touch with its stakeholders and unresponsive to the realities of the workplace environment, and its work may therefore not be credible among farm workers, loggers, and fishermen.

Stakeholders have also at times confused NIOSH with the Occupational Safety and Health Administration (OSHA); most workers are more familiar with OSHA's role in the workplace than with NIOSH's research. That has led to reluctance to work with NIOSH, in that some stakeholders are hesitant to work with a regulatory agency.

In its recent NORA initiative, the AFF Program has formed a NORA AFF Sector Council. Self-employed and unpaid family workers are represented on this council, but it includes no current hired laborers in AFF or direct representatives of hired laborers who were elected in a direct and democratic process by current AFF workers.

Populations at Risk

The AFF Program targeted specific populations that it deemed at higher risk than others but omitted certain other populations and fell short in defining the entire population of AFF workers at risk of injury and illness. There has yet to be a program-wide endeavor to characterize the numbers and types of workers involved in agriculture, forestry, and fishing. Some populations, such as hired farm workers, have also been poorly defined or miscategorized, and others, such as ranchers, have been largely unaddressed.

AFF Program leadership has a less than satisfactory record in addressing hired farm workers and did not respond to priority issues previously identified for this subpopulation. In May 1995, NIOSH convened a national task force of experts to identify priorities for surveillance and research on occupational safety and health of hired farm workers. The task force met, but the effort was stalled, and its work was put on hold. Three years later, Dr. Sherry Baron contacted a member of the task force to request that the California Institute for Rural Studies prepare the report, and the task force reached consensus without delay. Shortly after submitting their report to NIOSH for review in November 1998, task force members were informed that the report was issued (*http://www.cdc.gov/niosh/hfw-index.html*). For what

NIOSH refers to as priority populations for the period 1997-2006, the cumulative adjusted budget devoted to child safety was slightly more than $14 million, for fishing safety $2.4 million, for logging safety $0.2 million, and for "migrant and minority" populations an estimated $2.1 million (NIOSH Response to Question #5, 2007, see Appendix C). NIOSH has yet to allocate substantial resources that are consistent with the task force's recommendations for hired farm workers.

NIOSH has not accurately identified the hired farm workforce and continues to refer to this population as migrant and seasonal farm workers. Federal definitions of this population for the purpose of providing funds for education, health services, and legal services limits the eligible population to crop workers, but also includes food-processing workers. Furthermore, NIOSH has stated that "farm workers provide a good example of a population of non-English speaking, low-literacy immigrant workers who migrate between a series of temporary jobs" (Fine, 1996). That definition of the hired labor force is obsolete and unhelpful: although many hired farm workers are non-English speakers, some do speak English; 42 percent of hired farm workers migrate to find work, but most do not migrate (U.S. DOL, 2005); and many hired farm workers are immigrants, but quite a few are not. Moreover, large numbers of hired farm laborers work in livestock production, excluded from the current "migrant and seasonal" definitions. The basis of the inaccurate characterization of the hired workforce is federal legislation that funds services to address needs of "migrant and seasonal" workers, and cannot be attributed to NIOSH alone.

CONCLUSION

The AFF Program has conducted decent work but many opportunities for improvement remain, including the setting of priorities with stakeholder input and a focus on research of utmost importance to and impact on AFF worker safety and health. The new challenge is to create a cohesive program that establishes strategic goals with the input of stakeholders so that researchers will understand the issues facing AFF workers, conduct surveillance of all subpopulations of AFF workers, and create a research-to-practice stream of information that will have an impact on the stakeholder communities. Successful implementation of the research-to-practice component of the AFF Program will need to include participatory involvement at the ground level to provide data to answer stakeholder questions, identify how stakeholders access information, and create a continuous discussion with stakeholders. Given the programmatic gaps and challenges, the committee offers suggestions and more formal recommendations in Chapters 11 and 12 to build on the efforts of the AFF Program to date and to improve the entire system of NIOSH research and knowledge transfer activities.

11

New and Emerging Research in Agricultural, Forestry, and Fishing Safety and Health

The committee to review the National Institute for Occupational Safety and Health (NIOSH) Agriculture, Forestry, and Fishing Research Program (AFF Program) was charged with assessing the program's targeting of new research in occupational safety and health most relevant to future improvements in workplace protection. The committee was also asked to identify emerging issues important for NIOSH and the program. In keeping with the guidance of the Framework Document, this chapter provides the committee's suggestions based on expertise of individual members rather than as a product of a formal process to explore and synthesize recommendations that could be developed through a comprehensive review of the field.

IDENTIFICATION OF NEW AND EMERGING RESEARCH BY THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

Process for Identifying New and Emerging Research

The AFF Program identifies new and emerging research through planning inputs consisting of surveillance data, stakeholder needs, partner aims, information exchanged in symposia and conferences, and program evaluations.

Surveillance data and trends from the following sources are reviewed: Bureau of Labor and Statistics Census of Fatal Occupational Injuries, Traumatic Injury Surveillance of Farmers, Occupational Injury Surveillance of Production

Agriculture, Occupational Health Nurses in Agricultural Communities, Community Partners for Healthy Farming, Analysis of Surveillance Data for Agricultural Injuries, Cancer Control Demonstration Projects for Farming Populations, Birth Defects and Parental Occupational Exposures, Agricultural Health Study, Centers for Disease Control and Prevention Birth Defects Registry, Fatality Assessment and Control Evaluation (FACE), State-Based Fatality Surveillance Using FACE Model, Childhood Agricultural Injury Surveillance, National Agricultural Workers Survey, National Health Interview Survey, National Electronic Injury Surveillance System, Farm Family Health and Hazard Surveillance, Sentinel Event Notification System for Occupational Risk, Keokuk County Rural Health Study, Farmer Health Study, and the Work-Related Lung Disease Surveillance Report.

The NIOSH AFF Program identifies the following stakeholders and partners: farmers, hired farm workers, children as workers or bystanders, unpaid workers, forestry services workers, and fishermen. Stakeholders also include organizations, such as the Grange, United Farm Workers of America, Farm Safety 4 Just Kids, and the National Institute for Farm Safety. Private-sector stakeholders include equipment manufacturers, insurance companies, commodity groups, and workers' compensation organizations. Federal entities include the U.S. Department of Agriculture (USDA) extension agents, the U.S. Environmental Protection Agency, and the U.S. Coast Guard (USCG).

Advisory groups have included the NIOSH Agricultural Steering Committee and the NIOSH Board of Scientific Counselors. In addition, several program evaluations have been conducted, including a Progress Review Workshop (1992), a Project Facts Evaluability Assessment (1992), and an Extramural Committee Review of the Extramural Cooperative Agreement Programs (1995).

As a result of the aforementioned methods used to identify new and emerging research, the AFF Program has listed the following new technologies and potential emerging issues as potentially relevant for new research:

- Automatic steering, autopilot, and computer-operated equipment
- Biological manufacturing
- Biosensors
- Biotechnology
- Changing farmer demographics
- DNA sensing chips and nanolasers
- Exposure to genetically modified organisms
- Exposure to high-pressure hydraulic systems
- Fatigue
- High-speed equipment
- Irradiation of food

- Land application of sludge
- Managing safety in on-farm valued-added processing operations
- Power-transmission lines and communication towers (electric and magnetic fields and radiofrequency)
- Remotely controlled tractors and machinery
- Site-specific management
- Using global positioning systems to monitor worker activities
- Zoonotic-disease outbreaks

Assessment of the Agriculture, Forestry, and Fishing Research Program's Effectiveness in Targeting New Research

Given the trends in agriculture, forestry, and fishing, the worksites of tomorrow clearly will be different from the worksites of today. The changes, both predicted and unpredicted, will fuel the need for surveillance of such human factors as worksite organization and management; climate, technology, and policy change and of economics. On the basis of information provided by NIOSH, the committee concludes that the AFF Program has not developed a consistent process for identifying new research issues and developing a way to address emerging issues. The success of a public health research program is marked by its ability to recognize and address the needs of a targeted population. Because the AFF Program on the whole has struggled to conduct surveillance to understand the current needs of its worker populations, it is unable to forecast future needs.

In light of the fact that the program lacks an established procedure for assessing emerging issues in agriculture, forestry, and fishing, the committee further concludes that the AFF Program has fallen behind in understanding current practices and how these practices can create new hazards for workers. The program has instead focused resources on issues that have already been partly resolved by changes in work practices and environments. Thus, the AFF Program has not kept up with emerging issues and has lost the capability to gain useful knowledge and to respond with appropriate new technologies.

A few projects, however, have more successfully identified emerging issues and conducted research to address them. The fishing projects in Alaska and the farm-resident child-injury initiatives, for example, have consistently carried out sound research practices to affect fishermen and children, respectively, and have been able to identify new and emerging issues for these populations. Key factors in their success include the continuity of funding and staff. Long-term funding (3-5 years) enables researchers to carry out adequate surveillance, research, and outreach and to identify relevant issues on the horizon. Training and retention of key staff members are also vital for the successful execution of research from project

initiation to completion and for researchers to recognize such issues as changes in workplace practices.

The list of new technologies and potential emerging issues identified by NIOSH above appears to be a smorgasbord of unexplained significance; rather than reflecting a process by which the AFF Program can systematically identify and set priorities among new and emerging issues, the list appears to be simply a compilation of concerns and technologies. Regardless of how the list was assembled, the committee concurs that such issues as automated equipment, value-added processing on farms, changing farmer demographics, and zoonoses are emerging research issues and technologies that would benefit from NIOSH investigation.

NEW RESEARCH IDENTIFIED BY THE COMMITTEE

In evaluating the AFF Program's research, the committee identified several kinds of research missing in health effects, health services, intervention, and regulatory policies. Some research issues that have not been investigated are of great relevance to improvement of AFF worker safety and health and could substantially affect safety and health with help from NIOSH.

Health Effects Research

Health effects research is complex, and future efforts need to be directed toward more extensive collaboration among all scientists working in AFF, in both intramural and extramural settings. Collaboration in multicenter studies of key clinical problems would increase the power of studies to answer important scientific questions. Future efforts might take investigators in new directions, such as studying the health effects of shift work and other causes of sleep deprivation on the AFF workforce, or studying the risk of cancer among fishermen (Spitzer et al., 1975; Gallagher et al., 1985; Andersen et al., 1999).

The AFF Program has traditionally relied on engineering controls to eliminate or alleviate work environment hazards. In the new era of genetic and non-genetic marker technologies, the AFF Program needs to consider using these new preventive technologies for environmental and occupational disease prevention and control. At least one study has been funded on the emerging issue of gene-environment interactions; additional research needs to be conducted on preclinical identification of health hazards through biomarker technologies and include discussions on ethical concerns surrounding this issue.

New projects, which might be larger than those often funded by NIOSH, need to have adequate infrastructure to allow them to operate smoothly. The Agricultural Health Study—an important prospective cohort study of nearly 90,000 farmers and

their wives to explore the potential causes of cancer and other diseases—is a good example of extensive collaboration among NIOSH, the National Cancer Institute, the National Institute of Environmental Health Sciences, EPA, and various universities and institutes (National Cancer Institute, 2007). Clinician scientists would need to collaborate with laboratory-based scientists and epidemiologists to facilitate translation of knowledge into a form that can be communicated directly to AFF workers and those who provide health and safety services to them. Representatives of AFF communities need to play a large role in that dissemination process. Successful knowledge translation and dissemination will require that ways be found to overcome barriers of geography, economics, language, culture, and politics. A rigorous evaluation plan needs to be in place for all efforts of this nature.

The focus of health effects research may need to change as the AFF Program evolves. It may be wise to review priorities and accomplishments before the AFF Program enters its next phase, with input from NIOSH intramural and extramural researchers, scientists who are studying AFF issues through other funding streams, AFF workers, and medical and safety professionals who serve the AFF sector. Scientific information obtained through the efforts of all scientists working in AFF needs to be considered as future directions are determined. AFF workers from all levels of the workplace hierarchy need to be at the table when priorities and approaches to problems are considered.

Health Services Research and Training

NIOSH can identify useful structures that might function in advising the Education and Research Centers (ERCs) and the Centers for Agricultural Disease and Injury Research, Education, and Prevention (Ag Centers) so that training materials developed for occupational venues are clinically accurate, reflect current practice standards, integrate contemporary scientific and clinical findings, and are formally vetted before they are released for general use under the aegis of NIOSH.

Clinical science relative to occupational exposure assessment and intervention is advancing rapidly, including tools to identify workers with specific combinations of genetic variants and environmental stressors that put them at higher than normal risks of disease. NIOSH will need a mechanism to quickly feed such science into training curricula. AFF safety and health professionals need appropriate translation of the findings because they deal directly with AFF workers. Such discovery leads to specifically targeted therapies and intervention techniques for disease prevention and control—the very reason for conducting health services research and training. Telehealth is an emerging application used to expand access to healthcare services and training, especially for practitioners in rural communities: it serves as a means of providing AFF worker populations with access to medical specialist consultations

and as a way of providing continuing education to a variety of health practitioners on AFF topics.

The committee is impressed by efforts in the U.S. Public Health Service to explore factors that affect health outcomes. Much of the endeavor involves urban and suburban populations, and the committee encourages NIOSH to investigate with sister agencies on opportunities to conduct, endorse, or fund health outcomes research in rural AFF populations. Those populations have been only lightly studied despite the fact that their occupational pursuits and rural residence and work locations predispose them to some kinds of exposure and affect their access to healthcare. Such work might build on successful activities in urban settings.

NIOSH can explore ways to enhance attention to AFF issues in university-based clinical research training. Because NIOSH has excellent linkage through its ERCs, the potential to affect clinical curricula is enormous. Such linkage might capture nontrivial issues of rural geography, spatial isolation, lack of access to high-speed Internet infrastructures, cultural features, indigenous languages, and rural work patterns that are markedly different from those with which most urban-based clinical researchers have contact.

A continuing supply of physicians knowledgeable in the AFF arena and in other areas of occupational and environmental health is needed, as are incentives that would include occupational and environment health training and continuing education in medical school curricula. NIOSH can develop standardized assessment tools for extramural occupational health training activity so that there will be a mechanism to corral data on program relevance, quality, and execution. Recognizing that academic communities, volunteer organizations, and workers often have strong desires to implement interventions to prevent occupational injuries and illnesses and that they may lack resources to evaluate programs to guide the best use of their resources, the committee believes that a coordinated approach to training program evaluation has merit. Development of such tools would contribute information on knowledge and skill gaps, clinical and other professional relevance, needs for training and other professional experience, the ability of instructors and others to convey key messages, and incentives that might propel future collaborative activity in occupational training venues.

Intervention Research

The AFF Program needs a more systematic and unified approach to evaluating and disseminating intervention research. It has taken a unified approach with the National Agricultural Tractor Safety Initiative, albeit a decade or so late, and needs to take a similar approach to intervention research in general. Although there are regional differences among the activities undertaken by AFF workers, the many

similarities make it likely that a successful intervention developed in one Ag Center, such as a redesigned apple-picking basket in the Northeast Ag Center, would be useful in another center's work. The AFF Program needs a formal nationally coordinated mechanism for targeting intervention research to the highest-priority populations and highest-priority health effects so that the program can develop, pilot test, and evaluate appropriate interventions in an Ag Center and then expand interventions that have the greatest potential for success on a national scale. If an intervention has proved effective on a large scale, it needs to be aggressively disseminated to stakeholders through all available channels (such as trade and labor associations, publications, presentations, and extension agents), not merely posted on the National Agriculture Safety Database in the hope that employers and workers will visit the NIOSH Web site to search for solutions. The North American Guidelines for Children's Agricultural Tasks seem to be a good model for this kind of systematic development and rollout of an intervention, but the issues and most effective approaches may differ from children and adult AFF workers.

Regulatory Policies

Impact of Ending Statutory and Labor Exemptions for Agriculture

New research could be conducted on the safety impact of ending the longstanding statutory exemptions for agriculture under the Fair Labor Standards Act and the Occupational Safety and Health Act. As demonstrated by the remarkable success of Pacific and Northwest agriculture, in which all but a few of those exemptions have been superseded by state laws, there is a serious question of whether American agriculture would be harmed by abolishing the federal exemptions. NIOSH is uniquely positioned to compare state-level workplace regulations and safety outcomes with the corresponding performance of each state's farming sector. The much more limited exemptions for small forestry and fishing operations can also be examined.

New research could be conducted on the effect of ending child labor exemptions for agriculture. The General Accounting Office (GAO; now the Government Accountability Office) reports that there are compelling reasons to question regulations that exempt hired and unpaid family child workers in agriculture while children in all other industries are protected (GAO, 1998). Rather than continue its piecemeal approach of seeking corrections to various specific hazardous orders that apply to child workers, the AFF Program can focus on new research to examine the effects of eliminating statutory exemptions for hired and unpaid family child workers in agriculture. Research shows that nearly one-fourth of child farm injuries were among immediate family members, and at least one-third of these injured

children were performing tasks prohibited by hazardous work orders in hired child workers of the same age (Marlenga et al., 2007). Furthermore, 76 percent of workers less than 16 years old who died in connection with their work were working in a family business and were thus exempt from child labor laws. The committee recommends that the AFF Program continue research on how ending the "family farm exemption" would affect the labor market and other family farm workers. A related question is how raising the age restriction from 16 to 18 years for hazardous agricultural work would affect safety and health. As the GAO review points out, there are compelling reasons to question why children ages 16 and 17 are permitted to perform hazardous tasks in agriculture but would be forbidden to perform the same tasks in any other industry (GAO, 1998). The committee recommends that the AFF Program continue to support research to inform this question.

Impact of State Policies on Agriculture, Forestry, and Fishing Worker Safety and Health

New research is needed to study the effect of state policies on workplace safety and health. State policy initiatives, such as increases in minimum wage, are becoming more important because some state policies on occupational safety and health (such as those in California) are more stringent than federal regulations. An annually updated online reference source describing federal and state employment standards for the entire AFF workforce would be helpful. In 1988, a remarkably complete review of federal and state employment standards was published (Craddock, 1988); updating this document would be a good place for the AFF Program to start. It would become a valuable resource for employers, employees, and AFF safety and health professionals. It appears that no document of that kind has ever addressed the fishing and forestry industries.

High-quality surveillance and public policy assessment are clearly related, as was shown through a recent review of the enforcement and education activities of California's Cal/OSHA Program. California law states that employees must be insured under workers' compensation (by law, only employees earning less than $100 in any calendar quarter are exempt from this requirement); this system has been in place for more than 75 years. The Workers' Compensation Insurance Rating Bureau of California (WCIRB), the actuarial agency that reviews all paid claims, issues annual summaries of paid claims by frequency and severity. It produces a comprehensive record of the most serious injuries and deaths by job type and by the important factors involved in each claim, and its reports are extremely useful for surveillance purposes (Villarejo, 1998).

The WCIRB issued an analysis of all noncumulative workplace injuries and illnesses over a 3-year period for which an indemnity payment was made.[1] The analysis was multivariate and included independent variables, such as age of the worker, lack of work authorization (in the case of immigrant workers), duration of employment, and sex. The most significant finding was that only one factor was statistically shown to be associated with a reduction in overall noncumulative indemnity paid claims: Cal/OSHA enforcement and education (WCIRB, 2002). That finding suggests that the state's policy of enforcement and education has benefited both employers and workers.

EMERGING RESEARCH AND ISSUES IDENTIFIED BY THE COMMITTEE

The committee emerged from the review process with its own view of future AFF worksite challenges and opportunities for injury and disease prevention and promotion of healthy worker behavior. For NIOSH to continue safeguarding workers in agriculture, forestry, and fishing, the AFF Program needs to consider emerging research that the committee has identified as priority areas. The committee formulated these research issues and categorized them as high-, medium-, and low-priority to reflect their potential magnitude in AFF work environments while simultaneously recognizing the scarcity of NIOSH resources and the need to conduct research in focused areas. It is understood that the AFF Program needs to forge links with industry sectors capable of yielding key information and that these cross-cutting issues require bold program management with streamlined procedures and processes to aid cross-division research and interdisciplinary projects.

High-Priority Research

The committee identified several issues and research categories as having high-priority: changes in the demographic characteristics of the workforce, changes in the fishing industry, emerging forestry issues, blurring boundaries for food harvesting and food processing, food safety and food security, and the transformation and industrialization of agriculture. The committee hopes that the AFF Program will consider those crucial issues in the immediate future as it moves its research agenda forward.

[1]Indemnity payments are required for death or permanent disability, whether major or minor. In the event of a temporary disability, an indemnity payment for lost wages is required if the worker is hospitalized or is unable to work for more than 3 days.

Changes in Demographic Characteristics of the Workforce

It is important to monitor changes in the population at risk so that appropriate interventions can be targeted to reduce hazards, injuries, and illnesses related to work. The AFF working population has been undergoing substantial changes over the last several decades. For example, hired workers are increasingly involved in agricultural operations, such as dairy farming or row cropping, for which they may not be trained. The percentage of workers in agriculture who are hired rather than being owners or operators has increased dramatically in recent years, and the same may also be true for fishing. Hired workers may be recent immigrants, H-2A workers, or seasonal workers who come from other countries. Those changes underscore the need to develop surveillance systems that include hired workers to a much greater extent than has been the case.

Continuous review of the working population is needed to adapt research and interventions to other emerging characteristics of the aging workforce. The aging AFF workforce is a considerable issue (Robert Rummer, USDA Forest Service, presentation to committee, March 28, 2007; Jerry Dzugan, AMSEA, presentation to committee, March 29, 2007). For example, the average age of farm owners in the United States has increased over the last several decades (USDA, 2002); as these people continue to work through what would commonly be considered retirement age, the health and safety hazards of work will create new problems that need to be addressed. The percentage of farm operators who are female has also increased in recent years, and the risks to females associated with farm work have not been addressed to any great extent in the NIOSH AFF Program.

Changes in the Fishing Industry

After years of effort on the part of NIOSH's Alaska Field Station, USCG, the Occupational Safety and Health Administration, the Alaska Marine Safety Education Association (AMSEA), the North Pacific Fishing Vessel Owners' Association (NPFVOA), and industry and fisheries management, the commercial fishing death toll in Alaska has begun a downward trend (NIOSH, 2002). In 2006, however, commercial fishing still ranked as the most dangerous occupation in the United States, with a mortality of 141.7 per 100,000 fishermen (BLS, 2007a). The USCG report *Analysis of Fishing Vessel Casualties* (2006) showed that it was more dangerous to be a commercial fisherman in the Gulf of Mexico than in Alaska. NIOSH has been slow to expand its successes in Alaska to the commercial fishing centers in the lower 48 states, and it needs to begin to do so quickly in regions where the model could be transferable. In-shore fishery—consisting in New England mainly of lobstermen and shell fisherman; in the Chesapeake Bay, watermen involved in crabbing and oysters; and in the Gulf, shrimp fishermen—is substantially different

from offshore Alaska fishing. Offshore fishing in the Northeast is facing extinction due to depletion of the Gorges bank fishery, and these businesses tend to be non-corporate. These other fishing regions lack a support structure, such as AMSEA and NPFVOA, to provide training and outreach.

Another important source of risk in fishing is environmental degradation. As fish become scarcer and as fisheries close, margins for fishermen grow tighter and the cost of safety is weighed against the ability to operate the vessels. Overfishing can lead to rapid changes in technologies, spatial shifts in fishing, new management initiatives, and so forth that have the potential to impact fishing safety (Dolan et al., 2005).

With the ever-increasing demand for seafood outpacing the natural supply, there has been huge growth in aquaculture in the United States and around the world. Resources need to be dedicated to investigating safety and health issues emerging from aquaculture. Populations with little or no previous exposure to aquaculture are joining the industry and learning as they go. What hazards exist that they are unaware of? What challenges do they face in the exponential growth of a new industry?

Emerging Forestry Issues

The fatality rate in forestry workers is unacceptably high. According to presentations and public comments provided to the committee, some loggers are easily acquiring and using antiquated tools to harvest trees. Some loggers do not have formal training with logging equipment or electric tools, and many are unfamiliar with safety practices. The problem is compounded by the aging of the logging workforce, and older workers may face different and greater risks of injury and death than younger ones.

The U.S. forestry industry is undergoing substantial change due to mechanization, changing worksite labor organization, and increased use of contract labor for specified tasks. The increased use of mechanization is a challenge because it may increase some forms of worker exposure while decreasing others (Grevsten and Sjorgren, 1996; Attebrant et al., 1997; Axelsson, 1998; Neitzel and Yost, 2002). Resource degradation in forestry can limit the ability to use mechanical harvesters or potentially increase their risk by pushing harvesting onto steep slopes, degraded sites, or on other unstable terra firma. At the same time, mechanization may introduce ergonomic issues that have yet to be encountered (Gellerstedt, 1997; Oliver et al., 2000). Evolving workplace organization structures and the use of contract labor could exacerbate exposures, given management's desire to complete tasks quickly under environmental- and weather-related pressure and some workers' preference to work long hours at piece work rates (International Labour Organiza-

tion, 2000). The AFF Program needs to address these emerging developments in forestry services with targeted surveillance and research so that workers can avoid or mitigate such exposures.

Blurring Boundaries for Food Harvesting and Food Processing

With continuing changes in available technologies and economic pressures to increase profits by providing value-added products, many farms are increasing the amount of food processing performed on site. Post-harvest food processing generally entails cooling, cleaning, sorting, and packing. The primary goals of moving food processing closer to the fields and to the sea are to control undesirable chemical changes in the product, minimize physical damage, and obtain better control of pathogens through sanitation procedures. As these processes become more closely integrated with traditional harvesting activities, workers may be exposed to new hazards with which they are not familiar. There is a potential for increased worker exposure to risks and hazards when preventing food contamination and when maintaining ready access to sanitary facilities, drinking water, and food during the workday. Potential hazards include exposure to chemicals used as pesticides, or to control or enhance ripening or retard spoilage (such as argon, carbon dioxide, and carbon monoxide), or as sanitizers (such as hypochlorite solutions and ozone). Increased risk of repetitive motion injuries may result from new tasks associated with processing and packaging produce, such as twisting motions required to core lettuce. Additional surveillance and research activities may be required to fully characterize the magnitude and nature of these new hazards, and to develop appropriate intervention strategies.

Food Safety and Food Security

Hazardous food agents or contaminants can cause illness among people directly involved in food production. The list of hazardous agents is long and includes microbial and parasitic agents, multi-drug resistant bacteria, and antibiotic and pesticide residues. Other controversial issues, such as genetically modified foods that could contain allergens or toxins not found in conventionally produced foods, are also receiving attention from consumer and producer groups. Consumer preferences for ready-to-eat foods, changes in demographics and climate, and access to global markets have changed the incidence of food safety risks. In addition, there is a risk of intentional and unintentional food contamination due to agroterrorism or lack of oversight of food quality control. Those are all major concerns for public and private institutions.

Studies that integrate all the players and steps in the food chain—from farmers, ranchers, hired workers, forestry service workers, and fishermen to transport and

processing and packing industries to consumers—are needed to understand the risks of acute and chronic illnesses and how to prevent, monitor, and control them.

Industrialization of Agriculture

Several developments are converging in production agriculture that create new needs for robust programs in surveillance and health effects. For example, dairy and meat production capacity is increasingly concentrated in confinement operations, which results in larger aggregates of livestock at single farm sites. The environmental and ecological issues associated with concentrated animal feed operations have been subject to intense public scrutiny (NRC, 2003), but the health effects on employees and others associated with these worksites have been less intensively analyzed. Safety interventions need to also be studied for those working around large numbers of animals. In addition, large concentrated operations employ large numbers of workers and necessitate management and oversight functions far in excess of those of more conventional operations. Workforce issues affecting the injury and disease experience in such operations deserve attention, and NIOSH has the experience in other industrial sectors needed to plan and conduct such work. The committee encourages NIOSH to begin such analyses without delay and recommends that NIOSH provide encouragement and targeted funding for Ag Centers that may be in the best position to mount such efforts with dispatch.

Medium-Priority Research

Medium-priority issues and research subjects that are potentially critical in the near future were identified: the development of biofuels and their impact on workers and the environment, conditions of farm labor housing and its impact on public health, the rising demand for specialty agriculture, the integration of human and animal health, and the need to review equipment safety issues.

Biofuels

Biofuels have come to national attention in the last few years as a promising source of renewable energy. By developing technologies to convert corn, soybeans, plant residues, and other biomass materials into fuels, chemicals, and power, the United States could tap into cleaner and cheaper alternatives to petroleum (The White House, 2006). Biofuels have the potential to transform the energy sector and with it the industries associated with biofuels. Agriculture and forestry could face the greatest revolution since their industrialization at the outset of the 20th century.

The transition to a biofuels-based economy will alter the use of land, the types of crops planted, and the use of pesticides and machinery. With corn production concentrated in the Midwest, forestry biomass in the South and West, sugar production in the South and Midwest, and grass-based biomass on the High Plains, there could be a shift toward working in rural America and later a substantial increase in resource use. Those changes would be accompanied by the potential for additional safety and health issues that need to be considered by NIOSH:

- How will crop production technologies, seasonal work cycles, and distribution and transportation of raw materials and products? For example, if ethanol plants are built in rural communities, large concentrations of trucks will be transporting grain, other bulk byproducts, and ethanol to and from plants on two-lane roads. How will that affect the safety of rural residents? Could increased traffic in rural areas lead to an increase in collisions?
- How will new dedicated energy crop production systems affect worker safety?
- Will reduction in fossil fuel use by agricultural producers change exposures to farm equipment-related morbidity and injuries?

Farm-Labor Housing

The central importance of housing conditions for health status has been well understood in the public health community for more than a century. The first effort to address the living conditions specifically of hired farm laborers was California's 1915 Labor Camp Act, a response to horrific labor camp conditions that led to the Wheatland Hop Riot of 1913. There have been serious improvements in housing conditions of many migrant farm laborers, but virtually all recent health survey research have demonstrated that a large share of this workforce is still experiencing unwarranted risks to health that are associated with their housing conditions. Pesticides carried into a residence on work clothes, lack of refrigeration for food storage, absence of sanitary facilities, and extreme overcrowding have all been linked to adverse health outcomes in farm laborers. Forestry services workers and fishermen may also face similar housing issues. The issue is complex: socioeconomic status, housing conditions, risky behavior, workplace exposure, and immigrant worker acculturation may all be linked in unknown ways to observed health outcomes. The challenge to public health investigators to untangle those factors is daunting, and the committee recommends that NIOSH pursue such effort without further delay.

Specialty Agriculture

Production agriculture has rapidly shifted to accommodate the demands fostered by the globalization of the nation's food economy. Demand has increased for organic products (USDA, 2007) and for exotic plants and animals (Blisard et al., 2002). Vast stretches of cereal grain and row-crop production are now interspersed by acreage devoted to raising ornamentals, shrubs, and other nursery products; vegetables (including indoor hydroponic vegetables) and fruits; and specialty livestock (such as free range hens, milking goats, and North American bison). Those enterprises may entail activities and management practices noticeably different from the more conventional forms of American agriculture and may organize and pursue work tasks differently from other sectors and lead to different exposures of workers (David Runsten, Community Alliance with Family Farms, presentation to committee, March 28, 2007). NIOSH is encouraged to monitor, through USDA's National Agricultural Statistics Service surveillance, the emergence and development of those forms of production agriculture.

Integration of Human and Animal Health

Emerging and re-emerging pathogens include parasites and zoonotic agents that in recent decades have been associated with changes in the demographics of the workforce, in herd health practices, and in the practice of medicine and veterinary medicine in connection with the use of the same antimicrobial agents in humans and animals or the use in animals of antimicrobial agents that could be harmful to humans. For example, the accidental injection of Micotil (tilmicosin), a bovine antibiotic approved for use to prevent shipping fever in cattle), can cause death in humans when injected into the bloodstream. That is one example of human error causing an unforeseeable consequence to health. There needs to be a forum in which animal scientists, veterinarians, food safety experts, and social scientists come together to examine the complexity and hazard of animal handling and herd health issues in humans. The panel's expertise needs to include bioethics so that the humane treatment of animals and concurrent protection of human life are addressed. Another example of the need for an integrative approach to animal husbandry, production, and human health is the rising prevalence of neurocysticercosis, which was originally eradicated in the United States in the early 1900s. Neurocysticercosis is a parasitic infection that affects humans and pigs and was endemic only in Latin America, Asia, and Africa until the 1980s. The current increase in its incidence is related to the recent migration of hired labor from Latin American countries (Wallin and Kurtzke, 2004; DeGiorgio et al., 2005). Many neurocysticercosis patients may harbor the adult tapeworm *Taenia solium* in the intestines and could infect other humans and pigs. The complexity of the disease

goes beyond neurological consequences to range from seizures to permanent brain damage and ultimately death; sociocultural issues associated with food consumption and personal hygiene also have to be considered.

Outreach activities need to be developed in conjunction with programs to respond promptly to the needs of producers and consumers. Priority needs to be given to these outreach activities, considering the large number of people exposed to and affected by the hazards of animal handling. Furthermore, safety standards would be evaluated and updated as needed. The activities would include continuing critical analysis to determine whether target populations have been reached and their needs addressed. The integration of the cooperative extension service system, colleges of veterinary medicine and animal sciences, and the National Institute of Environmental Health Sciences is fundamental for the development of a much needed holistic approach to decipher and solve these complex problems.

Review of Equipment-Safety Issues

Advances in tools, equipment, and machinery are occurring rapidly. Cowboys are now riding motorcycles and all-terrain vehicles (ATVs) instead of horses, fishermen are using such advanced fibers as Spectra and Dyneema instead of wire rope, and former tobacco farmers are pulling fish out of ponds or trying their hand at organic food production. All those changes come about in an effort by AFF employers and workers to improve efficiency and perhaps make their jobs easier, but often they are embarking on a path with unknown risks. Many riders of ATVs are not trained to drive these fast-moving vehicles, and most do not wear protective helmets. Spectra and Dyneema appear amazingly strong but cannot be endorsed as reliable fishing tools, because of the lack of inspection standards. Farm equipment is being adapted for uses that were never foreseen by its manufacturers. In one photograph shown to the committee, a group of workers were shown lying face down on a platform attached to a tractor so that they could weed without bending over. The effort was probably intended to improve ergonomics and reduce back pain, but it could come at the cost of unforeseen consequences. The AFF Program needs to be constantly active in looking at emerging trends in AFF and take a more active role in foreseeing and addressing possible hazards from new and existing machinery.

Low-Priority Research

The committee identified four wide-reaching issues and research subjects that are candidates for long-term study: the impact of nutrient enrichment of food and genetically modified organisms (GMOs) on worker safety and health, transporta-

tion injuries, the impact of global warming on growing and harvesting practices and worker conditions, and the use of labor-management committees.

Nutrient Enrichment of Food and Genetically Modified Organisms

Micronutrient enhancement to reduce nutritional deficiencies in human populations globally is under study (Schreiner, 2005; Welch and Graham, 2005). These activities and the increasing use of GMOs to produce genetically modified crops may have an impact on aspects of agricultural safety and the health of workers involved in the production of these crops. From 1996 to 2005, the total surface area of land cultivated with GMOs increased from 4.2 million acres to 222 million acres, of which 55 percent was in the United States. Controversies surrounding genetically modified foods focus on consumer health and safety but not the health and safety of the farm workers.

Transportation Injuries

Hispanic farm workers have been reported to have 20 percent higher work-related mortality than non-Hispanic white farm workers. In Colorado, skull fractures and fatal intracranial head injuries have been reported to be more frequent in farmers and farm workers than in the general population; the risk in Hispanic farmers is 1.79 times greater than the risk in non-Hispanic farmers, and the risk in Hispanic farm workers is 2.50 times greater than the risk in non-Hispanic farm workers (Stallones and Sweitzer, 2000). Head injuries have been reported to be the leading cause of work injury-related death in farm workers in Texas (May-Lambert et al., 1998). Motor-vehicle collisions are the leading cause of head injury, but it has rarely been considered an issue related to the health and safety of migrant and seasonal farm workers.

The mobility of the population in question, which follows crops, exposes them to motor-vehicle injuries as part of their normal work environment. There is adequate evidence that Hispanic populations in Colorado have higher rates of fatal motor-vehicle collisions (relative risk [RR], 1.7), seatbelt nonuse (RR, 1.8), alcohol intoxication (RR, 2.7), speeding and invalid licensure (RR, 2.6) than non-Hispanic whites involved in fatal motor-vehicle collisions (Harper et al., 2000). In the United States, farm workers reportedly have higher than expected death rates related to motor vehicles (Colt et al., 2001). A study of Hispanic farm workers in California reported low use of seatbelts and car seats (Stiles and Grieshop, 1999). In Colorado, 53 percent of Hispanics reported not always wearing their seatbelts compared with 37 percent of all survey respondents (CDPHE, 2002). Driving while drowsy has been reported to cause 100,000 collisions a year and to result in 71,000 injuries and 1,550 deaths (NHTSA, 2002).

The National Highway Transportation Safety Administration conducted a study to identify issues in and strategies for highway safety in American Hispanic communities (Martinez and Veloz, 1996). The problem most often mentioned by Hispanic focus group participants and agency and organization representatives was drinking and driving, followed by low seatbelt use (Martinez and Veloz, 1996). Seven major challenges in addressing prevention in that population were identified: language; cultural differences within the Hispanic communities; low income coupled with low expectations for the future and limited resources for organizations to provide services to everyone in need; heavy use of alcohol combined with a lack of knowledge of the effects of alcohol on driving and confusion regarding alcohol laws; recent immigrants' lack of knowledge of American laws, inability to read signs and lack of valid drivers' licenses; Hispanic immigrants' lack of orientation to health maintenance and failure to accept safety readily as an issue; and absence of traffic-safety data on specific racial and ethnic groups (Martinez and Veloz, 1996).

Increased concern about health and safety among agricultural workers who commute from field to field and farm to farm during peak agricultural seasons has not increased the number of programs targeted at preventing specific types of injuries that are closely associated with the mode of travel of these workers and their families (Grieshop et al., 1998). The safety of motor vehicles used to transport migrant and seasonal agricultural workers is regulated by the Department of Labor under the Migrant and Seasonal Agricultural Worker Protection Act (29 USC §1801 et seq.), and these vehicles must comply with federal and state safety regulations. However, regulations promulgated under the act must consider "the extent to which a proposed standard would cause an undue burden on agricultural employers, agricultural associations, or farm labor contractors." The act also precludes the transportation of a worker on a tractor, combine, harvester, picker, or similar machinery or equipment while the worker is engaged in planting, cultivating, or harvesting agricultural commodities or caring for livestock or poultry. Regulations require the safe transport of migrant and seasonal farm workers, but it is not clear that they are being applied or what barriers impede the application of regulations that would improve safe transport.

Global Warming

Human-induced climate change, its potential impacts upon AFF working populations, and options for potentially effective interventions to preserve health status has received increasingly more attention in the last few years (Kilbourne, 1992; IPCC, 2007). The Intergovernmental Panel on Climate Change report forecasts an average global temperature increase of between 1.1 and 6.4 degrees Celsius, suggesting that warming of the climate system is unequivocal (IPCC, 2007).

Global climate change presently captures the attention of scientists the world over; however, its impact upon working agricultural populations is difficult to predict. For workers in AFF worksites, those effects may span a continuum from impact on wardrobes and safety gear to unexpected exposure to mold, fungi, insects, and ultraviolet radiation. Given that many AFF production sites are outdoors and unprotected, the warming of Earth's surface causes some concern, which in some areas may lead to increased problems with heat stress. Resistance to the use of safety protection in hot or humid environments is widespread among AFF populations, and this poses a challenge to adoption of protective barriers in affected settings. Such warming may contribute to a greater incidence of dermatological, infectious, inflammatory, and respiratory forms of human disease (Kilbourne, 1992). AFF worker exposures in warmer climates have been only lightly documented, and the committee recommends that NIOSH convene a panel of internationally recognized experts to identify the most important human exposures so that disease surveillance can be efficiently targeted. Finally, the committee recommends NIOSH monitor the spread of diseases typically associated only with tropical and subtropical environments, because the southern states will ultimately experience subtropical heat and humidity in large portions of the calendar year.

The agriculture, forestry, and fishing industries will also be affected. As the demand for seafood increases in the United States, the aquaculture industry will continue to grow. Those unfamiliar with raising seafood products will face unforeseen hazards associated with an increasingly warm planet, from microorganisms to plant infestations. Forests are being affected by beetles that survive in higher temperatures. Climate change may cause animals, plants, insects, and their associated disease vectors to flourish in areas that were previously inhospitable for habitation, and the impact on worker safety and health is unknown; infestations found only in Florida today may thrive in Virginia if global warming continues. How will workers be informed about the handling of invasive species and how can they be protected from exposure to foreign pathogens?

Joint Labor-Management Committees

A potentially valuable but underdeveloped method for improving worker safety is the formation of joint management-worker safety committees. Workers often have direct experience and knowledge about the risks associated with their jobs that could be invaluable to correcting problems where feasible. Such collaborations are common in some other sections of industry than in the AFF sector. Evaluation of the few existing AFF agreements could inform future directions of workplace safety programs. At the same time, worker advocates caution that workers in non-union settings may feel too vulnerable to make safety recommendations, a comment that needs to also inform research on this topic.

Joint management-worker safety committees may be construed as an unfair labor practice under the National Labor Relations Act (NLRA), especially if the worker members of a safety committee are selected in a company-wide secret ballot. However, hired agricultural workers, as previously described, are exempt from NLRA jurisdiction, so this would be of concern only to forestry and fishing firms. Moreover, the opinion of a knowledgeable labor attorney, provided on an informal basis and not constituting either legal advice or a legal opinion, indicates that such an election would not normally be considered an unfair labor practice under the NLRA (Joel Levinson, personal communication, May 11, 2007). It would be important to explore this concern further among both management and labor attorneys.

CONCLUSION

An essential and challenging aspect of NIOSH's stated mission "to provide national and world leadership to prevent work-related illnesses and injuries" includes the identification of emerging issues and new concerns for worker populations in agriculture, forestry, and fishing. The AFF Program should be at the forefront of efforts to review and define needs in agriculture, forestry, and fishing and should promote opportunities to pursue innovative ways of responding to these needs. The committee notes that the AFF Program has struggled in carrying out that task, and it has provided suggestions for approaching and undertaking such activities. However, the committee concedes that the task is important and warrants more extensive expert input and evaluation than the committee could provide in the context of its review. It hopes that the AFF Program will continue to engage its stakeholders and its advisory council for feedback and guidance.

12

Recommendations for Program Improvement

The National Institute for Occupational Safety and Health (NIOSH) Agriculture, Forestry, and Fishing Research Program (AFF Program) is the sole federal research program dedicated to enhancing the safety and health of workers in agriculture, forestry, and fishing. As such, the AFF Program should be the definitive leader and source of expertise in occupational safety and health in agriculture, forestry, and fishing. From its evaluation of the relevance and impact of the program (Chapter 10) and its assessment of new and emerging research (Chapter 11), the Committee to Review the NIOSH Agriculture, Forestry, and Fishing Research Program identified several potential opportunities to improve the relevance of the program's work and strengthen its impact on reducing injuries and illness in the AFF sectors. This chapter presents the committee's recommendations for program improvement.

As the committee reviewed materials provided by the AFF Program, gathered information from key stakeholders, and reviewed comments from the public, several barriers to the effectiveness of the program were apparent. The committee's recommendations are aimed at improving the program as a whole.

RECOMMENDATIONS

Establish Strategic Goals for Improvement in Administration and Evaluation

Recommendation 1: The AFF Program should establish strategic goals for the overall program and for separate subpopulations to provide a basis for improving program leadership, administrative oversight, and program evaluation.

AFF Program strategic goals should flow from the original enabling legislation, with the obvious expansion of the program to include strategic goals for forestry and fishing. The committee has highlighted the need for basic surveillance; worker health status assessment; design, field testing, and evaluation of efficacious interventions; provision of critical oversight mechanisms for professional education; and research to track key drivers that affect AFF worksites. Such goals must include capacity for NIOSH administration, inclusion of extramural centers, and a mechanism for external advice.

1.a: The AFF Program lacks a concerted effort and should focus its administrative efforts on improving program leadership, administrative oversight, and program documentation.

Improve Program Leadership

NIOSH is capable of deploying leadership across the AFF sectors. As mentioned in the ideal research program (Chapter 2), the committee recommends that a single person be charged with directing the entire program and overseeing, evaluating, and communicating its plans. However, content experts would be in charge of each arm of the program: a separate leader for agriculture, for forestry, and for fishing. Accordingly, the AFF Program should cultivate a proactive leadership approach that demonstrates inclusiveness and keen awareness of changes that take place across agriculture, forestry, and fishing.

Improve Administrative Oversight

NIOSH should specifically re-examine its internal coordination mechanisms, and implement simpler and more expedient means to ensure that all intramural program elements are functioning in a manner consistent with epidemiological insight and best management practices. The committee has serious reservations about the extraordinarily complex matrix system currently developed for program coordination, and instead recommends a relatively flat organization chart where

the person in charge of each arm would have a fair amount of responsibility and latitude to make appropriate decisions. The management matrix or organization structure should be flexible so that the AFF research teams can recognize and react quickly to changes in the AFF industries, the economy, new technologies, and relevant results of research in other programs, and managed in such a way that AFF research teams are encouraged to be proactive in anticipating and mitigating emerging risks and hazards.

Improve Program Documentation

NIOSH should move expeditiously to create a plan for open sharing of scientific information and best practices from past, present, and future intramural and extramural projects. To achieve that goal, the existing electronic centralized archival repository should be enhanced and be made more user-friendly. To facilitate the creation and maintenance of the archival repository, every project should be required to have an electronic submission form that permits information to be automatically uploaded into the repository within 90 days after project completion. Additional outputs include publications resulting from the research. The centralized repository should be easily accessible to researchers and to the general public. Search tools should be developed by NIOSH and made available to researchers. An incentive to do that will be to have publications and project reports listed with popular search engines so that they can be found and cited in the literature. Centers for Disease Control and Prevention (CDC)/NIOSH will have oversight and responsibility for the maintenance of this database.

The National Agricultural Safety Database (NASD) is a unique and valuable resource, but it is used by only 34 states. All states are represented by the NIOSH Centers for Agricultural Disease and Injury Research, Education, and Prevention (Ag Centers), and every state should be connected to the NASD. Information should be regularly evaluated and added to the database. The NASD could become the networking center for conferences, data, safety information, and research results.

1.b: The AFF Program should develop a comprehensive program evaluation mechanism to assess and set priorities among its research and transfer activities. It is important that effective evaluation be conducted as indicated in the logic model (Figure A-1). That cannot be accomplished in the absence of specific strategic goals against which progress can be measured. All aspects of the programs—including activities, outputs, and outcomes—should be systematically evaluated for relevance and impact. Assessment of program impact and feedback into the priority-setting process is essential because it leads to the identification of best practices. An evaluation process, such as the CDC Framework for Program

Evaluation in Public Health, should be adopted and consistently applied to all NIOSH programs.

Develop a Cohesive Program

Recommendation 2: The AFF Program should provide national leadership and coordination of research and transfer activities in agricultural, forestry, and fishing safety and health.

NIOSH has a unique role as a federal agency that directly funds occupational safety and health research through its intramural and extramural programs. As such, it is able to shape national priorities, strategies for action, and evaluation of health and safety programs in AFF. NIOSH is in a position to influence the direction and priorities of the regional and topical Ag Centers that it funds, and to lead and coordinate the work of related non-Ag Center projects. Those efforts need to be based on national goals and strategic planning, as mentioned in the previous recommendation, and should result in a coordinated effort aimed at developing and maintaining systems for comprehensive data collection, archiving, and sharing, and for research in and surveillance and evaluation of transfer activities. Exercising such national leadership would provide coherence and linkage among the diverse organizations engaged in intramural and extramural research and external partners. The national tractor initiative should not be the only project in which activities and strategies are nationally coordinated. Other agencies—such as the National Institutes of Health (NIH), the National Science Foundation, and the U.S. Department of Agriculture (USDA)—achieve such coherence by linking databases and structuring the request for application (RFA) and request for proposal (RFP) processes.

To follow this recommendation, NIOSH should create a national coordinating council that includes key stakeholders and the directors of the Ag Centers. The council would oversee strategic research goals (for example, in health effects, intervention, and health services research) and provide direction for occupational safety and health training so that the most pressing clinical needs are addressed. Coordination requires a process for maintaining continuous communication with all stakeholders; annual regional and national workshops and conferences are examples of an appropriate mechanism for strengthening leadership and coordination. The AFF Program should continue to convene symposia to explore contemporary AFF worksite and environmental exposures, because it has an essential role in the training of health services professionals. Discussion of basic methods already in use in the field is slow to reach health and safety practitioners in rural areas, and the meetings would help to educate rural practitioners. Practitioners'

insights about real-world clinical problems that affect rural populations would be invaluable to investigators.

The Ag Centers are superbly positioned to assist the AFF Program with coordinating national and regional initiatives, as they are strategically placed at university-affiliated or located at not-for-profit medical centers and are placed to reflect agricultural programmatic and regional differences (NIOSH, 2000a). To reflect the comprehensive charge of the AFF Program, the Ag Centers should consider undertaking additional responsibility in forestry and fishing, where regional issues apply, to obviate the creation of separate infrastructures to serve the needs of workers in forestry and fishing. Alternatively, providing R01 and R21 awards to non-Ag Center researchers might be a cost-effective way to further research objectives in forestry and fishing. Should the former be considered, the Ag Centers should in name also echo the array of issues covered and be referred to as AFF Centers.

Implement a Comprehensive Surveillance System

Recommendation 3: The AFF Program should implement a comprehensive surveillance system.

Surveillance is critical for developing and evaluating intervention programs and provides information needed to guide in-depth research areas. Current surveillance systems that cover occupational health, hazard, and injury are not comprehensive in that they do not cover the AFF workforce. The surveillance activities described in the NIOSH AFF evidence package reflect a piecemeal approach to surveillance and fail to address such critical issues as the population at risk and the incorporation of disease surveillance that includes more than respiratory disease, hazard surveillance that includes exposures other than to pesticides, and injury surveillance that includes a national focus on fatal and nonfatal injuries in all AFF workers.

Basic demographic and health effects surveillance of each population at risk of exposure in connection with worksite activity is essential; without it, no effective targeting of other programmatic elements can occur. Surveillance must be broad-based with respect to population targets because the sector is diverse in settings and employment practices and places some specific populations—such as children, female spouses, and the elderly—at risk. For various reasons, NIOSH has had considerable difficulty engaging in surveillance, although attempts were made for agriculture in the 1990s through the Farm Family Health and Hazard Surveillance program and the Occupational Health Nurses in Agricultural Communities initiative. Additionally, it also funded the National Farm Medicine Center in Wisconsin and the Great Plains Center for Agricultural Health in Iowa to conduct limited surveillance. More recently, NIOSH has funded USDA's National Agricultural Statistics Service (NASS) and the Department of Labor (DOL) to

conduct targeted surveillance of youthful workers, adult owners and operators, and agricultural employees. The committee received numerous written comments from the public that specifically mentioned the primary need for a comprehensive surveillance system.

The AFF workforce continues to change rapidly in the following ways: a decline in self-employed and unpaid family workers; an increase in regular or year-round hired farm workers from 712,715 in 1974 to 927,708 in 2002 (U.S. Department of Commerce, 1977; USDA, 2002a); an increase in reliance on contract labor and farm-management firms; and marked shifts in demographics among hired and contract workers, such as Africans in the fishing industry in Alaska, Mayan-speaking Guatemaltecos in New York state dairies, and indigenous immigrants throughout the nation. The committee strongly urges NIOSH to update and broaden its understanding of hired workers to include—without regard to immigration status or ethnicity—all hired AFF laborers, such as confined livestock, fishing vessel, fish farm, and forestry fire abatement workers. New approaches to surveillance may be necessary to explore and could include more orientation toward regional surveillance and more involvement with local and state health departments. Expanding on existing expertise with the state-based Fatality Assessment and Control Evaluation (FACE) programs to incorporate disease surveillance provides an avenue to become more comprehensive in the surveillance approach.

Additionally, there is little evidence that AFF Program staff have considered workplace injury and illness in H-2A workers. That is an important topic in the context of the policy debate regarding immigration reform and the Agricultural Jobs congressional proposal advocated by both AFF employers and workers' unions. Involving other federal, state, and local agencies in the discussion of expanded surveillance, which includes temporary workers, would begin to address this gap.

NIOSH must demonstrate greater willingness to use results of surveillance by its partners, including the CDC Injury Center, the regional Ag Centers, the National Children's Center for Rural and Agricultural Health and Safety, agricultural safety specialists in the nation's land-grant institutions, equipment manufacturers, and other organizations representing agriculture, fishing, or forestry workers and employers groups. NIOSH should evaluate opportunities to use National Agricultural Statistics Services, the National Animal Health Monitoring System, and other existing programs for surveillance purposes.

The committee has concluded that NIOSH should:

1. Conduct research on the potential use of both ongoing and non-routine surveillance systems to identify priority topics for future research or intervention. A focus on hazard surveillance, sentinel health and injury events, and occupational illness outbreak investigations similar to the FACE investigations may be more cost-effective than the current piecemeal approach.

2. Convene a panel of surveillance experts from state health departments, FACE program experts, universities, the State and Territorial Injury Prevention Directors Association, workers' compensation insurance experts, labor organizations representing all AFF sectors including temporary workers, and the Council of State and Territorial Epidemiologists to develop new approaches to AFF surveillance.

3. Implement pilot surveillance systems based on the new approaches proposed by the convened experts.

4. Develop an evaluation plan to assess the quality of the pilot surveillance systems.

Identify and Track AFF Populations at Risk

Recommendation 4: The NIOSH AFF Program should clearly identify and track its target populations.

Because of the scope and diversity of workplace activities in AFF, it is impossible to conduct effective research covering this broad range of hazards and risks. Therefore, the committee underscores the necessity of the initial needs assessment stage of at-risk population exposure rates and hazardous work conditions.

4.a: A clear definition of worker populations "at risk" is needed. It is not apparent from materials and responses provided to the committee how the AFF Program has defined those populations. The term *special populations at risk* is not suitable for identifying a person or group of people working in AFF activities. A revised definition should reflect persons at risk for occupational injuries and illnesses in AFF enterprises and those visiting AFF worksites (see Chapter 2 and Appendix E).

NIOSH's use of *child labor* as a way of defining exposure of children is inadequate because the current definition used in NIOSH-supported programs includes myriad activities and situations that do not accurately represent "labor". The primary focus of NIOSH research is attention to hazards faced by workers that are directly associated with the tasks they perform. Agricultural work is considered (with exemptions) hazardous to children under 18 years old by the International Labour Organization and DOL. Therefore, the AFF Program should primarily focus on risks faced by children under age 18, whether they are unpaid family workers or hired workers. Visiting a farm or playing in a safe area at a farm does not constitute labor, although it entails risk given that a farm is a work environment. In addition, various age groups, including persons over age 18, have been targeted for different studies, and this further complicates NIOSH's apparent definition of *child labor*.

The definitions of minority populations—which include children, the Navajo, and Hispanics and Latinos—are combined with occupation type, and this compli-

cates the definition of *labor* and adds confusion to the goal of unambiguous surveillance and to the socio-cultural implications associated with minority populations that face AFF exposures. The definition of *migrant and seasonal workers*, which has historically only included crop workers and thereby ignored the serious occupational hazards faced by livestock and other workers, should be in accordance with USDA definitions of hired and contract labor and should be clearly differentiated from *self-employed workers* and *family workers* (see Appendix F for methods of identifying workforce populations).

4.b: The AFF Program should conduct comparative studies across agriculture, forestry, and fishing to set priorities better and to respond to dynamic workforce and workplace conditions. The AFF Program's research, prevention, and outreach efforts have been specific to settings, with few comparative studies across the different AFF sectors. It is not clear how priorities are decided on or determined; the studies had different objectives, used different definitions for essentially similar populations, used various numerators and denominators, and used non-comparable classification schemes to characterize exposure.

In the last 2 decades, the AFF workforce has changed with the influx of non-English speaking workers, the aging of the workforce, industrialization of the three sectors, and diversification of food, fiber, and fuel production. The committee believes that there is a need for NIOSH to monitor the workforce better to track changes and determine needs for research, prevention, and outreach.

Conduct Research on Knowledge Diffusion Processes

Recommendation 5: NIOSH should conduct research on the science of knowledge diffusion to identify effective methods for AFF research-to-practice programs.

Knowledge diffusion and its impacts on target populations warrant in-depth research. In the AFF sector, the workforce is inaccessible through standard methods because of the diversity in the population with respect to culture, geography, language, and work subculture and because it is dispersed throughout industries involving farms, boats and ships, and the forest without an easy access point to provide educational materials or equipment training. To reach those populations, new methods should be developed to address language and cultural barriers. The role of cultural context—for example, in child labor policy on farms—needs to be incorporated into knowledge diffusion programs. That is also relevant for adult AFF workers. The use of theory-based research in educational programs designed to increase safety and health behaviors holds promise for improving the effectiveness and efficiency of knowledge diffusion (Cole, 2002; Morgan et al., 2002).

5.a: The AFF Program should incorporate broader social science expertise into the research diffusion process. Knowledge translation, communication of research findings, and interventions developed by the AFF Program require special attention. There has been some success when the topic of health has been introduced as a means of changing behaviors (Perry et al., 1999; Rydholm and Kirkhorn, 2005); however, serious gaps remain in health literacy, knowledge translation, and communication with affected populations and the public at large. This is an especially difficult problem in production agriculture in light of the diversity in the populations at risk. Professionals in disciplines such as cultural anthropology and rhetoric would be consulted to assist AFF Program scientists and national program staff to develop outreach materials; it is not realistic to expect working populations to follow recent developments through websites and printed reports. The use of traditional forms of communication needs to be re-evaluated by NIOSH staff, inasmuch as an increasing number of workers are from other countries and may not be literate in either English or Spanish. The utility of hazard-related pictures or narrative stories where language barriers exist needs to be researched further for use with AFF workers. Academe is especially well suited to explore such strategies and communicate new findings.

5.b: The AFF Program should explore communication tools capable of reaching the AFF workforce. The AFF workforce comprises a wide array of ethnic groups, many of whose people speak only their native language, not English. Moreover, low literacy is common in the AFF workforce. Further complicating the communication difficulty is the strong preference in many cultures for face-to-face discourse. Thus, a communication problem can arise in conveying facts and ideas from scientists who regularly rely on the Internet or other forms of modern communication to populations that rely on more personal interactions. NIOSH should endeavor to engage practitioners who have long experience in communication with the AFF workforce. The objective would be to develop a more realistic method of engaging in policy and regulatory discussion with these highly diverse groups.

As early as 1990, studies were being conducted on the best modes of communication for farming populations (Thu et al., 1990). Farmers recognized the hazardous nature of their work and reported a desire to have access to occupational safety and health services and a willingness to pay for services (Thu et al., 1990). They reported that they most commonly turn to farm magazines, Cooperative Extension, medical centers, and veterinarians for information (Thu et al., 1990), but these do not appear to be the modes of communication being used widely by NIOSH staff. The AFF Program should ask its partners to publish summary reports of relevant findings in suitable trade publications. For example, *National Fisherman* and *The Packer* are widely respected sources of information among practitioners in the fishing and fruit and vegetable industries, respectively. Newsletters directed

to healthcare workers are another important venue for dissemination of research findings and intervention initiatives.

Successful projects have used clinical services, education, and on-farm safety reviews; social marketing, electronic communication, and networking to provide education, train the trainers, and communicate with agricultural workers; and diverse audience-specific methods for communication with Hispanic children, parents, and farm workers.

Improve Stakeholder Engagement and Partnerships

The path on which NIOSH embarked when given its congressional mandate in 1990 is so important that only first-class principles for engaging stakeholders will do; anything less will make a travesty of congressional appropriation of resources. In recent years, NIOSH has embraced stakeholders in a number of occupational safety and health initiatives, as evidenced by the successful National Occupational Research Agenda (NORA) and NORA II initiatives. The participatory approach between NIOSH and stakeholders involves both parties early in the decisionmaking process and leads to more successful outcomes for employers and employees.

Recommendation 6: The AFF Program should establish a new model to involve stakeholders throughout the research process, and should also establish an effective multipartite stakeholder mechanism that includes at-risk workers and other organizations to focus on occupational safety and health.

6.a: The AFF Program should develop a new model for targeting all key stakeholders as full participants in its research program design and execution. The most-effective research projects have proactively involved workers through various stages of the research process. As mentioned in the ideal research program (Chapter 2), research must be participatory and community- or work population-based so that there is buy-in from the AFF community and stakeholder involvement should not be limited to the beginning and end stages. A participatory research model would involve different target populations from the prioritization of candidate projects to the inception, design, conduct, analysis, publication, and outreach of experiments and their conclusions.

6.b: The AFF Program should establish a coordinating council that would serve as a public advisory committee and would assume lead responsibility for informing public discourse on occupational safety and health issues. As mentioned in recommendation 2, this group would be critical in advising and coordinating the AFF Program's efforts. The evaluation committee strongly believes that a public advisory committee should be representative of *all* workers in agriculture,

forestry, and fishing. The AFF Program should use this council to establish an effective mechanism for input into policy and programs that includes representation of principal stakeholders, including AFF producers, workers, and their representatives; labor and farm management contracting agencies; the private sector, including AFF corporations and AFF service and supply industries; those delivering health and safety programming; researchers; and appropriate government policymakers. Most Ag Centers already have regional advisory structures whose members include farmers, ranchers, and other commodity growers, thereby insuring access to stakeholders. By establishing a meaningful national advisory group that truly represents the needs and concerns of all worker groups, AFF Program research and interventions will more fully meet their objectives. The committee commends recent NIOSH efforts to establish advisory mechanisms for the agricultural and fishing sectors. Such efforts need to be broadened to cover all of AFF in a more representative manner.

6.c: The AFF Program should continue to partner with appropriate federal and state agencies and establish additional interagency partnerships to increase the capacity for carrying out research and transfer activities. Federal and state governments are secondary stakeholders that if fully engaged could profoundly amplify NIOSH's efforts; such federal agencies as the USDA, the National Institutes of Health (NIH), and the U.S. Environmental Protection Agency (EPA) are natural allies to engage in such partnerships. The committee commends NIOSH for its partnerships with EPA and NIH's National Institute of Environmental Health Sciences (NIEHS), which continue to bolster work in organophosphates and other pesticide exposures. The AFF Program could expand its interagency partnerships to include federal agencies that handle food and animal issues, such as the U.S. Food and Drug Administration and USDA's Agricultural Research Service, Animal and Plant Health Inspection Service, and Food Safety and Inspection Service. The USDA Forest Service should serve as a partner in providing information and collaboration on forestry research, a field lacking sufficient expertise in the nascent forestry component of the AFF Program. AFF Program staff could work more closely with DOL to devise methods for more accurately capturing employment data on agriculture, forestry, and fishing. For transportation injuries, the AFF Program would be well served with interagency collaborations and non-profit partnerships, such as with the U.S. Department of Transportation and the National Safety Council, respectively.

Given the regional nature of the 10 NIOSH Ag Centers, state agencies serve as vital resources and potential partners. Some Ag Centers have successfully worked with cooperative extension services, state occupational safety and health agencies, state environmental protection agencies, and state departments of agriculture and should continue to engage in these valuable partnerships.

NIOSH should be commended for its collaboration with the National Cancer Institute, NIEHS, and EPA on the Agricultural Health Study, a prospective study of 90,000 people that has the potential to elucidate relationships between farm exposures and various chronic and other health outcomes. The committee recommends that NIOSH increase involvement in this joint initiative relative to cancer (and other diseases) because it could resolve questions about glioma etiology; explore the role of exposure to selected airborne toxins, such as cattle urine and metabolites of long-term manure storage; identify potential contributions to human disease of volatile organic chemicals, such as benzene and toluene, that are ubiquitous in agricultural, forestry, and fishing environments; identify other nonfarm employment exposures as potential occupational confounders; and develop and promulgate guidelines for organizing cancer prevention and control projects in AFF populations.

Even though the program has invested little in reproductive health research, NIOSH should also be applauded for its involvement with the CDC state birth defects registries, which make it possible to identify testable hypotheses and explore potential relationships between AFF occupational exposures and detectable birth defects. Other federal initiatives warranting NIOSH attention include the Genes, Environment, and Health Initiative (*http://genesandenvironment.nih.gov*) sponsored by NIH, which will develop new tools for measuring environmental exposures that affect health, and the National Children's Study (*http://nationalchildrensstudy.gov*) sponsored by NIH, CDC, EPA, and the Department of Education, which will explore the effects of occupational exposures on children and other matters.

6.d: The AFF Program should establish public-private partnerships to work more closely with equipment, facility, and pesticide manufacturers in design and development processes. Sound engineering methods and products should always be preferred for intervention so that the risk of hazard exposure can be minimized or eliminated and the human element of "good work practices" does not have to be depended on. Stakeholders should be included at all levels of intervention research, from the manufacturer to the user of AFF equipment, facilities, and pesticides. A participatory approach needs to be cultivated with equipment manufacturers, facility designers, and pesticide manufacturers. A German automobile manufacturer once said in a television commercial about safety that "some things are too important not to share," referring to the patented crumple zone body design that it shared with other car makers and which are now standard in automobiles. The goal of bringing NIOSH into the equation of occupational safety and health is to establish the spirit of sharing by prevention through design.

NIOSH should be encouraged to partner with non-profit organizations, such as the National Safety Council, and to leverage support from one or more private

foundations to provide supplemental resources. For example, the W.K. Kellogg Foundation, the Bill and Melinda Gates Foundation, and the California Endowment already have program experience and relevance in the broad arena of agricultural and extractive industry policy, and they may be in a position to offer advice and exploratory evidence. The Farm Foundation recently sponsored an ad hoc committee of stakeholders to provide a forum for industry, academe, and advocacy groups to explore common themes in agricultural safety and health. A similar initiative is needed to address safety and health issues in forestry.

Implement Integrative and Interdisciplinary Approaches

Recommendation 7: The AFF Program should implement integrative and interdisciplinary approaches in its research practices.

It is apparent that the agriculture, forestry, and fishing sectors are different and have different subcultures. The AFF Program's best work has been done when researchers have left their offices and "gotten their boots dirty" in fields, forests, and fishing docks. During the committee's meeting with invited stakeholders, panel members from industry and academe continued to stress the success achieved when NIOSH researchers went to worksites, met their customers, and took a hands-on approach to their work. In order for this type of interdisciplinary activity to be successful, individuals experienced in participatory research need to be involved (such as anthropologists and sociologists). Furthermore, once the research was complete, the most effective researchers returned to the field and conducted outreach to help put ideas into practice.

7.a: Researchers that receive funding from the AFF Program should visit worksites regularly so that they can acquire understanding of the workplace environment and thus develop and integrate culturally appropriate and sensitive approaches. NIOSH program managers and staff should make it a habit to get into the field regularly to test their hypotheses with workers and should be adaptable to changing needs and demands. Once a study is complete, measurements taken, and implementation and interventions formulated, NIOSH managers and staff should revisit worksites so that they become advocates for recommended changes and improvements lest the quest for change stagnate.

AFF grant guidelines issued by NIOSH should incorporate "field time" in proposed research. The incorporation of field time can be accomplished in a number of ways, including (1) prospective documentation, in research proposals submitted for NIOSH support, of plans, endorsed over support letter signatures, to engage stakeholders; (2) written evidence in final project reports of compliance with established principles of community-based participatory research; and (3) documentary

evidence of field time in scientific articles, clinical notes, insertions in *Morbidity and Mortality Weekly Report, NIOSH Alerts*, and other documents.

7.b: The AFF Program should increase the use of interdisciplinary teams to address the environmental, social, cultural, and psychological complexities of issues that face AFF workers. Industrial processes of agriculture, forestry, and fisheries are undertaken in environmental settings that often contribute to the high risk associated with the occupations involved, including weather conditions, steep slopes, and high seas that affect the machinery and equipment involved. In agriculture, the immediate proximity of the worksite to residences means that spouses and children are potentially affected—for example, by pesticide drift contamination, children's injuries that take place during play, and respiratory, zoonotic, and other diseases—even when family members are not directly involved in farming activities. Similarly, proposed solutions to AFF health and safety problems—whether engineering, regulatory, or educational solutions or the use of personal protective equipment—often require an understanding of the social, cultural, political, and psychological context of the causes and consequences of injuries or illnesses.

The interdisciplinary teams should include sociologists, psychologists, anthropologists, political scientists, economists, and human factors specialists to help researchers understand the social processes that contribute to injury and illness, the social processes that contribute to the successful transfer of solutions, and the analysis and evaluation of what works in AFF worksites. Some examples are the impact of private-sector organizational solutions, such as the use of insurance companies for farm compliance with best practices, and social marketing strategies to overcome resistance to change. The application of such innovative solutions in other AFF contexts has the potential to increase the impact beyond the examples cited. Furthermore, a successful approach would include qualitative research training experts on review panels to evaluate this type of research.

Enhance Awareness of National Policy

Recommendation 8: The AFF Program staff should develop greater awareness of national policy activities because they can have a substantial impact on AFF worker populations and risk factors.

National policy decisions affect how farming, logging, and fishing can be conducted; consequently, they affect conditions in which AFF workers will be at risk of occupational injury or disease. The policies include changes in the allowed catch from fisheries and limits on logging in the nation's vast national forests that result from decisions regarding endangered habitats. NIOSH personnel that are well-informed of current national policies that affect agriculture, forestry, and fishing

are more capable of responding to the changing needs of affected worker populations. AFF Program staff should be continually informed about labor law affecting the AFF workforce, such as child labor. The "Farm Bill", emerging immigration policies, and trade policies are especially relevant for AFF Program staff.

The Farm Bill

The expected 2008 reauthorization of the Food, Conservation, and Energy Act, colloquially known as the Farm Bill, will contribute to shaping the economic climate in which agricultural businesses make production decisions. Federal farm support programs dictate the types of commodities that receive federal payments and thus shape the landscape of plantings, and these shifts in crop plantings can alter the farm labor market. Strong interest in biofuels production has already altered cropping patterns in broad swaths of the Midwest and High Plains. That will probably result in changes in the design and use of and the demand for agricultural equipment and in the development of a rural trucking industry, and thereby change worker exposures.

Immigration Policies

Of immediate concern is Congress's failure to enact comprehensive immigration reform. Immigrants make up a large fraction of hired AFF workers. The Department of Homeland Security recently promulgated new regulations requiring employers to dismiss employees who are unable to prove their legal status; such dismissals would be based on "no-match" findings of name and Social Security number in federal records. Enforcement of the regulation has been stayed by court order under litigation brought by a number of labor organizations and the American Civil Liberties Union. Farm employers now face the difficult challenge of proving that their hired workers are eligible to work in the United States or recruiting persons who are eligible. Many farm employers will probably turn to the existing H-2A visa program for recruiting and hiring contract laborers from Mexico, Central America, and Asia. Under current rules, H-2A visa holders will not be permitted to have family members accompany them while working in the United States, and employers will be required to provide housing and transportation costs.

Immigration patterns can also affect worker health. A relatively small proportion of immigrant workers may carry diseases that are endemic in their regions of origin (Asia, Africa, Central and South America, and other places), such as tuberculosis and parasitic diseases, and thereby pose a potential health threat to other workers and possibly to the public at large. Other issues have an even greater impact, such as language barriers, ethnically driven social constructs, and policy shifts at the federal level.

The industry-backed "Agricultural Jobs" proposal, supported by the United Farm Workers of America and other advocates, will be introduced as a separate, stand-alone legislative proposal. The outcome of the legislation, which is uncertain at this writing, will largely determine who will be hired to work on American farms in the future. The proposed language specifically addresses housing needs of immigrant contract workers, and this aspect has implications for where workers will reside—in on-farm housing subject to federal regulation or, with vouchers, in any type of housing, including informal dwellings not subject to inspection by health authorities. Workers who live in on-farm housing can be subject to harassment and coercion to work unpaid overtime; but at the same time the preferred options of affordable private market, non-profit, and government-sponsored program housing is shrinking. In addition, most housing provided by non-profit organizations or public agencies is family housing, and is unavailable to groups of unaccompanied men.

Trade Policies

Trade issues are of paramount importance to the AFF sector because of AFF commodity import and export. Trade agreements potentially can function as economic drivers for change, which could influence production capacity in the AFF sector and influence exposure of domestic workers and those outside the United States. The impact is already being felt in the sugar cane and sugar beet industries of the Deep South and far North, respectively; other impacts are seen in commodities as diverse as cotton and tuna. In the agricultural sector, another development adds complexity to the trade issue: genetically engineered organisms. Whole agricultural enterprises, such as rice and cotton production, have experienced savage swings in demand as countries have responded to reports of genetic shift in non-target crops, which have resulted in dramatic shifts in worker employment and exposure.

SUMMARY

The AFF Program plays a positive and crucial role in providing information and tools to promote a safer and healthier work environment in agriculture, forestry, and fishing. The committee hopes that its recommendations will help refocus and redirect program efforts, thereby enhancing the program's impact on the safety and health of all populations at occupational risk in agriculture, forestry, and fishing.

Glossary

Activities efforts and work of the program, staff, grantees, and contractors (for example, surveillance, health effects research, intervention research, health services research, information dissemination, training, and technical assistance).

Agricultural engineering the development of engineering science and technology in the context of agricultural production and processing and for the management of natural resources.

End outcomes improvements in safety and health in the workplace. Defined by measures of health and safety and of impact on processes and programs (for example, changes related to health, including decreases in injuries, illnesses, or deaths and decreases in exposures due to research in a specific program or subprogram).

Epidemiology the study of factors affecting the health and illness of populations.

Ergonomics the application of scientific information concerning humans to the design of objects, systems, and environment for human use.

Exposure assessment an evaluation of the potential exposures to humans and the environment from the production, distribution, use, disposal, and recycle of a chemical substance.

External factors actions or forces beyond NIOSH's control (for example, by industry, labor, regulators, and other entities) with important bearing on the incorporation in the workplace of NIOSH's outputs to enhance safety and health.

Extramural research research supported by funds from NIOSH to researchers and organizations outside NIOSH through a grant, contract, or cooperative agreement.

Health effects research research that investigates physical, chemical, and biologic hazards (injuries and exposures, illness, and death).

Hired farm worker persons that are paid to perform duties on a farm.

Farmworker adjective used to describe a noun, such as "farmworker health" or "farmworker families."

Farm worker any person (self-employed, unpaid, or paid) that performs tasks on a farm.

Industrial hygiene the science of anticipating, recognizing, evaluating, and controlling workplace conditions that may cause workers' injury or illness.

Intermediate outcomes related to the research program's association with behaviors and changes at individual, group, and organization levels in the workplace. An assessment of the worth of NIOSH research and its products by outside stakeholders (for example, production of standards or regulations based in whole or in part on NIOSH research; attendance in training and education programs sponsored by other organizations; use of publications, technologies, methods, or recommendations by workers, industry, and occupational safety and health professionals in the field; and citations of NIOSH research by industry and academic scientists).

Intervention research includes studies in which researchers arrange (or follow) a systematic change in conditions to determine the effects on a physical capacity, skill, or performance.

Intramural research research within NIOSH.

Knowledge diffusion the adaptation of knowledge in a broad range of scientific and engineering research and development.

Outputs a direct product of a NIOSH research program that is logically related to the achievement of desirable and intended outcomes (for example, publications in peer-reviewed journals, recommendations, reports, Web site content, workshops and presentations, databases, educational materials, scales and methods, new technologies, patents, and technical assistance).

Planning inputs stakeholder input, surveillance, and intervention data, and risk assessments (for example, input from Federal Advisory Committee Act panels or the National Occupational Research Agenda research partners, intramural surveillance information, or health hazard evaluations).

Populations at risk people that have proximity to the activities of agriculture, forestry, and fishing and to the potential dangers involved in those activities.

Production inputs intramural and extramural funding, staffing, management structure, and physical facilities.

Stakeholder individual or party that has an interest in and may be affected by the NIOSH AFF Program.

Technology transfer the process of developing practical applications for the results of scientific research.

Surveillance the observation and recording of injuries, illnesses, and deaths.

Zoonoses, zoonotic diseases diseases caused by infectious agents that can be transmitted between (or are shared by) animals and humans.

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Appendixes

A

Framework for the Review of Research Programs of the National Institute for Occupational Safety and Health*

This is a document prepared by the National Academies' Committee for the Review of NIOSH Research Programs,[1] also referred to as the Framework Committee. This document is not a formal report of the National Academies—rather, it is a framework proposed for use by a number of National Academies committees that will be reviewing research in various research programs and health-outcomes programs. This version will be posted on the website of the National Academies and NIOSH for review. It is a working document that will be subject to change by the Framework Committee aimed at improving its relevance on the basis of responses received from evaluation committee members, NIOSH, stakeholders, and the general public before and during the course of the assessments conducted by independent evaluation committees of up to 15 research programs and health-outcomes programs.

*Version of 12/19/05.

[1]Members of the National Academies' Committee for the Review of NIOSH Research Programs include: David Wegman (Chair; University of Massachusetts Lowell School of Health and Environment), William Bunn, III (International Truck and Engine Corporation), Carlos Camargo (Harvard Medical School), Susan Cozzens (Georgia Institute of Technology), Letitia Davis (Massachusetts Department of Public Health), James Dearing (Kaiser Permanente), Fred Mettler, Jr. (University of New Mexico School of Medicine), Franklin Mirer (Hunter School of Health Sciences), Jacqueline Nowell (United Food and Commercial Workers International Union), Raja Ramani (Pennsylvania State University), Jorma Rantanen (Finnish Institute of Occupational Health), Rosemary Sokas (University of Illinois at Chicago School of Public Health), Richard Tucker (Tucker and Tucker Consultants, Inc. and University of Texas at Austin), and James Zuiches (North Carolina State University).

All public comments submitted to the Committee for the Review of NIOSH Research Programs will be included in the Public Access File for this study as provided in the National Academies Terms of Use (www.nationalacademies.org/legal/terms.html). Please keep in mind that if you directly disclose personal information in your written comments, this information may be collected and used by others.

CONTENTS

ACRONYMS

ABLES	Adult Blood Lead Epidemiology and Surveillance
ACOEM	American College of Occupational and Environmental Medicine
AOEC	Association of Occupational and Environmental Clinics
BLS	Bureau of labor Statistics
CDC	Centers for Disease Control and Prevention
EC	Evaluation Committee
FACE	Fatality Assessment Control and Evaluation
FC	Framework Committee
HHE	Health Hazard Evaluations
MSHA	Mine Safety and Health Administration
NEISS	National Electronic Injury Surveillance System
NIOSH	National Institute for Occupational Safety and Health
NORA	National Occupational Research Agenda
NORA1	National Occupational Research Agenda 1996-2005
NORA2	National Occupational Research Agenda 2005-forward
OSHA	Occupational Safety and Health Administration
OSHAct	Occupational Safety and Health Act of 1970
OSH Review Commission	Occupational Safety and Health Review Commission
PART	Performance Assessment Rating Tool
PEL	Permissible Exposure Limits
SENSOR	Sentinel Event Notification System of Occupational Risks
TMT	Tools, Methods, or Technologies

In September 2004, the National Institute for Occupational Safety and Health (NIOSH) contracted with the National Academies to conduct a review of NIOSH research programs. The goal of this multiphase effort is to assist NIOSH in increasing the impact of its research efforts in reducing workplace illnesses and injuries and improving occupational safety and health. The National Academies agreed to conduct this review and assigned the task to the Division on Earth and Life Studies and the Institute of Medicine.

The National Academies appointed a committee of 14 members, including persons with expertise in occupational medicine and health, industrial health and safety, industrial hygiene, epidemiology, civil and mining engineering, sociology, program evaluation, communication, and toxicology; representatives of industry and of the workforce; and a scientist experienced in international occupational-health issues. The Committee on the Review of NIOSH Research Programs, referred to as the Framework Committee (FC), held meetings during 2005 on May 5-6 and July 7-8 in Washington, DC, and on August 15-16 in Woods Hole and Falmouth, MA.

This document is not a report of the National Academies; rather, it presents the evaluation framework developed by the FC to serve as a guideline and structure for NIOSH program reviews by Evaluation Committees (ECs) to be appointed by various divisions and boards of the National Academies. The ECs will use this framework in reviewing as many as 15 NIOSH research programs during a 5-year period. This is a working document. It is shared with NIOSH and the public. The framework and criteria may be modified by the FC on the basis of responses it receives from the ECs and other sources. It is incumbent upon the ECs to consult with the FC if portions of the evaluation framework presented here are inappropriate for the specific program under review.

I. OVERVIEW OF CHARGE

At the first meeting of the FC, Lewis Wade, NIOSH senior science advisor, emphasized that the reviews should focus on evaluating NIOSH's research programs impact and relevance to health and safety in the workplace. In developing a framework, the FC was asked to address the following:

1. Evaluation committee assessment of progress in reducing workplace illnesses and injuries facilitated by occupational safety and health research through (a) an analysis of relevant data about workplace illnesses and injuries for the program activity, and (b) an evaluation of the effect that NIOSH research has had in reducing illnesses and injuries. The evaluation committees will rate the performance of each

program for impact of the program in the workplace. Impact may be assessed directly or, as necessary, using intermediate outcomes to estimate impact. Qualitative narrative evaluations may also be appropriate under certain circumstances.

2. Evaluation committee assessment of progress in targeting new research to the areas of occupational safety and health most relevant to future improvements in workplace protection.
3. Evaluation committee identification of significant emerging research areas which appear especially important in terms of their relevance to the mission of NIOSH.

Those three charges constitute the scope of work of the individually appointed, independent ECs formed by the National Academies.

I.A. NIOSH Strategic Goals and Operational Plan

As a prelude to understanding the NIOSH strategic goals and operational plan, NIOSH research efforts should be understood in the context of the Occupational Safety and Health Act (OSHAct) under which it was created. The OSHAct identifies workplace safety and health to be a national priority and gives employers the responsibility for controlling hazards and preventing workplace injury and illness. The act creates an organizational framework for doing this, with complementary roles and responsibilities assigned to employers and employees, OSHA, the States, the OSH Review Commission, and NIOSH. As one component of a national strategy the act recognizes NIOSH's roles and responsibilities to be supportive and indirect—NIOSH's research, training programs, criteria and recommendations are all intended to be used to inform and assist those actually responsible for hazard control (OSHAct Section 2b and Sections 20 and 22).

Section 2b of the OSHAct describes thirteen interdependent means of accomplishing the national goal, one of which is "by providing for research . . . and by developing innovative methods . . . for dealing with occupational safety and health problems." Sections 20 and 22 give the responsibility for this research to NIOSH. In addition, NIOSH is given related responsibilities including: the development of criteria to guide prevention of work-related injury or illness, development of regulations reporting on the employee exposures to harmful agents, the establishment of medical examinations programs or tests to determine illness incidence and susceptibility, publication of a list of all known toxic substances, the assessment of potentially toxic effects or risk associated with workplace exposures in specific settings, the conduct of education programs for relevant professionals to carry out

the OSHAct purposes, and assisting the Secretary of Labor regarding education programs for employees and employers in hazard recognition and control.

The NIOSH mission is "to provide national and world leadership to prevent work-related illness, injury, disability, and death by gathering information, conducting scientific research, and translating the knowledge gained into products and services". To fulfill its mission, NIOSH has established the following strategic goals:[2]

- **Goal 1: Conduct research to reduce work-related illnesses and injuries.**
  - ♦ Track work-related hazards, exposures, illnesses, and injuries for prevention.
  - ♦ Generate new knowledge through intramural and extramural research programs.
  - ♦ Develop innovative solutions for difficult-to-solve problems in high-risk industrial sectors.
- **Goal 2: Promote safe and healthy workplaces through interventions, recommendations, and capacity-building.**
  - ♦ Enhance the relevance and utility of recommendations and guidance.
  - ♦ Transfer research findings, technologies, and information into practice.
  - ♦ Build capacity to address traditional and emerging hazards.
- **Goal 3: Enhance global workplace safety and health through international collaborations.**
  - ♦ Take a leadership role in developing a global network of occupational health centers.
  - ♦ Investigate alternative approaches to workplace illness and injury reduction and provide technical assistance to put solutions in place.
  - ♦ Build global professional capacity to address workplace hazards through training, information sharing, and research experience.

In 1994, NIOSH embarked on a national partnership effort to identify research priorities to guide occupational health and safety research for the next decade. The National Occupational Research Agenda (NORA) identified 21 high-priority research areas (see Table 1). NORA was intended not only for NIOSH but for the entire occupational health community. Approaching the 10-year anniversary of

[2]See also *http://www.cdc.gov/niosh/docs/strategic/*.

TABLE 1 NORA High-Priority Research Areas by Category

Category	Priority Research Area
Disease and injury	Allergic and irritant dermatitis
	Asthma and chronic obstructive pulmonary disease
	Fertility and pregnancy abnormalities
	Hearing loss
	Infectious diseases
	Low-back disorders
	Musculoskeletal disorders of upper extremities
	Trauma
Work environment and workforce	Emerging technologies
	Indoor environment
	Mixed exposures
	Organization of work
	Special populations at risk
Research tools and approaches	Cancer research methods
	Control technology and personal protective equipment
	Exposure-assessment methods
	Health-services research
	Intervention-effectiveness research
	Risk-assessment methods
	Social and economic consequences of workplace illness and injury
	Surveillance research methods

NORA, NIOSH is working with its partners to update the research agenda. In the second decade of NORA, an approach based on industry sectors will be pursued. NIOSH and its partners will form sector research councils that will work to establish sector-specific research goals and objectives. Emphasis will be placed on moving research to practice in workplaces through sector-based partnerships.

Figure 1 is the NIOSH operational plan presented as a logic model[3] of the path from inputs to outcomes for each NIOSH research program. The FC adapted the model to develop its framework. NIOSH will provide similar logic models relevant to each research program evaluated by an EC.

I.B. Information from Other Evaluations

The FC is aware that several NIOSH programs have already been subjected to evaluation by internal and external bodies. Those evaluations range from overall assessments of NIOSH, such as the recent 2005 Performance Assessment Rating

[3]Developed by NIOSH with the assistance of the RAND Corporation.

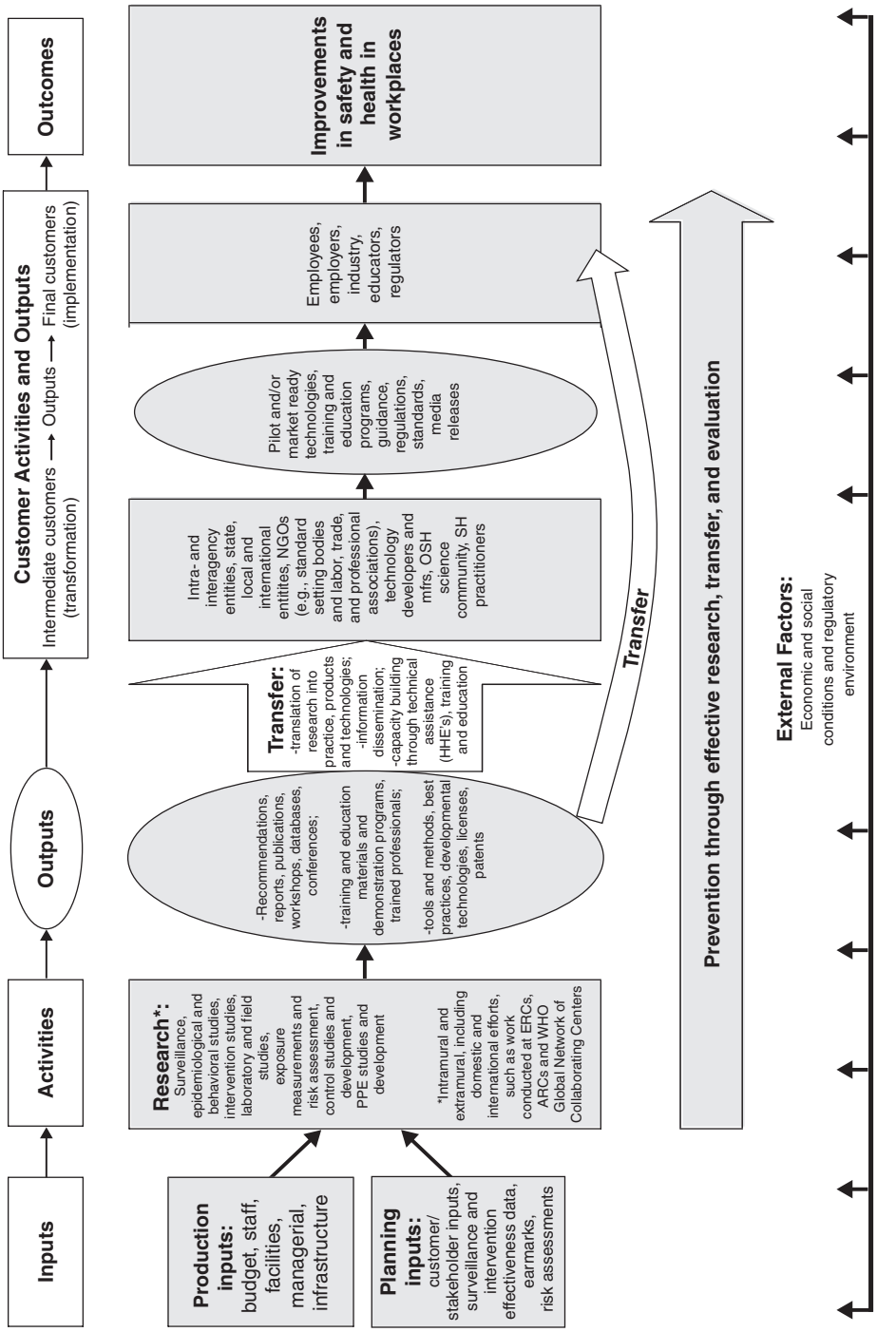

FIGURE 1 The NIOSH operational plan presented as a logic model

Tool (PART) review,[4] to evaluation of research program elements such as any external scientific program reviews. The ECs should review all available prior reviews. Although it is important to consider all prior reviews in the present evaluation to aid in understanding the evolution of the programs and program elements, the ECs' evaluations of NIOSH's programs are independent of the prior reviews and evaluations.

I.C. Evaluation Committees

Individual ECs will be formed through a process consistent with the rules of the National Academies for the formation of balanced committees. The committees will be composed of persons with expertise appropriate to evaluating specific NIOSH research programs and may include representatives of stakeholder groups (such as labor unions and industry) and experts in technology transfer and program evaluation. The committees will conduct appropriate information-gathering sessions to obtain information from the sponsor (a NIOSH research program), stakeholders affected directly by the NIOSH research, and relevant independent parties. Each EC will consist of about 10 members, will meet about three times, and will prepare a report. The National Academies will deliver the report to NIOSH within 9 months after the individual EC is formed. EC reports will be subjected to the National Academies report-review process.

I.D. Evaluation Committees' Information Needs

The ECs are expected to conduct information-gathering as appropriate on

- Background and resources of the program:
  - History of program, including results of previous reviews.
  - Program funding, by year, for the current year and the last 10 years.
  - Program funding, by objective or subprogram.
  - Extramural-grant awarding, cooperative agreement and contracting process, solicitation of research ideas, and advisory activities.
- Program goals and objectives.
- Internal NIOSH processes and research:
  - Intramural surveillance, research, and transfer activities.
  - Process to solicit and approve intramural research proposals.

[4]PART focuses on assessing program-level performance and is one of the measures of success for the Budget and Performance Integration initiative of the president's management agenda (see CDC Occupational Safety and Health at *http://www.whitehouse.gov/omb/budget/fy2006/pma/hhs.pdf*).

- NIOSH-funded extramural research:
  - Requests for proposals, cooperative agreements and research contracts distributed.
  - Awardee products, including close-out reports, surveillance, research, and transfer activities, peer-reviewed publications, and patents.
- Products and technology transfer:
  - Data related to program publications, conferences, recommendations, patents, and so on.
  - Past and planned mechanisms for transferring outputs to outcomes.
  - Interventions, recommendations, and information-dissemination and technology-transfer activities designed to get research findings used to improve occupational safety and health.
  - Outcomes of research, alerts, standard-setting, investigations, and consultations; for example—documented reductions in risk after program-supported interventions, employer and industry behavior changes made in response to research outputs, and worker behavior changes in response to research outputs.
- Impact on worker safety and health—data necessary to evaluate program impact on health outcomes (work-related injuries and illnesses) and exposures.
- The most severe or most frequent adverse health and safety outcomes or exposures in the research program and the most accessible improvements with respect to health and safety.
- Interactions within NIOSH and with other stakeholders:
  - The role of program research staff in NIOSH policy-setting, Occupational Safety and Health Administration (OSHA) and Mine Safety and Health Administration (MSHA) standard-setting, and voluntary standard-setting and other government policy functions.
  - Other institutions and research programs with overlapping or similar portfolios and an explanation of the relationship between the NIOSH work and staff and those of other institutions.
  - Stakeholder perspectives (OSHA, MSHA, union and workforce, industry, and so on.)
  - Key partnerships with employers, labor, other government organizations, academic institutions, nonprofit organizations, and
  - International involvement and perspective.
- Systems to identify emerging problems and emerging research, including plans.

II. SUMMARY OF EVALUATION PROCESS

The ECs are charged with assessing the relevance, quality, and impact of NIOSH research programs. In conducting their evaluations, the ECs should ascertain whether NIOSH is doing the right things (relevance) and doing them right (quality) and whether these things are improving health and safety in the workplace (impact).

II.A. The Evaluation Flow Chart (Figure 2)

To address its charges, the FC has developed a flow chart (Figure 2) that breaks the NIOSH logic model into discrete, sequential program components to be characterized or assessed by the ECs. The components to be assessed are as follows:

- Major program-area *challenges.*
- Strategic *goals and objectives.*
- *Inputs* (such as budget, staff, facilities, the institute's research management, the NIOSH Board of Scientific Counselors, the NORA process, and NORA work groups).
- *Activities* (efforts by NIOSH staff, contractors, and grantees, such as hazard and health-outcome surveillance, exposure-measurement research, health-effects research, intervention research, health services, other research, and technology-transfer activities).
- *Outputs* (the products of NIOSH activities, such as publications, reports, conferences, databases, tools, methods, guidelines, recommendations, education and training, and patents).
- *Intermediate outcomes* (responses by NIOSH stakeholders to NIOSH products, such as public or private policy change, training and education in the form of workshop or seminar attendance, self-reported use or repackaging of NIOSH data by intermediary stakeholders, adoption of technologies developed by NIOSH, implemented guidelines, licenses, and reduction of workplace hazardous exposures and other risk factors).
- *End outcomes* (such as reduction of work-related injuries or illnesses, or hazardous exposures in the workplace).

Drawing on the program logic model, the flow chart, and EC members' expertise, the ECs will delineate important determinants of a NIOSH research program's agenda and the consequences of the NIOSH research activity. Determinants are conceptualized as inputs and external factors. Examples of external factors are

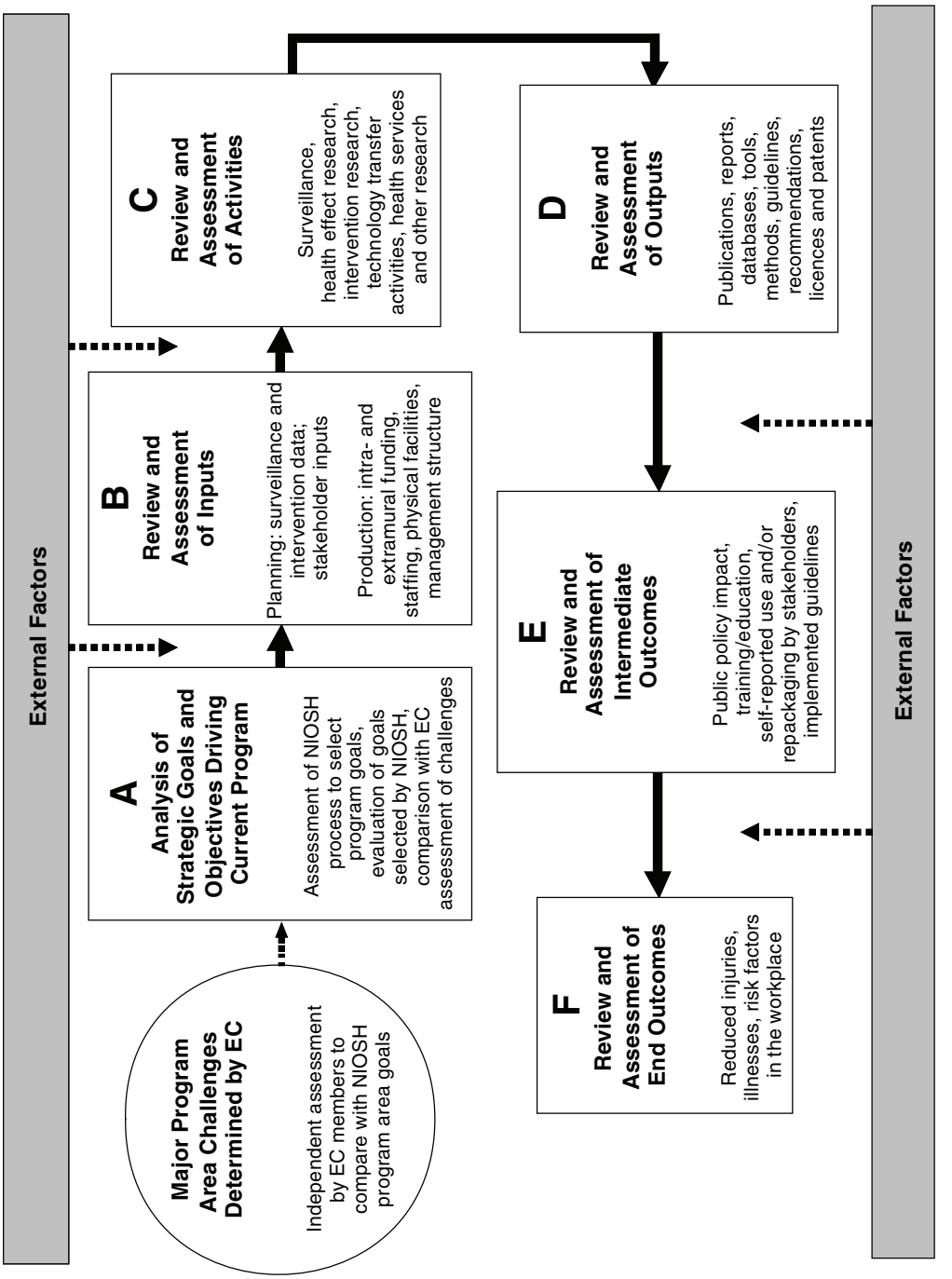

FIGURE 2 Flow chart for the evaluation of the NIOSH research program

the research activities of industry and other federal agencies and the political and regulatory environment, which can affect all components of the research program (Figure 2). *For purposes of this review, the results of inputs and external factors are the program research activities, outputs, and associated transfer activities that may result in intermediate outcomes and possibly eventual end outcomes.*

The FC has used the NIOSH logic model to develop the flow chart to define the scope and steps of an EC evaluation. The FC's vision of how a program evaluation should occur is incorporated in a summary manner in the flow chart and discussed extensively in later sections. For example, the FC identified two types of outcomes: (a) *intermediate outcomes*, which represent implementations (what external stakeholders, such as employers, do in reaction to the products of NIOSH work, including new regulations, widely accepted guidelines, introduction of control technologies in the workplace, changes in employer or worker behaviors, and changes in diagnostic practices of health-care providers), and (b) *end outcomes*, which are improvements (reductions in work-related injuries, illnesses, and hazardous exposures). For the purpose of evaluation, the FC does not differentiate between NIOSH's "intermediate customer" and "final customer" activities (Figure 1); instead it combines them into a single category (Box E, Review and Assessment of Intermediate Outcomes, Figure 2). Training and development programs were appropriately defined as outputs by NIOSH in the logic model, but the FC finds more value in focusing on response to such offerings as intermediate outcomes (Box E) in the flow chart. The number of workers exposed to training activities represents a type of implementation of NIOSH outputs in the workplace. In evaluating each program or major subprogram, the EC must collect, analyze, and evaluate information on items described in each of the boxes of Figure 2. Further details on the evaluation are described in Section III of this document.

II.B. Steps in Program Evaluation

The FC has concluded that useful evaluation requires: (a) a disciplined focus on a small number of questions or hypotheses typically related to program goals, performance criteria, and performance standards; (b) a rigorous method for answering the questions or testing the hypotheses; and (c) a credible procedure for developing qualitative and quantitative assessments. The evaluation process developed by the FC is summarized here and described in detail in Section III of this document.

1. Gather appropriate information from NIOSH and other sources.
2. Determine timeframe that the evaluation will cover (see III.B.1).
3. Identify program-area major challenges and objectives (see III.B.2). All NIOSH research programs, whether based on health outcomes or sectors, are designed to be responsive to the safety and health problems

in today's or tomorrow's workplace. In the NIOSH vision, mission, values, and goals, each research program should have its own objectives. The ECs will provide an independent assessment of the major program challenges and determine whether they are consistent with the research program's stated goals and objectives.

4. Identify subprograms and major projects in the research program. It is important for each EC to determine how necessary it is to disaggregate a program to achieve a manageable and meaningful evaluation of its components and the total program. Each research program may need to be broken down into several recognizable subprograms or major projects if an effective evaluation is to be organized. It may be advantageous for an EC to disaggregate a program into subprograms that NIOSH identifies.
5. Evaluate the program and subprogram components sequentially as discussed in Section III, using the flow chart (Figure 2) as a guide (Sections III.B.3 through III.B.8). This will involve qualitatively assessing each phase of a research program by using the questions and guidance provided by the FC and professional judgment.
6. Evaluate the research program's potential outcomes not yet appreciated (Section III.B.9).
7. Evaluate and score the program outcomes and important subprogram outcomes specifically for contributions to improvements in workplace safety and health. A worksheet is provided with specific items for consideration (Section III.B.10).
8. Evaluate and score the overall program for impact (Section III.B.10). Final program ratings will consist of a numerical score and discussion of its rationale.
9. Evaluate and score the overall program for relevance (Section III.B.10). Final program ratings will consist of a numerical score and discussion of its rationale.
10. Identify significant emerging research areas (Section III.C). On the basis of the expert judgment of EC members and information gathered from stakeholders (such as, labor, industry, academe, and government agencies) and from appropriate NIOSH sentinel-event field-investigation activities, the EC will respond to Charge 3 by identifying and describing emerging research that appears especially important in its relevance to the mission of NIOSH. The EC will assess the extent to which NIOSH's program is responsive to today's and tomorrow's needs and determine whether there are any gaps in response.
11. Prepare report by using the template provided in Section IV as a guide.

II.C. Assessing Relevance

FC members identified numerous *possible* factors to consider in assessing the relevance of NIOSH research programs, such as:

- The severity, frequency, or both of the health and safety outcomes addressed and the number of people at risk (magnitude) for these outcomes.
- The extent to which NIOSH research programs have identified and addressed gender issues and the concerns related to vulnerable populations. Vulnerable populations are defined as groups of workers who have (1) biological, social, or economic characteristics that place them at increased risk of developing work-related conditions and/or (2) inadequate data collected about them. Vulnerable populations include disadvantaged minorities, disabled individuals, low-wage workers, and non-English speakers for whom language or other barriers present health or safety risks.
- The extent to which NIOSH research programs have addressed the health and safety needs of small businesses.
- The "life stage" of the problems being addressed. As the health effects are understood, emphasis should shift to intervention research, and from efficacy to effectiveness to research on the process of dissemination of tested interventions. Gaps in the spectrum of prevention need to be addressed; for example, research on exposure assessment may be necessary before the next intervention steps can be taken.
- The structure, in addition to the content, of the research program. A relevant research program is more than a set of unrelated research projects; it is an integrated program involving an interrelated set of surveillance, research, and transfer activities.
- Appropriate consideration by NIOSH of stakeholder inputs.

II.D. Assessing Impact

Causal attribution is a major aspect of program evaluation. It is necessary for the ECs to assess, to the extent possible, NIOSH's contribution to end outcomes. Data on reductions in work-related injuries, illnesses, and hazardous exposures will be available for some programs. In some cases, they may be quantifiable. It is possible, however, to evaluate the impact of a NIOSH research program whether the outcomes are intermediate outcomes or end outcomes. Intermediate outcomes may be used as proxies for end outcomes in assessing impact if there is no direct evidence of improvements in health and safety as long as the ECs qualify their find-

ings. The ECs will describe the realized or potential benefits of NIOSH's programs. Examples of realized intermediate outcomes include: new regulations, widely accepted guidelines, work practices, and procedures, all of which may contribute measurably to enhancing health and safety at the work place.

The contribution of a NIOSH program to technology now in use or being implemented is another important part of impact assessment. NIOSH's contribution can be assessed as major or important, moderate, likely, limited, or none. If technology development is in progress or has been abandoned, for whatever reason, the benefits are only potential or consist of knowledge gain.

III. EVALUATION OF NIOSH RESEARCH PROGRAMS—THE PROCESS

III.A. Analysis of External Factors Relevant to the NIOSH Research Program

As depicted in the logic model (Figure 1), the end outcome of reduced injuries, illnesses, or exposures is effected through stakeholder activities and outputs. All those involve the use of NIOSH outputs by stakeholders in industry, labor, other government agencies, and so on. It is evident that actions beyond NIOSH's control—by industry, labor, and other entities—have important bearings on the incorporation in the workplace of NIOSH's outputs to enhance health and safety. The implementation of research findings may depend on existing or future policy considerations.

III.A.1. Overview

External factors may be considered as forces beyond the control of NIOSH that may affect the evolution of the program. External factors dominate the evolution of the path from NIOSH inputs to occupational health and safety outcomes (Figure 1). External factors can also be considered inputs to the evaluation of each aspect (planning, implementation, transfer, and others) of NIOSH research programs (Figure 2).

Identification of external factors by the ECs is essential to providing a context for NIOSH program evaluation. External factors may best be assessed through the expert judgment of EC members regarding the knowledge base, the research program, and implementation of interventions as these relate to the needs in the occupational health or safety area targeted by the research program. The ECs, however, may choose additional approaches to assess external factors.

The FC recommends the ECs ask NIOSH to identify and describe external factors early in the evaluation sequence. Factors external to NIOSH might have been responsible for achieving some outcomes, and they might also have presented formidable obstacles. The ECs must address both possibilities.

III.A.2. Considerations for Discussion

Some external factors may involve constraints on research activity related to target populations, methodological issues, and resource availability. For example, evaluators might examine whether

- Projects addressing a critical health need are technologically feasible. A workforce with appropriate size and duration, magnitude, and distribution of exposure for measuring a health effect may not exist. For example, no population of workers has been exposed for 30 years to formaldehyde at the current OSHA Permissible Exposure Level (PEL), so the related cancer mortality can not yet be directly assessed.
- Research is inhibited because NIOSH investigators are unable to access an adequate study population. Under current policy, NIOSH must either obtain an invitation by management to study a workplace or seek a judicial order to provide authority to enter a worksite. (Cooperation under court order may well be insufficient for effective research.)
- Research is inhibited because the work environment, materials, and historical records cannot be accessed even with management and workforce cooperation.
- Adequate or established methods do not exist for assessing the environment.
- Records needed for historical-exposure reconstruction cannot be accessed or do not exist.
- Intervention research is inhibited because an appropriate employer partner cannot be identified to institute the intervention.
- The NIOSH contribution to a certain area of research is reduced because other institutions are working in the same area.
- NIOSH resources are inadequate to tackle the key questions.

Evaluation of the impact of NIOSH research outputs on outcomes may require consideration of external factors that might have impeded or aided implementation, measurement, and so on. For example, evaluators might consider whether

- Regulatory end points are unachievable because of obstacles to regulation or differing priorities of the regulatory agencies. For example, recommendations for improved respiratory protection programs for health-care workers might not be implemented because of enforcement policies or lack of acceptance by the administration of health-care institutions.
- A feasible control for a known risk factor or exposure is not im-

plemented because the costs of implementation are too high or the economic incentives under current circumstances do not favor such actions.

- Improvements in end points are unobservable because baseline and ongoing surveillance data are not available. For example, the current incidence of occupational noise-induced hearing loss is not known although surveillance for a significant threshold shift is feasible. (NIOSH conducts surveillance of work-related illnesses, injuries, and hazards, but comprehensive surveillance is not possible with existing resources.)
- Reductions in adverse effects of chronic exposure cannot be measured. For example, 90% of identified work-related mortality is from diseases, such as cancer, that arise only after decades of latency from first exposure; therefore, effects of reducing exposure to a carcinogen cannot be observed in the timeframe of most interventions.
- A regulation is promulgated that requires a technology that was developed but not widely used.

III.B. Evaluating NIOSH Research Programs (Addressing Charges 1 and 2)

III.B.1. Identifying Period of Time to Be Evaluated

Through study of materials presented by the NIOSH research program and other sources, an EC will become familiar with the history of the research program being evaluated and its major subprograms, program goals and objectives, resources, and other pertinent information.

It is useful for the ECs to consider three general timeframes in conducting their reviews:

- 1970-1995, the period from the founding of NIOSH to the initiation of the NORA process (pre-NORA period).
- 1996-2005 (NORA 1 period).
- Current period and forward (NORA 2 period).

It will be important for the ECs to get a general sense of the history of the NIOSH research program and its impact, but their efforts should be focused on the impact and relevance of NIOSH programs from 1996 on. It is recognized that many of the intermediate and end outcomes since 1996 are the consequence of research outputs accomplished earlier. Both the relevance of the research program

targets of NORA 1 and the proposed NORA 2 objectives for the next decade should be considered.

NIOSH is in the midst of a substantial restructuring of the NORA agenda, and expert judgment about relevance and prospective impact of current research programs will be most useful to the agency. The timeframes provided here are only for general guidance; the exact dates of the period to focus on in reviewing programs will depend on the specific research program under review.

III.B.2. Identification of Major Challenges (Circle in Figure 2)

Early in its assessment process, an EC should independently identify the major challenges for its research program. These would be the matters the EC believes should have priority in the research program being evaluated. In arriving at a list of challenges, the EC should rely on surveillance findings, including NIOSH investigations of sentinel events (through health-hazard or fatality-assessment programs), and its own expert judgment. Those should be supplemented with determinations or recommendations by appropriate advisory sources regardless of whether these sources have contributed to NIOSH program deliberations. This process will allow the EC to compare its assessment of challenges to be addressed by NIOSH with NIOSH program goals, and to evaluate the congruence between the two as a measure of relevance (Charge 2).

III.B.3. Analysis of Research Program Strategic Goals and Objectives (Box A in Figure 2)

The research program goals and objectives should be evaluated, with a focus on how each research program's goals are related to NIOSH's agency-wide strategic goals and to the major current challenges and emerging problems identified in the step above. Differences may exist between the importance or relevance of an issue and the influence NIOSH-funded research might have in addressing the issue. The EC should recognize that NIOSH research priorities may be strategic rather than based on the assessment of the state of knowledge.

Some aspects of the NIOSH research program's strategic goals and objectives would have been already subjected to evaluation by internal or external bodies. Research program relevant evaluations that should be requested include the NIOSH annual program review by the Leadership Team; the NORA research program proposal pre-award external review, NORA post-award program external review, and external scientific program review.

Questions to Guide the Evaluation Committee

1. Are the strategic goals and objectives of the program well defined and clearly described?
2. In the last decade, how well were program goals and objectives aligned with NORA 1 priorities?
3. How do the current strategic goals and objectives of the program relate to the current NIOSH strategy, including NORA 2?
4. Are the research program goals, objectives, and strategies relevant to the major challenges in the research program and likely to address emerging problems in the research program (as determined by the EC)?
    a. Did past program goals and objectives (research and dissemination/transfer activities) focus on the most relevant problems and anticipate the emerging problems in the research program?
    b. Are the current program goals and objectives targeted to the most relevant problems and likely to address emerging problems in the research program?
5. How does the program identify emerging research areas?
    a. What information is reviewed by NIOSH?
    b. What advisory or stakeholder groups are asked to identify emerging areas?
    c. What new research areas have been identified in the program?
    d. Were important areas overlooked?

Assessment

The EC will provide a qualitative assessment discussing the relevance of the area's goals, objectives, and strategies as related to the research program's major challenges and emerging problems.

III.B.4. Review of Inputs (Box B in Figure 2)

Inputs are categorized as planning or production inputs in the NIOSH logic model. Planning inputs include stakeholder inputs, surveillance and intervention data, and risk assessments. Production inputs include intramural and extramural funding, staffing, management structure, and physical facilities.

Inputs for program evaluation include existing intramural and extramural information and, potentially, surveys or case studies that might have been developed specifically to assess progress in reducing workplace illnesses and injuries and to provide information relevant to targeting research appropriately to future

needs. The ECs should request the relevant planning and production inputs from NIOSH.

Planning Inputs

Planning inputs can be qualitative or quantitative. Sources of qualitative inputs include

- Federal Advisory Committee Act panels (Board of Scientific Counselors, Mine Safety and Health Research Advisory Committee, National Advisory Committee on Occupational Safety and Health, and so on).
- NORA research partners, initial NORA stakeholder meetings, later NORA Team efforts (especially strategic research plans), and the NORA Liaison Committee and federal liaison committee recommendations.
- Other federal research agendas, industry, labor, academe, professional associations, industry associations, and Council of State and Territorial Epidemiologists.
- OSHA and MSHA strategic plans.

Attention should be given to how comprehensive the inputs have been and to what extent gaps have been identified or considered.

Sources of quantitative inputs include

- Intramural surveillance information, such as descriptive data on exposures and outcomes (appropriate data may be available from a number of NIOSH divisions and laboratories).
- Health Hazard Evaluations (HHEs).
- Reports from the Fatality Assessment Control and Evaluation (FACE) program.
- Extramural health-outcome and exposure-assessment data from (1) OSHA and MSHA (inspection data) and the Bureau of Labor Statistics, U.S. Department of Defense, and U.S. Department of Agriculture (fatality, injury, and illness surveillance data); (2) state government partners, including NIOSH-funded state surveillance programs, such as Sentinel Event Notification System of Occupational Risks (SENSOR), Adult Blood Lead Epidemiology and Surveillance (ABLES), and state-based FACE; and (3) non-government organizations, such as the Association of Occupational and Environmental Clinics (AOEC) and

the American College of Occupational and Environmental Medicine (ACOEM).
- Appropriate data from NIOSH-funded, investigator-initiated extramural research.

Production Inputs

For each research program under review, NIOSH should specify an identifiable portion of the NIOSH intramural budget, staff, facilities, and management that has been allocated by divisions and offices that play a major role in the research program. Production inputs should be described primarily in terms of intramural research projects and staff, relevant extramural projects (particularly cooperative agreements and contracts), and HHEs and related staff. Consideration should also be given to budget inputs for program evaluation and to leveraged funds provided by partners, such as National Institutes of Health and the Environmental Protection Agency joint requests for applications or program announcements and OSHA, MSHA, and Department of Defense contracts with NIOSH to conduct work.

Assessment of those inputs should include consideration of (1) the degree to which allocation of funding and personnel has been reasonably consistent with the resources needed to conduct the research and (2) the extent to which funding for the relevant intramural research program activity has been limited by lack of discretionary spending beyond salaries (travel, supplies, external laboratory services, and so on). The assessments, therefore, should consider the adequacy of the qualitative and quantitative planning inputs and the use and adequacy of production inputs, particularly (1) and (2) above.

Questions as a Guide for the Evaluation Committee

1. Were the planning, production, and other input data adequate?
2. How well were the major planning, production, and other program inputs used to promote the major activities?
3. Were the sources of inputs and the amount and quality of inputs adequate?
4. Was input obtained from stakeholders representing vulnerable working populations and small businesses?
5. Were production inputs (intramural and extramural funding, staffing, management, and physical infrastructure resources) consistent with goals and objectives of the program?

Assessment

The EC will provide a qualitative assessment that discusses the quality, adequacy, and use of inputs.

III.B.5. Review of Activities (Box C in Figure 2)

Activities are defined as the efforts and work of the program, its staff, and its grantees and contractors. For purposes of the present evaluation, activities of the NIOSH program under review should be divided into research and transfer activities. Research activities may be further categorized as surveillance, health-effects research, intervention research, health-services research, and other research (see sample classification of research activities in Table 2). Transfer activities include information dissemination, training, technical assistance, and education designed to translate research outputs into content and formats designed for application in the workplace to produce improvements in occupational safety and health. Depending on the scope of the program under review, activities may also be grouped by research program objectives or subprograms.

Conventional occupational-health research focuses appropriately on health effects and technology. A focus on socioeconomic and policy research and on surveillance and diffusion research is also needed to effect change because not all relevant intermediate outcomes occur in the workplace. There are important outcomes farther out on the causal chain that NIOSH can affect and thereby influence health and safety in the workplace. Some examples of types of research that might also prove important in addressing NIOSH's mission are

- Socioeconomic research on cost shifting between worker compensation and private insurance.
- Surveillance research to assess the degree of significant and systematic underreporting of select injuries and illnesses on OSHA logs.
- Research on methods to build health and safety capacity in community health centers that serve low-income and/or minority-group workers, and to improve recognition and treatment of work-related conditions.
- Transfer research to change health and safety knowledge in teenagers while they are in high school to improve the likelihood of reduced injuries when they enter the workforce.
- Community-based participatory research on differences between recently arrived immigrants and US-born workers regarding perceptions of acceptable health and safety risks to target programs to meet the workforce training needs of immigrant workers.

TABLE 2 Examples of NIOSH Program Research and Transfer Activities

Surveillance
(including hazard and health surveillance and evaluation of surveillance systems)

Health-effects research
Epidemiologic research
Toxicologic research
Laboratory-based physical and safety risk factor research
Development of clinical screening methods and tools

Exposure-assessment research
Intervention research
Control technology
- Engineering controls and alternatives
- Administrative controls
- Personal protective equipment

Work organization research
Community-based participatory research
Policy research (such as alternative approaches to targeting inspections)
Diffusion and dissemination research
- Training effectiveness
- Information-dissemination effectiveness
- Diffusion of technology

Health-services and other research
Access to occupational health care
Infrastructure research—delivery of occupational-health services, including international health and safety
Socioeconomic consequences of work-related injuries and illnesses
Worker compensation

Technology-transfer and other transfer activities
Information dissemination
Training programs

The ECs should review the list of research and transfer activities (projects) for the research program under review that have been completed, are in progress, or have been planned. Surveillance activities should be included in this review. An EC should request that the NIOSH program under review provide a list of activities, grouping the projects into research activities as in Table 2, and specify whether they are intramural or extramural. For extramural projects, the key organizations and principal investigators' names should be requested, as should whether the projects were in response to a request for proposal or a request for application. For an in-

tramural project, the EC should ask NIOSH to provide a list of key collaborators (other government agency, academe, industry, and/or union partners).

The ECs should evaluate each of the research activities outlined in Table 2 to the extent that each forms an important element of the program research. In the case of a sector research program (for example, mining, construction) in which health-effects research is not being reviewed, the ECs should determine what research inputs are being used by the program to develop its targets and then assess the value of the inputs.

Questions to Guide the Evaluation Committee in Assessing Research Activities

1. What are the major subprograms or groupings of activities within the program?
2. Were the activities consistent with program goals and objectives?
3. Were the research activities relevant to the major challenges in the research program?
   a. Did they address the most serious outcomes?
   b. Did they address the most common outcomes?
   c. Did they address the needs of both genders, vulnerable working populations, and small businesses?
4. Were the research activities appropriately responsive to the input of stakeholders?
5. To what extent were partners involved in the research activities?
6. Are the resource allocations appropriate, and appropriate at this time, for the research activities?
7. To what extent did peer reviews (internal, external, and precourse or midcourse) affect the activities?
8. Is there adequate monitoring of quality assurance procedures to ensure credible research data, analyses, and conclusions?

Questions to Guide the Evaluation Committee in Assessing Transfer Activities

1. Is there a coherent planned program of transfer activities?
2. Are the program's information dissemination, training, education, technical assistance, or publications successful in reaching the workplace or relevant stakeholders in other settings? How widespread is the response?
3. To what extent did the program build research and education capacity (internal or external)?

Assessment

For this part of the assessment, the EC will provide a qualitative assessment discussing relevance and quality. This evaluation must include consideration of the external factors identified in Section III.A that constrain choices of research projects. The EC will consider the appropriateness of resource allocations with respect to issues' importance and the extent to which the issue is being addressed. A highly relevant and high-quality program would be comprehensive, address high-priority needs, produce high-quality results, be highly collaborative, and be of value to stakeholders. Programs may be progressively less relevant or of lower quality as those key elements are not up to the mark or are missing. The discussion should cover those aspects in sufficient detail to arrive at a qualitative assessment of the activities. Assessment of the transfer activities must include considerations of program planning, coherence, quality, and impact.

III.B.6. Review of Outputs (Box D in Figure 2)

As shown in Figure 1, research inputs and activities lead to outputs. An output is a direct product of a NIOSH research program that is logically related to the achievement of desirable and intended outcomes. Outputs are created for researchers, practitioners, intermediaries, and end-users, such as consumers. Outputs can be in the form of publications in peer-reviewed journals, recommendations, reports, Web-site content, workshops and presentations, databases, educational materials, scales and methods, new technologies, patents, technical assistance, and so on. Outputs of NIOSH's extramurally funded activities should also be considered. Examples of major outputs are provided in Table 3.

Depending on the intended audience, outputs may be tailored to communicate information most effectively to increase the likelihood of comprehension, knowledge, attitude formation, and behavioral intent. The extent of use of formative evaluation data (data gathered prior to communication for the purpose of improving the likelihood of the intended effects) or intended user feedback in the design of the output can be considered an indicator of output quality.

In addition to outputs themselves, many related indicators of the production, reference to, and utility of outputs can be conceptualized and made operational. Examples include the extent of collaboration with other organizations in the determination of research agendas, the conduct of research, the dissemination of research results, and interorganizational involvement in the production of outputs. Coauthorship is a measure of the centrality of NIOSH researchers in the broader research community.

TABLE 3 Examples of a Variety of Scientific Information Outputs

Peer-reviewed publications by NIOSH staff
Total number of original research articles by NIOSH staff
Total number of review articles by NIOSH staff (including best-practice articles)
Complete citation for each written publication
Complete copies of the "top five" articles
Collaboration with other public- or private-sector researchers
Publications in the field of interest with other support by investigators also funded by NIOSH (for example, ergonomic studies with other support by an investigator funded by NIOSH to do ergonomics work, in which case NIOSH should get some credit for seeding interest or drawing people into the field)

Peer-reviewed publications by external researchers funded by NIOSH
Total number of NIOSH-funded original research articles by external researchers
Total number of NIOSH-funded review articles by external researchers (including best-practices articles)
Complete citation for each written report
Complete copies of the "top five" articles
Collaboration with other government or academic researchers

NIOSH reports in the research program
Total number of written reports
Complete citation for each written report
Complete copies of the "top five" reports

Sponsored conferences and workshops
Total number of sponsored conferences
Total number of sponsored workshops
For each sponsored conference or workshop, describe:
- Title, date, and location
- Partial vs complete sponsorship (if partial, who were cosponsors?)
- Approximate number of attendees and composition of participants
- Primary "products" of the event (such as publication of conference proceedings)

NIOSH's assessment of value or impact

Databases
Total number of major databases created by NIOSH staff
Total number of major databases created by external researchers funded by NIOSH grants,
For each database:
- Title, objective (in one to four sentences), and start and stop dates
- Partial vs complete sponsorship (if partial, who were cosponsors?)
- Study or surveillance-system design, study population, and sample size
- Primary "products" of the database (such as number of peer-reviewed articles and reports)
- Complete copies of the "top two" publications and/or findings, to date, from each database

continued

TABLE 3 Continued

Recommendations
Total number of major recommendations
For each:
- Complete citation (article, report, or conference where recommendation was made)
- Summary in one to four sentences
- Percentage of target audience that has adopted recommendation 1, 5, and 10 years later
- Up to three examples of implementation in the field

Identifications of "top five" recommendations to date

Tools, methods, or technologies (TMT)
Total number of major TMT (includes training and education materials)
For each:
- Title and objective of TMT (in one to four sentences)
- Complete citation (if applicable)
- Percentage of target audience that has used TMT 1, 5, and 10 years later
- Up to three examples of implementation in the field

Identification of "top five" TMT to date

Patents
Total number of patents
For each:
- Title and objective patent (in one to four sentences)
- Complete citation
- Percentage of target audience that has used product 1, 5, and 10 years later
- Up to three examples of implementation in the field

Identification of "top five" patents to date

Miscellaneous
Any other important program outputs

The EC should ask NIOSH to provide information on all relevant outputs for the specific program for the chosen time period.

Questions to Guide the Evaluation Committee

1. What are the major outputs of the research program?
2. Did the research program produce outputs that addressed the high-priority areas?
3. To what extent did the program generate important new knowledge or technology?
4. Are there peer-reviewed publications that are widely cited and considered to report "breakthrough" results?

5. Were outputs relevant to both genders, vulnerable populations and health disparities?
6. Were outputs relevant to health and safety problems of small businesses?
7. Are products user-friendly in terms of readability, simplicity, and design?
8. To what extent did the program help to build the internal or extramural institutional knowledge base?
9. Did the research produce effective cross-agency, cross-institute, or internal-external collaborations?

Assessment

For this part of the assessment, the EC should provide a qualitative assessment discussing relevance, quality, and usefulness. A highly ranked program will be one with outputs that address needs in high-priority areas, contain new knowledge or technology that is effectively communicated, contribute to capacity-building both inside and outside NIOSH, and are relevant to the pertinent populations. The discussion should cover those aspects in sufficient detail to support the qualitative assessment of the outputs.

III.B.7. Review of Intermediate Outcomes (Box E in Figure 2)

Intermediate outcomes, for the purposes of this evaluation, are related to the program's association with behaviors and changes at individual, group, and organizational levels in the workplace. An intermediate outcome reflects an assessment of worth by stakeholders outside NIOSH (such as managers in industrial firms) about NIOSH research or its products.

Intermediate outcomes include the production of standards, or regulations based in whole or in part on NIOSH research (products adopted as public policy or as policy or guidelines by private organizations or industry); attendance at training and education programs sponsored by other organizations; use of publications by workers, industry, and occupational safety and health professionals in the field; and citations of NIOSH research by industrial and academic scientists.

More difficult-to-collect intermediate outcomes that may be valid indicators of quality or utility include self-report measures by users and relevant nonusers of NIOSH outputs. These indicators include the extent to which key intermediaries find value in NIOSH databases for the repackaging of health and safety information, the extent to which NIOSH recommendations are in place and attended to

in workplaces, and employee or employer knowledge of and adherence to NIOSH recommended practices.

A research program might be evaluated in terms of whether it is recognized as a national center of excellence, is one of the larger and best research programs in the country, is recognized only in terms of particular staff or a particular laboratory, duplicates other, larger facilities, or is not unique or has little capability or capacity.

Questions to Guide the Evaluation Committee

1. Has the program resulted in stakeholder training or education activities that are being used in the workplace or in school or apprentice programs? If so, what is the response to what is being done, and how widespread is the response?
2. Has the program resulted in standards, regulations, public policy, or voluntary guidelines that have been transferred to or created by the workplace in response to NIOSH outputs?
3. Has the program resulted in new control technology or administrative control concepts that are feasible for use or have been adopted in the workplace to reduce risk factors?
4. Has the program resulted in new personal protective equipment that is feasible for use or has been adopted in the workplace to reduce risk factors or exposures?
5. Has the program contributed to changes in health care practices to improve recognition and management of occupational health conditions?
6. Has the program resulted in research partnerships with stakeholders leading to changes in the workplace?
7. To what extent did the program's stakeholders find value in NIOSH's products (as shown by document requests, web hits, conference attendance, and so on)?
8. Has the program resulted in changes in employer or worker practices associated with the reduction of risk factors?
9. Does the program or a subprogram provide unique staff or laboratory capability that is a necessary national resource? If so, is it adequate or does it need to be enhanced or reduced?
10. Has the program resulted in interventions that protect both genders, vulnerable workers or address the needs of small businesses?
11. To what extent did the program contribute to increased capacity at worksites to identify or respond to threats to safety and health?

Assessment

Only a qualitative assessment of product development, usefulness, and impact is required at this point in the EC report. Some thought should be given to the relative value of intermediate outcomes, and the FC recommends applying the well-accepted hierarchy-of-controls model. The discussion could include comments on how widely products have been used or programs implemented. The qualitative discussion should be specific as to the various products developed by the program and the extent of their use by specific entities (industry, labor, government, and so on) for specific purposes. Whether the products have resulted in changes in the workplace or in the reduction of risk factors should be discussed. The recognition accorded to the program or the facilities by its peers (such as recognition as a "center of excellence" by national and international communities) should be considered in the assessment. A program to be highly ranked should have a high level of performance in most of the relevant questions in this section. Whether the impact was caused by NIOSH alone or in combination with external agents should also be considered in the evaluation. An aspect of the evaluation can be whether the impact would have probably occurred without NIOSH's efforts.

III.B.8. Review of End Outcomes (Box F in Figure 2)

End outcomes are defined by measures of health and safety and of impact on process and programs. The FC recognizes that a major challenge in assessing the causal relationship between NIOSH research and specific occupational health and safety outcomes is that NIOSH does not have direct responsibility or authority for implementing its research findings in the workplace. Furthermore, the benefits of NIOSH research program outputs can be realized, potential, or limited to knowledge gain. For example, negative studies contribute to the knowledge base and the generation of important new knowledge is a recognized form of outcome, in the absence of measurable impacts.

Outcome impact depends on there being a "receptor" for research results, including regulatory agencies, consensus and professional organizations, and employers. The ECs should consider questions related to the various stages that lead to outputs, such as

1. Did NIOSH research identify a gap in protection or a means of reduction of risk?
2. Did NIOSH convey that information to potential users in a usable form?
3. Was the research applied?
4. Did the results work?

End outcomes, for purposes of this evaluation, are changes related to health, including decreases in injuries, illnesses, deaths, and decreases in exposures or risk factors resulting from the research in the specific program or subprogram. Quantitative data are preferable to qualitative, but qualitative analysis may be necessary.

Sources of quantitative data include

- Bureau of Labor Statistics (BLS) data on fatal occupational injuries (Census of Fatal Occupational Injuries) and nonfatal injuries and illnesses (Annual Survey of Occupational Injury and Illnesses).
- NIOSH intramural surveillance systems, such as the National Electronic Injury Surveillance System (NEISS), the coal worker x-ray surveillance program, and agricultural worker surveys conducted by NIOSH in collaboration with the US Department of Agriculture.
- State-based surveillance systems, such as the NIOSH-funded ABLES, and the SENSOR programs (for asthma, pesticides, silicosis, noise-induced hearing loss, dermatitis, and burns).
- Selected state workers-compensation programs.
- OSHA, which collects exposure data, in the Integrated Management Information System.

The FC is unaware of surveillance mechanisms for many occupationally related chronic illnesses such as cancers arising from long exposure to chemicals and other stressors. For many outcomes, incidence and prevalence are best evaluated by investigator-initiated research.

The strengths and weaknesses of the various sources of outcome data should be recognized by the ECs. Quantitative accident, injury, illness, and employment data and databases are subject to error and bias and should be used by the ECs for drawing inferences only after critical evaluation and examination of whatever corroborating data are available. For example, it is widely recognized that occupational illnesses are poorly documented in the BLS Survey of Occupational Injuries and Illnesses, which captures only incident cases among active workers. Most illnesses that may have a relationship to work are not exclusively so related, and it is difficult for health practitioners to diagnose work-relatedness; few are adequately trained to make this assessment. Many of these illnesses have long latency and do not appear until years after people have left the employment in question. Surveillance programs may systematically undercount some categories of workers, such as contingent workers. Challenges posed by inadequate or inaccurate measurement systems should not drive programs out of difficult areas of study, and the ECs will need to be aware of such a possibility. In particular, contingent and informal working arrangements that place workers at greatest risk are also those on which

surveillance information is almost totally lacking, so novel methods for measuring impact may be required.

In addition to measures of illness and injury, levels of exposure to chemical and physical agents and to safety and ergonomic hazards can be useful. Exposure or probability of exposure can serve as an appropriate proxy for disease or injury when a well-described occupational exposure-health association exists. In such instances, decreased exposure can be accepted as evidence that the end outcome of reduced illness has been achieved. That is particularly necessary in cases (such as exposure to asbestos) in which latency between exposure and disease outcome (lung cancer) makes effective evaluation of the relevant end outcome infeasible.

As an example of how exposure levels can serve as a proxy, the number of sites that exceed an OSHA Permissible Exposure Limit (PEL) or an American Conference of Governmental Industrial Hygienists threshold limit value is a quantitative measure of improvement of occupational health awareness and reduction of risk. In addition to exposure level, the number of people exposed and the distribution of exposure levels are important. Those data are available from multiple databases and studies of exposure. Apart from air monitoring, such measures of exposure as biohazard controls, reduction in requirements for use of personal protective equipment, and reduction of ergonomic risks are important.

Clearly, the commitment of industry, labor, and government to health and safety are critical external factors. Several measures of this commitment can be useful for the EC: monetary commitment of the groups, attitude, staffing, and surveys of relative level of importance. To the extent that the resources allocated to safety and health are limiting factors, the ECs should explicitly assess NIOSH performance in the context of constraints.

Questions to Guide the Evaluation Committee

1. What are the amounts and qualities of end-outcomes data (such as injuries, illness, exposure and productivity affected by health)?
2. What is the temporal trend in those data?
3. Is there objective evidence of improvements in occupational safety or health?
4. To what degree has the NIOSH program or subprogram been responsible for improvements in occupational safety or health?
5. If there is no time trend in the data, how do findings compare with data from other comparable US groups or the corresponding populations in other countries?
6. Is there evidence that external factors have affected outcome measures?

7. Has the program been responsible for outcomes outside the United States that have not been described in another category?

Assessment

For this part of the assessment, the EC should provide a qualitative assessment discussing the evidence of reductions in injuries and illnesses or their appropriate proxies (impacts).

III.B.9. Review of Other Outcomes

There may be health and safety impacts not yet appreciated, and other beneficial social, economic, and environmental outputs, including potential NIOSH impacts outside the United States. Many NIOSH study results and training programs may be judged to be important, or there may be evidence of implementation of NIOSH recommendations, outside the United States.

Questions to Guide the Evaluation Committee

1. Is the program likely to produce a favorable change that has not yet occurred or not been appreciated?
2. Has the program been responsible for other social, economic, security, or environmental outcomes?
3. Has the program's work had an impact on occupational health and safety in other countries?

Assessment

Evaluation by the EC may consist of a discussion of other outcomes, including positive changes that have not yet occurred; other social, economic, security, or environmental outcomes; and the impact that NIOSH has had on international occupational safety and health. It might also consider the incorporation of international research results into the NIOSH program of knowledge transfer for industry sectors.

III.B.10. Summary Evaluation Ratings and Rationale

An EC should use its expert judgment to rate the relevance and impact of the research program and its important subprograms by first summarizing its assessments of the subprograms and overall program according to the several items listed in Table 4. Table 4 is only a *worksheet* intended as an aid to the EC in its evalua-

TABLE 4 Evaluation Committee Worksheet to Assess Research Programs and Subprograms
Please respond to each with "major or important," "moderate," "likely," "limited," or "none."

Background Context for Program Impact

1.1 Evidence of reduction of risk factors in the workplace (intermediate outcome) and evidence that external factors affected reduction
1.2 Evidence of reduction in workplace exposure, illness, or injuries (end outcome) and evidence that external factors affected reduction

Addressing Charge 1	Activity Category	**Program**	**Subprogram**			
			1	**…**	**…**	**n**
1.3 Contributions of NIOSH research and transfer activities to changes in work-related practices	Research					
	Transfer					
1.4 Contributions of NIOSH research and transfer activities to reductions in workplace exposure, illness, or injuries	Research					
	Transfer					
1.5 Evidence of external factors preventing application of NIOSH research results	Research					
	Transfer					
1.6 Contribution of NIOSH research to enhancement of capacity in government or other research institutions	Research					
	Transfer					
1.7 Contributions of NIOSH research to productivity, security, or environmental quality (beneficial side effects)	Research					
	Transfer					
Addressing Charge 2						
2.1 Relevance of current and recently completed research and transfer activities to future improvements in workplace safety and health	Research					
	Transfer					
2.2 Progress in targeting research to areas of study most relevant to future improvements in occupational safety and health	Research					
	Transfer					

tion. Its purpose is to encourage the EC to summarize its work in one place and to concentrate on the subprograms and the items that will contribute to the final impact and relevance scores.

To set the context for this step in the evaluation of the impact of the research program in preparation to respond to charge 1, the EC will first need to consider the available evidence of changes in work-related risks and adverse effects and external factors related to the changes. That information should be organized as a prose response to items 1.1 and 1.2 in Table 4.

Next, the EC should review the responses to the questions in Sections III.B.6 through III.B.8 and systematically rate the impact of the research program and its subprograms by responding to items 1.3-1.7 in Table 4. To complete the table, the EC response should use one of the following five terms: "major or important," "moderate," "likely," "limited," or "none" (since 1995). The EC should evaluate separately the impact of the research and the impact of transfer activities. High ratings on items 1.3-1.7 require the committee's judgment that the program has contributed to outcomes. For example, outcomes have occurred earlier than they would have or are better than they would have been in the absence of the research program, or outcomes would have occurred in the absence of external factors beyond NIOSH's control or ability to plan around.

The EC should then assess the relevance of the research program and subprograms in preparation for addressing charge 2. The EC should review the responses to the questions in Sections III.B.2 through III.B.5 and rate the relevance of the research program and its subprograms by responding to items 2.1 and 2.2 in Table 4. The same five terms should be used ("major or important," "moderate," "likely," "limited," or "none") to evaluate separately the relevance of the research and the relevance of the transfer activities. Transfer activities occur in two contexts: (1) NIOSH efforts to translate intellectual products into practice and (2) efforts by stakeholders to take advantage of NIOSH products.

Final Program Ratings

To provide the final assessment of the research program for charge 1 (impact) and charge 2 (relevance), the ECs will use their expert judgment, their responses to the questions in Table 4, and any other appropriate information to arrive at one overall rating for the impact of the research program and one for its relevance to the improvement of occupational safety and health. In light of substantial differences among the types of research programs that will be reviewed and the challenge to arrive at a summative evaluation of both impact and relevance, however, the FC chose not to attempt to construct a single algorithm to produce the two final ratings.

Having completed Table 4, the EC should undertake its final assessment of the impact and relevance of the program. Final program ratings will consist of the numerical scores and prose descriptions of why the scores were given. As explained below, the ECs will summarize their responses to charges 1 and 2 by rating the relevance and impact of the NIOSH research program on five-point scales in which 1 is the lowest and 5 the highest rating. The FC has made an effort to establish mutually exclusive rating categories in the five-point rating scale; when the basis of a rating fits more than one category, the highest applicable score should be assigned. ECs will need to consider the impact and relevance of both NIOSH completed research and research in progress. In general, the assessment of impact will consider research completed, and the assessment of relevance will include research in progress related to likely future improvements. When assessing the relevance of the program, the EC should keep in mind how well the program has considered the frequency and severity of the problems being addressed, whether appropriate attention has been directed to both genders, vulnerable populations or hard-to-reach workplaces, and whether the different needs of large and small businesses have been accounted for.

The FC has some concern that the impact scoring system proposed below might be considered a promotion of the conventional occupational-health research paradigm that focuses on health-effect and technology research and not give much emphasis to socioeconomic and policy research and to surveillance and diffusion research (as opposed to activities) needed to effect change. Clearly, not all intermediate outcomes occur in the workplace. There are important outcomes much farther out on the causal chain that NIOSH can affect, and not all these can be defined as well-accepted intermediate outcomes. NIOSH, for example, has an important role to play in generating knowledge that may contribute to changing norms in the insurance industry, in health-care practice, in public-health practice, and in the community at large. The ECs may find that some of these issues need to be addressed and considered as important to influence the external factors that limit application of more traditional research findings. Given the rapidly changing nature of work and the workforce and some of the intractable problems in manufacturing, mining, and some other fields, the ECs are encouraged to think beyond the traditional paradigm.

Rating of Impact

5 = Research program has made a major contribution to worker health and safety on the basis of end outcomes or well-accepted intermediate outcomes.

4 = Research program has made a moderate contribution on the basis of end outcomes or well-accepted intermediate outcomes; research program generated important new knowledge and is engaged in transfer activities, but well-accepted intermediate outcomes or end outcomes have not been documented.
3 = Research program activities or outputs are going on and are likely to produce improvements in worker health and safety (with explanation of why not rated higher).
2 = Research program activities or outputs are going on and may result in new knowledge or technology, but only limited application is expected.
1 = Research activities and outputs are NOT likely to have any application.
NA = Impact cannot be assessed; program not mature enough.

Rating of Relevance

5 = Research is in highest-priority subject areas and highly relevant to improvements in workplace protection; research results in, and NIOSH is engaged in, transfer activities at a significant level (highest rating).
4 = Research is in high-priority subject area and adequately connected to improvements in workplace protection; research results in, and NIOSH is engaged in, transfer activities.
3 = Research focuses on lesser priorities and is loosely or only indirectly connected to workplace protection; NIOSH is not significantly involved in transfer activities.
2 = Research program is not well integrated or well focused on priorities and is not clearly connected to workplace protection and inadequately connected to transfer activities.
1 = Research in the research program is an ad hoc collection of projects, is not integrated into a program, and is not likely to improve workplace safety or health.

III.C. Identifying Significant Emerging Research (Addressing Charge 3)

Among the most challenging aspects of conducting research for the purpose of prevention of injury and illness is identifying new or emerging needs or trends and formulating an active research response that appropriately uses scarce resources in anticipation of those needs. Each EC should review the procedures that NIOSH has in place to identify needed research relevant to the NIOSH mission.

Each EC should review the success that NIOSH has had in identifying and addressing research to emerging issues. The review should include examination

of leading indicators from appropriate federal agency sources, such as the Environmental Protection Agency, the Department of Labor, the National Institute of Standards and Technology, the National Institutes of Health, the Department of Defense, and the Department of Commerce. Those indicators should track new technologies, products, and processes and disease or injury trends.

One source of inputs deserving particular attention is the NIOSH HHE reports. NIOSH's HHE program is a separate legislatively mandated program that offers a potential mechanism to identify emerging research needs that could be incorporated as an input in each of the programs evaluated. The ECs should consider whether appropriate consideration has been given to findings from the HHE investigations as they are related to the research program under review.

Some additional indicators might include NIOSH and the NIOSH-funded FACE, the AOEC reports, the US Chemical Safety Board investigations, SENSOR and other state-based surveillance programs, and others. In addition, appropriate federal advisory committees and other stakeholder groups should be consulted to provide qualitative information.

The EC members should use their expert judgment both to evaluate what NIOSH has identified as emerging research targets (charge 2) and to respond to charge 3 by providing recommendations to NIOSH for additional research that NIOSH has not yet identified. An EC's response to charge 3 will consist primarily of recommendations for research in subjects that the EC considers important and of the committee's rationale.

Questions to Guide the Evaluation Committee

1. What information does NIOSH review to identify emerging research needs?
   a. What is the process for review?
   b. How often does the process take place?
   c. How are NIOSH staff scientists and NIOSH leadership engaged?
   d. What is the process for moving from ideas to formal planning and resource allocation?
2. How are stakeholders involved?
   a. What advisory or stakeholder groups are asked to identify emerging research targets?
   b. How often are such groups consulted, and how are suggestions followed up?
3. What new research targets have been identified for future development in the program under evaluation?
   a. How were they identified?

b. Were there lessons learned that could help to identify other emerging issues?
c. Does the EC agree with the issues identified and selected as significant and with the NIOSH response, or were important issues overlooked?
d. Is there evidence of unwise expenditure of resources on unimportant issues?

IV. EVALUATION COMMITTEE REPORT TEMPLATE

The following outline flows from the FC's review of the generalized logic model prepared by NIOSH, the request for information from NIOSH programs, and the assessment model described earlier in this report.

I. Introduction:
This section should be a brief descriptive summary of the history of the program (and subprograms) being evaluated, with respect to pre-NORA, NORA 1, and current and future plans of the research program presented by NIOSH. It presents the context for the research on safety and health; goals, objectives, and resources; groupings of subprograms; and any other significant or pertinent information. (A list of the NIOSH materials reviewed should be provided in an appendix to the EC report.)

II. Evaluation of programs and subprograms (charges 1 and 2):
A. Evaluation summary (includes a brief summary of the evaluation with respect to impact and relevance, scores for impact and relevance, and summary statements addressing charges 1 and 2).
B. Strategic goals and objectives: Describes assessment of the subprograms and overall program for relevance.
C. Review of inputs: Describes adequacy of inputs to achieve goals.
D. Review of activities: Describes assessment of the relevance and quality of the activities.
E. Review of research program outputs: Describes assessment of relevance, quality, and potential usefulness of the research program.
F. Review of intermediate outcomes and causal impact: Describes assessment of the intermediate outcomes and the causal attribu-

tion to NIOSH; includes the likely impacts and recent outcomes in the assessment.

G. Review of end outcomes: Describes the end outcomes related to health and safety and provides an assessment of the type and degree of causal attribution to NIOSH.
H. Review of other outcomes: Discusses other health and safety impacts that have not yet occurred; other beneficial social, economic, and environmental outcomes; and international dimensions and outcomes.
I. Summary of ratings and rationale (see Table 4).

III. Identification of needed research (charge 2):
The EC should assess the progress that the NIOSH program has made in targeting new research in the fields of occupational safety and health. There should be a discussion of the assessment process and results.

IV. Emerging research areas (charge 3):
The EC should assess whether the NIOSH program has identified significant emerging research areas that appear especially important in terms of their relevance to the mission of NIOSH. The EC should respond to NIOSH's perspective and add its own recommendations.

V. Recommendations for program improvement:
On the basis of the review and evaluation of the program, the EC may provide recommendations for improving the relevance of the NIOSH research program to health and safety conditions in the workplace and the impact of the research program on health and safety in the workplace as related to the research program under review.

Appendix A: List of the NIOSH and related materials collected in the process of the evaluation

V. FRAMEWORK COMMITTEE FINAL REPORT

At the conclusion of all individual program reviews, the FC will prepare a final report summarizing the findings of all the evaluating committees and providing NIOSH with an overall evaluation. All program ratings will be summarized and might be plotted graphically or with a Web chart.

The following is a proposed outline of the FC's final report:

I. Summary of national needs identified by the research programs reviewed.
   A. On the basis of the best available evidence, place those needs in the context of the overall estimated potential work-related disease and injury burden.
   B. Discuss the choices made and alternatives that might be the focus of current or future attention.
   C. Comment on programs not selected by NIOSH for evaluation by the National Academies.
II. Assessment of how well the program goals.
   A. Were matched to the research program needs.
   B. Were adjusted to new information and inputs as the field of interest changed or program results became available.
III. Assessment of NIOSH overall performance in the research programs reviewed.
   A. Distribution of available inputs.
   B. Activities and outputs.
   C. Intermediate outcomes.
   D. Summary assessment of significant differences among the programs.
   E. International impact.
   F. Leveraging of the NIOSH research activity with respect to other public and private research programs.
   G. Assessment of relative importance of external factors in permitting or preventing intermediate or end outcomes; attention paid to accounting for and planning within the constraints of external factors (not simply assigning lack of progress to external factors).
IV. Overall assessment of NIOSH impact on progress in reducing occupational injury and illness.
   A. Breakthrough knowledge.
   B. International impact.
   C. Addressing disparities.
   D. Targeting residual risks and intractable risks.
   E. Coordinating NIOSH research activity with respect to other public and private research programs.
   F. Impact on occupational safety and health.
V. Summary, Conclusions, and Recommendations.

B

Committee Methods for Gathering Information

This appendix details the methods used by the National Research Council Committee to Review the NIOSH Agriculture, Forestry, and Fishing Research Program to gather information to carry out its work. The methods were reviewing written information from the National Institute for Occupational Safety and Health, inviting comments from stakeholders, and hearing presentations at two information-gathering meetings.

WRITTEN INFORMATION FROM NIOSH

The NIOSH Agriculture, Forestry, and Fishing Research Program (AFF Program) provided a roughly 500-page notebook of information to the committee in advance of the committee's first meeting. The notebook, referred to by NIOSH and the committee as the evidence package, contained information on the history of the AFF Program; the program's resources, goals, and objectives; intramural research activities; extramural research funded by NIOSH; program products and technology transfer; and relevant NIOSH-wide processes and activities. The AFF Program and others in NIOSH provided extensive additional information to the committee in response to questions that arose during the evaluation process. All interactions and follow-up with NIOSH were carried out through staff. A list of materials provided to the committee by NIOSH is found in Appendix C. In addition to written materials provided by NIOSH, the committee had independent access to other NIOSH papers and conference materials.

STAKEHOLDER COMMENTS

The committee was directed by the Framework Document to consider stakeholder input in assessing the impact and relevance of the NIOSH AFF Program. Issues of interest included whether stakeholder input was taken into consideration in shaping the program and stakeholders' views on the program's research activities and products.

The Framework Document did not specify the means of eliciting input from stakeholders. The committee determined that conducting a systematic survey was not feasible within the constraints of the project. As an alternative, the committee invited stakeholders to provide comments relevant to its evaluation of the impact and relevance of the NIOSH AFF Program. The objective was to assemble comments from a diverse group of organizations and individuals. Individual invitations to comment were sent to about 200 people and organizations. The invitation was also posted on a publicly available Web site.

Identification of Stakeholders

The committee identified possible stakeholders in the NIOSH AFF Program through several means. The intramural research program provided a list of its stakeholders, who included collaborators and partners. Working independently and drawing on suggestions from committee members and staff, the committee identified as possible stakeholders individuals and organizations with an interest in equipment safety, child and youth safety in agriculture, occupational chemical exposures, farmworker safety and health, logger safety and health, fishing vessel safety, and labor issues. The group included researchers in academe and private organizations, professional societies, organizations representing labor and industry, and others that deal directly with AFF safety and health or were considered likely to be aware of safety and health issues. Stakeholders were identified in the various sectors associated with AFF: academe, government, non-profit interests, and labor. The committee also identified potential stakeholders among minority-group professional organizations and small business associations. The list of stakeholders included representatives of federal and state agencies and of researchers and organizations in other countries.

Letters to Stakeholders

The invitation to comment on the NIOSH AFF Program was issued in a letter from committee Chair Paul Gunderson (see Box B-1). The committee staff sent the letter by e-mail in early April 2007 to each of the identified stakeholders. Committee

BOX B-1
Letter Inviting Comment on the NIOSH Agriculture, Forestry, and Fishing Research Program

Dear Colleague:

As the Chair of the National Academies Committee to Review the NIOSH Agriculture, Forestry, and Fishing (AFF) Research Program, I invite your input to our committee's work. The committee's charge is to evaluate the impact and relevance of NIOSH's work in reducing workplace injury and illness and identify future directions NIOSH might take. The Committee to Review the NIOSH AFF Program is seeking input and advice from a variety of individuals and organizations that we believe are likely to have an interest in agriculture, forestry, and fishing safety and health and associated research. You have been identified as a potential source for such inputs and advice.

The committee's charge is to examine the following issues for the NIOSH AFF Research Program:

1. Progress in reducing workplace illness and injuries through occupational safety and health research, assessed on the basis of an analysis of relevant data about workplace illnesses and injuries and an evaluation of the effect that NIOSH research has had in reducing illness and injuries.
2. Progress in targeting new research to the areas of occupational safety and health most relevant to future improvements in workplace protection.
3. Significant emerging research areas that appear especially important in terms of their relevance to the mission of NIOSH.

The committee will evaluate the AFF Safety and Health Research Program using an assessment framework developed by the NRC/IOM Committee to Review the NIOSH Research Programs. The evaluation will consider what the NIOSH program is producing as well as whether the program can reasonably be credited with changes in workplace practices, or whether such changes are the result of other factors unrelated to NIOSH. For cases where impact is difficult to measure directly, the committee reviewing the AFF Safety and Health Research Program may use information on intermediate outcomes to evaluate performance.

The NIOSH AFF Safety and Health Program provided the NRC evaluation committee with information on its work in five goal areas:

(1) Hazard Surveillance—reduce hazards, illnesses, and injuries in the AFF workforce by conducting population-based and hazard surveillance;

(2) Priority Populations at Risk—reduce injuries, illnesses, and fatalities among subgroups of the working population determined to be at high risk or underserved by traditional occupational health approaches;

(3) Chemical Exposures—determine the chronic effects of agricultural exposures/health outcomes from toxic exposures and develop appropriate interventions to reduce the incidence of disease;

(4) Hazard Control Systems—reduce injuries and illnesses in AFF Program-related industries by developing and demonstrating control systems and making them available; and

continued

BOX B-1
Continued

(5) Outreach—reduce injuries and illnesses by informing and educating employers and employees about occupational safety and health hazards and control systems.

We would be very grateful for your comments on any or all of these areas. It would be valuable for the committee to know whether you are familiar with NIOSH activities and products related to agriculture, forestry, and fishing safety and health and what kind of experience you may have had working with the agency or its products. The committee would be particularly interested in comments you may have on the relevance and impact of NIOSH's work in agriculture, forestry, and fishing safety and health over the past 10 years in any of the five areas of research it has defined.

In addition, we would value your views on two other matters included in the committee's charge. First, what have you seen as the major research needs and challenges over the past 10 years in agriculture, forestry, and fishing safety and health? Second, what do you see as significant emerging research needs or opportunities concerning agriculture, forestry, and fishing safety and health?

The committee will review the comments it receives at its remaining meeting, which will be held on May 30-31, 2007. We encourage you to submit your comments in time for consideration at the May meeting. You are welcome to comment as an interested individual or from the perspective of your organization. In addition, please feel free to share this letter with other individuals or organizations with an interest in the AFF safety and health research program.

Please provide your comments through our National Academies staff, using any of a variety of routes: e-mail, mail, fax, telephone, or through our web-based comment form, where providing name and affiliation is optional. However, note that any written comments submitted to the committee (whether by mail, e-mail, fax, or the project's comment form) will be included in the study's public access file.

If you have any questions about contacting the committee or providing materials for the committee's consideration, I encourage you to speak with our study director Peggy Tsai. Contact details are provided at the end of this letter.

Thank you very much for any assistance you can provide to our study committee as we conduct our review of the NIOSH AFF Safety and Health Research Program.

Sincerely,

Paul Gunderson, Ph.D.
Chair, Committee to Review the NIOSH Agriculture,
Forestry, and Fishing Research Program

Submitting Comments to the Study Committee

Mail:
Peggy Tsai
Board on Agriculture and Natural Resources
500 Fifth Street, N.W.
Washington, DC 20001

members did not contact any stakeholders directly. The letter was also made available publicly from early April through early June 2007 in a posting on a National Academies Web site. In addition, a NIOSH Web page noted the opportunity for NIOSH stakeholders to provide input to the review and provided a link to the National Academies site. Interested stakeholders were asked to send their comments to the study staff via postal mail, e-mail, or the project Web site. Responses could be submitted anonymously through the Web site. The committee invited stakeholder comments on several points: familiarity with NIOSH activities and products related to AFF, experience in working with NIOSH, the relevance and impact of NIOSH's work over the last decade in reducing occupational injuries and fatalities, and the major research challenges over the last decade and significant emerging research needs in AFF safety and health.

By June 2006, 64 responses had been received. Stakeholder comments are available to the public through the National Academies Public Access file and were provided to NIOSH in their original form.

Overall, the NIOSH stakeholders who responded provided favorable comments. The committee recognizes that the responses to the request for comments are not necessarily representative of all NIOSH stakeholders. However, the comments provided to the committee gave helpful insights into respondents' perspectives on the NIOSH AFF Program and informed the committee's understanding of the program's relationship with some of its stakeholders.

Comments on Emerging Research Needs or Opportunities

To assist the committee in reviewing stakeholder input, the staff compiled the comments on emerging research needs or opportunities. The compilation is presented in Box B-2; some comments are captured in abbreviated form, and others are presented nearly verbatim. No attempt was made to evaluate the merits of individual stakeholder suggestions or to set priorities within or between the broad research categories used by the staff to group the comments. The presentation of suggestions in Box B-2 does not represent an endorsement by the committee.

Respondents

The following responded to the committee's invitation for comments on the NIOSH AFF Program:

Brian Aldrich
Cornell University

Steven Banks
Farmer

BOX B-2
Emerging Research in Agriculture, Forestry, and Fishing Safety and Health Suggested by Stakeholders

Social Attitudes
Gain better understanding of the social factors on farms that affect safety practices.

Children's Safety
With changes in the global marketplace, it is important to understand the changing role of children as sources of labor on farms and society's tolerance of putting children at undue risk.

Hearing Impairment and Loss
Assess the prevalence of hearing loss in workers in agriculture (and in rural areas in general). Effectiveness of hearing-loss prevention programs must be assessed and established before widespread implementation.
Additional research is needed to explore the association between hearing impairment and traumatic occupational injury in agriculture.

Healthcare
Affordable healthcare should be available to farmers and rural workers. Healthcare availability and affordability may be factors in the demise of family farms.

Surveillance
Implement a comprehensive surveillance program on a national scale to monitor occupational disease, injury, and death. Resources can then be focused better to address and prevent disease, injury, and death.
A more comprehensive surveillance system is needed. Less emphasis should be placed on writing papers and reports, and more on implementing surveillance in the workforce and working face to face with organizations and workers.

James Bittner
Singer Farms

Donald S. Bloswick
University of Utah

Roy Buchan
Colorado State University

Bob Callender
New York State Department of Environmental Conservation

Paul Clemente
New York State Department of Environmental Conservation

Henry P. Cole
University of Kentucky

Ergonomics
Design of equipment and tools.

Educational Collaboration
More involvement with the universities that offer agriculture degrees is needed. In the last 4 or 5 years, that appears to have fallen drastically. Web sites for the University of Texas center are all but useless.
High-school agricultural science teachers need an intensive laboratory safety workshop and certification. NIOSH is perhaps the best-positioned entity to assist in this endeavor by providing funding to conduct week-long safety certification workshops.

Immigrant and Migrant Workers
Immigrants do more of the low-quality at-risk work than non-immigrants. Communication should be made available in their own languages so that their exposure to risk can be reduced.
There should be less emphasis on migrant labor. There needs to be much more emphasis on sustaining the work of older producers and laborers.

Applied Research
Pulmonary disease, ergonomic issues, noise exposure, and traumatic injury associated with farm machinery will be important research topics. Applied field research is necessary to address the problems of occupational safety. There are so many unknowns that regional and local research may be needed.
Translational methods that are participatory should be developed and demonstrated.

Prevention and Treatment
Gain better understanding of risk and protective factors for stress-related illness on the farm.

Miscellaneous
Implement safety standards in areas that are being placed into land trusts.
Emerging subjects include zoonotic infectious diseases, special populations, and the psychosocial impact of diminishing natural resources on AFF workers.

Mary Lou Wranesh Cook
SUNY Institute of Technology

George Cook
University of Vermont

Jim T. Criswell
Oklahoma State University

George Daniels
Farm Employers Labor Service

Helene Dembrowski
Dembrowski Orchards, Inc.

Mike DeSpain
Tribal EPA

Eileen Douglas
Unknown

Daniel Ructor
America Loggers Council

Linda Fetzer
Pennsylvania State University

Kimberly Fleming
Cornell Cooperative Extension

Ralph Gaiss
Northeast Equipment Dealers Association

Judith Gillan
The New England Small Farm Institute

Kevin Hackett
Oklahoma Cooperative Extension Service Program

Dan Hair
Workers' Compensation Fund

George F Henning
Pennsylvania Agromedicine

Ron Jester
University of Delaware

Katherine H. Kirkland
Association of Occupational and Environmental Clinics (AOEC)

Richard Klossner
Farmer

Jeffrey Levin
Southwest Center for Agricultural Health, Injury Prevention, and Education

John May
NYCAMH/Northeast Center

Karen Mountain
Migrant Clinicians Network

Cynthia Mulbury
Northern Orchard Co., Inc

Melvin L. Myers
University of Kentucky
Emory University

Anne Nolan
Hudson River HealthCare Inc.

Mike Olin
Farmer

Sharon Pahlman
Cooperative Extension, University of Maryland

Dwayne Pavelock
Sam Houston State University

William Pickett
Queen's University

Mark Purschwitz
Marshfield Clinic Research Foundation

Deborah Reed
University of Kentucky

Marie Reed
Texas Department of State Health Services

Heidi Roeber Rice
HealthPartners Occupational and Environmental Medicine

Dan Roth
Finger Lakes Coalition of Farmworker Agencies

Charles V. Schwab
Iowa State University

Charles Siepel
New Mexico State University, Cooperative Extension Service

Jim Steinke
Farm Equipment Safety Source

James Tollett
Southern Arkansas University

Robin Tutor
East Coast Migrant Head Start Project

Doug Ullrich
Sam Houston State University

Peter Wallingford
Wallingford's Fruit House

Louise Waterman
Vermont Agency of Agriculture, Food and Markets

John R. Wheat
The University of Alabama

Catharine Young
The New York State Senate

Tom Zangrillo
Scattered Acres Farm

COMMITTEE MEETINGS

The committee held three face-to-face meetings during the course of its study. The first two included open sessions for information gathering. The agendas for the open sessions appear below. The third meeting was closed. After the third meeting, the committee held a subcommittee meeting and several e-mail exchanges to finalize its report.

Meeting I
January 19, 2007
Keck Center of the National Academies
500 Fifth Street, N.W.
Washington, D.C.

Friday, January 19, 2007

10:00 a.m. **Welcome and Introductory Remarks**
Paul Gunderson, PhD
Committee Chair

10:05 a.m.	**NIOSH Overview** Lewis V. Wade, PhD NIOSH Senior Scientific Advisor
10:30 a.m.	**NIOSH Agriculture, Forestry, and Fishing Research Program Overview** George Conway, MD, MPH Director, NIOSH Agriculture, Forestry, and Fishing Program
11:00 a.m.	**Surveillance (Chapter 3)** John P. Sestito, JD, MS NIOSH Surveillance Program Coordinator
11:30 a.m.	**Children Working in Agriculture (Chapter 4.1)** Dawn N. Castillo, MPH Chief, Surveillance and Field Investigations Branch NIOSH Division of Safety Research
12:00 p.m.	Lunch
1:00 p.m.	**National Children's Center Rural and Agricultural Health and Safety Program** Barbara C. Lee, RN, PhD Director, National Farm Medicine Center, National Children's Center for Rural and Agricultural Health and Safety, Marshfield Clinic
1:30 p.m.	**Commercial Fishing Safety (Chapter 4.4)** Jennifer M. Lincoln, PhD Commercial Fishing Research Program Officer Assistant Program Manager, NIOSH Agriculture, Forestry, and Fishing
2:00 p.m.	**Chemical Exposures and Health Effects (Chapter 5)** Teresa M. Schnorr, PhD, MS Director, Division of Surveillance, Hazard Evaluations, and Field Studies
2:30 p.m.	Break
2:45 p.m.	**Tractor Safety (Chapter 6)** John R. Myers, MSF Health Statistician, NIOSH Division of Safety Research
3:15 p.m.	**Health Communications/Outreach (Chapter 7)** Larry Chapman, PhD Department of Biological Systems Engineering University of Wisconsin–Madison

3:45 p.m. **Public Comment**
(Individuals should sign up ahead of time at the registration table to provide comment)
4:15 p.m. **Wrap-up of Open Session**
Paul Gunderson, Committee Chair
4:30 p.m. **Adjourn**

Meeting II
March 28-29, 2007
Beckman Center of the National Academies
100 Academy Drive
Irvine, CA

Wednesday, March 28, 2007

9:00 a.m. **Welcome and Introductions**
Description of study charge and goals for the meeting
Paul Gunderson, Committee Chair
9:10 a.m. **Panel on the NIOSH Ag Centers**
- Pacific Northwest Agricultural Safety and Health Center
  Richard A. Fenske, Director
- Western Center for Agricultural Health and Safety
  Marc B. Schenker, Director
- High Plains Intermountain Center for Agricultural Health and Safety
  Stephen J. Reynolds, Director
- Southwest Center for Agricultural Health, Injury Prevention, and Education
  Jeffrey L. Levin, Director

11:10 a.m. Break
11:25 a.m. **Forestry Landscape**
John J. Garland, Professor Emeritus of Forest Engineering
Oregon State University
12:00 p.m. **Fishing Landscape**
Michael M. Rosecrans, Chief of Fishing Vessel Safety, U.S. Coast Guard
12:30 p.m. Lunch
1:30 p.m. **Agricultural Health Study**
Michael Alavanja (via teleconference), NIH Senior Investigator

2:00 p.m. **Regulatory Perspective—Cal/OSHA**
William Krycia, Regional Manager, Department of Industrial Relations

2:30 p.m. **Pesticide Safety—California Environmental Protection Agency**
Charles M. Andrews, Chief of Worker Health and Safety Branch, Department of Pesticide Regulation

3:00 p.m. Break

3:20 p.m. **Producer Communities**
- Organics
  David Runsten, Executive Director, Community Alliance with Family Farms
- Dairy
  Ray Souza, President, Western United Dairymen
- Crops and Growers
  George Daniels, Executive Vice President, Farm Employers Labor Service

4:50 p.m. Wrap-up for the day

5:00 p.m. **Adjourn**

Thursday, March 29, 2007

8:30 a.m. **LaborPanel** *
- California Rural Legal Assistance, Inc.
  Ilene Jacobs, Director, California Rural Legal Assistance, Inc.
  Michael Marsh, Director, Agricultural Worker Health Project, California Rural Legal Assistance, Inc.
- International Brotherhood of Teamsters
  Mike Johnston (via teleconference), Campaign Coordinator, Strategic Research and Campaigns Department

9:30 a.m. Break

9:45 a.m. **The Future of Agriculture, Forestry, and Fishing**
- Vision of forestry for the future
  Robert B. Rummer (via teleconference), USDA Forest Service, Project Leader of Forest Operations and Engineering Research
- Vision of agriculture for the future
  Brad Rein, USDA National Program Leader
- Vision of fishing for the future
  Jerry Dzugan, Director of Alaska Marine Safety Education Association

11:15 a.m. **Public Comment**
(Individuals should sign up ahead of time at the registration table to provide comment)
11:40 a.m. **Wrap-up of Open Session**
Paul Gunderson, Committee Chair

*Representatives of the United Farm Workers of America, United Food and Commercial Workers, Farm Labor Organizing Committee, and Frente Indigena De Organizaciones were invited to speak to the committee but declined.

ACKNOWLEDGMENTS

The committee extends its gratitude to the NIOSH staff. The AFF Program staff faced the substantial task of assembling the initial set of materials that were provided to the committee for this study. They also assembled a considerable amount of material in response to the committee's requests for additional information. The committee extends particular thanks to the NIOSH staff who gave presentations or responded to questions from the committee at its meetings, including Lewis Wade, George Conway, John Sestito, Dawn Castillo, Barbara Lee, Jennifer Lincoln, Teresa Schnorr, John Myers, Larry Chapman, Richard Fenske, Marc Schenker, Stephen Reynolds, and Jeffrey Levin.

The committee also thanks the many members of the agriculture, forestry, and fishing communities outside NIOSH who contributed to the study by providing comments on the NIOSH AFF Program, making presentations at the committee's meetings, or providing additional information in response to committee requests. In addition to those listed earlier in this appendix, the committee acknowledges David Wegman of the National Academies Committee for the Review of NIOSH Research Programs, Michael Alavanja, Charles Andrews, George Daniels, Jerry Dzugan, John Garland, Ilene Jacobs, Mike Johnston, William Krycia, Michael Marsh, Brad Rein, Michael Rosecrans, Robert Rummer, David Runsten, and Ray Souza.

The committee recognizes especially the assistance of George Conway. Dr. Conway served as the committee's point of contact for the NIOSH AFF Program and was tireless and gracious in his efforts to respond to the committee's many information requests and questions. The committee is also grateful for the assistance of Raymond Sinclair, who ably and patiently acted as a liaison between the committee and NIOSH as a whole.

The committee appreciates the support of Andrew Pope, director of the Institute of Medicine Board on Health Sciences Policy, Greg Symmes, deputy executive of the Division of Earth and Life Studies, and Evan Douple and Sammantha Magsino, who serve as staff to the Committee for the Review of NIOSH Research Programs.

C

Information Provided by the NIOSH AFF Program

Some of these documents are available online at the following NIOSH website: *http://www.cdc.gov/niosh/nas/agforfish/*. All of the materials are available for review at the National Academies through the study's public access file.

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D

Biographic Sketches of Committee Members

Paul D. Gunderson (***Chair***) is the former director of the National Farm Medicine Center (1992-1996) and former director of the Marshfield Medical Research and Education Foundation (1993-2000), both in Marshfield, Wisconsin. In those capacities, he conducted numerous research initiatives exploring the health effects of agricultural exposures, convened scientific meetings and seminars, chaired scientific review mechanisms that rated applications for federal funding, and testified before Congress about the need for a national agenda on agricultural health and safety. Dr. Gunderson has a deep appreciation of farming and its associated hazards and is an expert on farmer suicide. His career exploring the health impact of human activity in agricultural work settings began in 1976 with research on the respiratory effect of working in poultry barns and continued until his initial retirement in 2000. He serves as director of the Dakota Center for Technology-Optimized Agriculture in Devils Lake, North Dakota. Dr. Gunderson served as an adjunct professor in public health administration with the University of Minnesota School of Public Health and an adjunct professor in the Health Services Management and Administration Program of St. Mary's University, Winona, Minnesota. He received the 2006 Stueland Scholar Award from the National Farm Medicine Center at the Marshfield Clinic Research Foundation for his contributions to research in agricultural worker health. He has published more than 90 papers on agricultural safety and health in scientific journals and chaired scientific review panels for the National Cancer Institute and the Centers for Disease Control and Prevention. He began his career as a high-school teacher of English and industrial arts in the

United States and in Papua New Guinea. He is also pastor of the Drake, Martin, and Harvey United Methodist parishes in Harvey, North Dakota. Dr. Gunderson received his PhD in education from the University of Minnesota, his MA in industrial technology from Ball State University, and his BS in English from Moorhead State College, Minnesota.

Maria T. Correa is an associate professor of epidemiology and public health in the College of Veterinary Medicine at North Carolina State University. Her expertise is in agricultural health with emphasis on zoonotic diseases, agromedicine, Hispanic and Latino farmworker issues, program development and evaluation, and international public health. Her current research and outreach activities focus on the risk of transmission of foreign-animal diseases at the farm level, foreign-animal diseases, bioterrorism and agroterrorism agents, zoonotic diseases, and biosecurity. Dr. Correa conducts surveys to assess the prevalence of zoonotic diseases and the risk of zoonotic-disease transmission and uses epidemiologic and anthropologic information to understand illness and health. She also conducts evaluations of a target group's knowledge of disease transmission and prevention and identifies factors (such as use of alternative medicine, sociocultural understanding of disease, immigration status, and isolation of the community) that limit the group's access to Western medicine or public-health information. Dr. Correa is a member of the board of directors of the North Carolina Agromedicine Institute. She is a member of the American College of Epidemiology, the North Carolina Veterinary Medical Association, and the Phi Zeta Veterinary Honorary Society. Dr. Correa received her *Practicante de Veterinaria* (degree in veterinary sciences) from the State University of Uruguay and her MSc and PhD in epidemiology from Cornell University.

R. Alan Davis is the safety and compliance manager at American Seafoods Company, one of the largest commercial fishing companies in the country. He develops, directs, and provides safety, health, and emergency training for nearly 1,000 multicultural employees at American Seafoods; investigates injuries and accidents and identifies their causes; and conducts in-port and at-sea vessel safety inspections, including machine guarding, work practices, life safety, medical provisions, and Occupational Safety and Health Administration (OSHA) compliance. He previously was a loss-control specialist at the University of Washington, where he worked with national experts on prevention of back injuries, repetitive-motion injuries, workplace violence, and chemical exposures. Mr. Davis was a safety and security specialist at Tyson Seafood Group, where he developed and provided safety and emergency training for more than 700 employees, investigated injuries and accidents, and supervised the creation of an injury- and illness-reporting database. He has served as a member of the National Institute for Occupational Safety and

Health National Occupation Research Agenda mining, fishing, and forestry peer-review panel and has participated in numerous International Fishing Industry Safety and Health conferences. He has also served in various American Society of Safety Engineer (ASSE) chapters and is a past president of the Puget Sound Chapter. With nearly 8 years of experience with commercial fishing companies, he was recently appointed to the U.S. Coast Guard's Commercial Fishing Industry Vessel Safety Advisory Committee and has been nominated for a position on the Maritime Advisory Committee on Occupational Safety and Health. He began his career in safety as a volunteer firefighter and emergency medical technician while in high school. Mr. Davis is a Certified Safety Professional and received his BS in occupational safety and health from North Carolina A&T State University.

James A. Dosman is the director of the Institute of Agricultural Rural and Environmental Health at the University of Saskatchewan, the only institution in Canada that provides research, education, and health promotion to agricultural and rural populations. He is a fellow of the Royal College of Physicians and Surgeons of Canada and a professor in the Department of Medicine at the University of Saskatchewan. His expertise includes respiratory diseases, occupational diseases, and agricultural medicine. Dr. Dosman has chaired or co-chaired five international symposia on health issues related to agriculture and rural populations. He is a founding chair of the Canadian Coalition for Agriculture Safety and Rural Health (1992), founding co-chair of the Canadian Rural Health Research Society (2002), a past member of the Governing Council of the Medical Research Council of Canada (1995-2000), and a past president of the Canadian Thoracic Society. He helped to establish such initiatives as the first annual Agriculture Health and Safety Conference, the Canadian Agricultural Injury Surveillance Program, the Canadian Agriculture Safety Program, and the Agricultural Health and Safety Network, which provides educational services, respiratory health and hearing screening programs, courses in emergency preparedness, and other educational opportunities to the rural population. He is a current grantee of the Canadian Institutes of Health Research in fields related to occupational and environmental exposures and a member of the Canadian Nuclear Safety Commission. He is an associate member of the Western College of Veterinary Medicine and of the Department of Community Health and Epidemiology at the University of Saskatchewan. Dr. Dosman received his MD, MA, and BA from the University of Saskatchewan.

William A. Groves is an associate professor of industrial health and safety and chair of the graduate program in industrial health and safety in the Department of Energy and Geo-Environmental Engineering of Pennsylvania State University. He is a Certified Industrial Hygienist and a Certified Safety Professional. His research interests are in the development of sensors and instrumentation for measurement

of organic vapors, exposure assessment methods and strategies, biologic monitoring, and personal protective equipment. He developed a sampling system for measuring respirator protection from ammonia in livestock production facilities. He is a member of the American Industrial Hygiene Association (AIHA) Gas and Vapor Detection Systems Committee and a member of the Pennsylvania State University Outreach and Graduate Education Committee. He has been a reviewer for the *AIHA Journal*, *The Analyst*, and the Royal Society of Chemistry. From 1997 to 1999, Dr. Groves was an assistant professor in the Department of Preventive Medicine and Environmental Health and co-director of the industrial-hygiene core of the Great Plains Center for Agricultural Health, both at the University of Iowa. Dr. Groves was an industrial hygienist and engineering loss-control representative with Aetna Life and Casualty from 1986 to 1990 and an industrial hygienist at Newport News Shipbuilding from 1990 to 1991. Dr. Groves received his PhD and MPH in industrial health from the University of Michigan and his BS in chemical engineering from Case Western Reserve University.

Ronald L. McAllister is manager of support and facilities at Case New Holland (CNH) America LLC, a large manufacturer of agricultural equipment. He is responsible for the prototype shop, which builds agricultural equipment for the New Holland and Case IH brands as part of the engineering product-development process, along with drafting, tool design, and facilities at CNH in New Holland, Pennsylvania. His specialty is the design and improvement of equipment related to forage harvesting and round balers. For more than 35 years, Mr. McAllister has been directly involved with safety-related aspects of product development. He was a member of the CNH product-safety review committee for 12 years and chaired it for 4 years. During that time, he participated in more than 100 product-safety reviews and provided recommendations for safety improvements in products before production. He was also involved in the development of industry-wide standards. Mr. McAllister guided academic and industry leaders in the revision of American Society of Agricultural and Biological Engineers (ASABE) S279, *Lighting and Marking of Agricultural Equipment on Highways*, and he led support of extensive research conducted at Ohio State University that helped to define the specifications for the revision of that standard. He holds five U.S. patents. In 2006, he was awarded the National Association of Mutual Insurance Companies Engineering Safety Award by ASABE for his dedication and outstanding leadership and accomplishments in agricultural safety engineering. Mr. McAllister holds a BS in agricultural engineering from Virginia Polytechnic Institute and State University.

James D. McGlothlin is an associate professor of industrial hygiene and ergonomics and director of the Occupational and Environmental Health Sciences Graduate Program at Purdue University. Dr. McGlothlin is a Certified Professional Ergono-

mist and is retired from the National Institute for Occupational Safety and Health (NIOSH). He studies the relationships between ergonomics, epidemiology, and industrial hygiene to reduce risk and evaluate and control physical, chemical, and biologic hazards in the occupational environment. He develops and administers ergonomic programs to prevent musculoskeletal injuries, promote health, and improve productivity and quality in the workplace. Most recently, he has worked on methods to integrate real-time sampling methods with videography to develop more accurate worker risk-assessment profiles and to develop more cost-effective controls. His research also looks to develop systems to detect and identify airborne infectious agents, such as the H5N1 virus, the agent of avian influenza. At NIOSH, Dr. McGlothlin served as a senior researcher in ergonomics at the Engineering Control Technology Branch (1997-1998), an occupational and environmental safety and health specialist (1991-1996), an industrial hygienist (1985-1991), and chief of the Division of Safety Research (1984-1985). Dr. McGlothlin received his PhD in industrial health with a specialty in ergonomics from the University of Michigan-Ann Arbor. He holds an MPH in epidemiology, an MS in environmental and industrial health, and a BA in industrial psychology from the University of Hawaii.

Susan H. Pollack is an assistant professor in the University of Kentucky College of Medicine Department of Pediatrics and in the College of Public Health Department of Preventive Medicine and is board-certified in pediatrics and preventive and occupational medicine. She directs the Pediatric and Adolescent Injury Prevention Program at the Kentucky Injury Prevention and Research Center. Dr. Pollack is interested in all aspects of injury epidemiology and prevention in children and adolescents and teaches health professionals and the public about injury epidemiology and prevention. She has had funding, publications, and a national role in the issue of occupational injuries among working teens. She is the principal investigator in the Injury Free Coalition for Kids of Lexington at Kentucky Children's Hospital, one of more than 40 such sites across the country originally funded through a Robert Wood Johnson Foundation grant, and has been serving as the Kentucky State SAFE KIDS Coordinator. She works closely with the Kentucky State Department for Public Health, supporting rural county health departments in child-health and injury-prevention issues. Her other interests include child-fatality review, emergency medical services for children, health and safety in child care and among incarcerated adolescents, and whitewater river safety. She has served in a number of injury leadership positions for the American Academy of Pediatrics, including serving as a member of the National Committee on Violence, Injury and Poison Prevention. Dr. Pollack received her MD from Eastern Virginia Medical School, her MS in physiology from Georgetown University, and her AB in environmental biology and sociology from Smith College.

Lorann Stallones is a professor of epidemiology in the Colorado State University Department of Psychology. She is also the director of the Colorado Injury Control Research Center and an adjunct professor in the Department of Preventive Medicine and Biometrics of the University of Colorado Health Sciences Center. Her research is in injuries in farmers; adolescent farm work, fatigue, and injuries; the relationship between pesticides and mental health (depressive symptoms and neurobehavioral symptoms); pesticides and safety practices on farms; and pesticide exposures of migrant and seasonal farm workers. She has also studied the relationships between congenital anomalies, birth weight, and pesticide exposures; head injuries and cancer in Hispanic farm workers; and musculoskeletal injuries, suicide, and respiratory symptoms in farmers. Dr. Stallones is on the editorial board of the *Journal of Agricultural Safety and Health*. She was a member of the Epidemiology Committee of the Howard Hughes Medical Institute predoctoral fellowship panel (1996, 1998, and 1999) and chair of the committee (2000 and 2001). She was on the 2003 National Academy of Sciences Vietnam Education Fellowship Review Panel. She has served on numerous grant-review panels for the National Institute for Occupational Safety and Health and the National Center for Injury Prevention and Control and was a regular member of the Injury Research Grant Review Committee (1991-1995) and the Safety and Occupational Health Study Section (2003-2007). She has reviewed grants for the British Columbia Health Research Foundation, Health Canada, and the United States-Israel Binational Science Foundation. She was secretary-treasurer of the Society for Epidemiologic Research (1990-1993). She was president of the National Association of Injury Control Research Centers (1998-1999). She served on the Board of Directors for the American College of Epidemiology (2003-2006) and was recently elected to serve as secretary (2006-2011). Dr. Stallones received her PhD in epidemiology and her MPH in community health from the University of Texas School of Public Health and her BA in cultural anthropology from the University of California, Santa Barbara.

Don Villarejo is a cofounder and retired as executive director of the California Institute for Rural Studies, which he served for 22 years. He has been working to improve the health and well-being of California's hired farm workers and to expand healthcare for the working poor. His research interests include pest management, farm-labor contractors and safety in the fields, farm-labor housing, reclamation policy in the western states, and new methods for surveying farmworker populations. In addition to his speaking engagements at agricultural health and safety seminars and conferences, Dr. Villarejo conducts training for attorneys and field staff members of the Agricultural Labor Relations Board. He received the 2005 Advocate of Social Justice Award from the Ecological Farming Association for his long-term contributions to the well-being of the people who work in food production and agriculture. He also received a Board of Directors Award from the

Mexican-American Concilio of Yolo County in California. Dr. Villarejo received his PhD, MS, and BS in physics from the University of Chicago.

Susanna G. Von Essen is a professor of internal medicine in the Pulmonary, Critical Care, Sleep and Allergy Section of the College of Medicine and a faculty member of the Environmental, Agricultural, and Occupational Health Sciences Department of the University of Nebraska Medical Center College of Public Health. Dr. Von Essen works as a pulmonary and critical-care physician, does research on agricultural health, and teaches on such topics as rural health and occupational pulmonary disorders. Her current research interests include gene-environment interactions associated with exposures to organic dust in production agriculture. She served on the Institute of Medicine committee that prepared the report *Damp Indoor Spaces and Health* and currently serves as a member of the Agricultural Health Study Advisory Panel. Dr. Von Essen received her MD from the Washington University School of Medicine, her MPH from the University of Michigan, and her undergraduate degree in zoology and German from the University of Nebraska-Lincoln.

James J. Zuiches is the vice chancellor for extension, engagement, and economic development at North Carolina State University. Dr. Zuiches leads and coordinates far-reaching programs in those fields at the university. His efforts include activities of the Cooperative Extension Service, the Industrial Extension Service, the Small Business and Technology Development Center, noncredit operations of the McKimmon Center for Extension and Continuing Education, the Economic Development Partnership, and the H. Hugh Shelton Initiative for Leadership Development. His research specialties include demography, rural sociology, and research administration. He was a professor in community and rural sociology and project leader for the National Coalition for Rural Entrepreneurship at Washington State University, where he also served as dean of the College of Agriculture and Home Economics for 8 years and director of Cooperative Extension and the Agricultural Research Center for 4 years. Dr. Zuiches served at Cornell University, Michigan State University, the National Science Foundation, and the W.K. Kellogg Foundation. He has more than 70 publications, including journal papers, book chapters, bulletins, and editorials. He is a Fellow of the American Association for the Advancement of Science, serves on the National Research Council Committee on the Review of NIOSH Research Programs, and has served as a member of the Board on Agriculture and Natural Resources. Dr. Zuiches received his PhD and MS in sociology from the University of Wisconsin-Madison and his BA in philosophy and sociology from the University of Portland, in Oregon.

E

Methods for Identifying the Agriculture, Forestry, and Fishing Workforce Population

DISTINGUISHING BETWEEN EMPLOYMENT AND WORKFORCE POPULATION

Efforts to measures the size of a population at occupational risk are often based on a determination of "employment" in the economic sector of interest. It is usually assumed that that term refers to the number of people who are self-employed or are employed by others. It is implicit that those people do not change their employment status throughout all or most of the calendar year. Thus, measures of employment are sometimes thought of as more or less equivalent to determinations of the number of people actually working.

However, the agriculture, forestry, and fishing (AFF) sector is unusual in three respects. First, many workers are employed for only a portion of the year. Second, there is a high rate of turnover of hired and contract workers; a great many workers are known either to enter or to leave the AFF sector workforce in the course of a year. Fully 16 percent of the nation's hired crop-farm workers in 2001-2002 were determined to have been immigrant "newcomers", that is, foreign-born persons who had been working in the United States for less than a year when interviewed by the U.S. Department of Labor (DOL).[1] Presumably, the newcomers replaced people who had left crop-farm employment. Third, the AFF labor force includes

[1]United States Department of Labor. Office of Assistant Secretary for Policy. Office of Programmatic Policy, *Findings from the National Agricultural Workers Survey (NAWS) 2001-02. A Demographic and Employment Profile of United States Farm Workers*, Research Report No. 9, March 2005, p. 8.

children and the elderly, many of whom would classify themselves as retired but work actively on the farm during planting and harvesting. Many children and older adults do not receive money and do not appear on farm records.

Confounding the difficulty is that the AFF labor force is known to be much larger than the corresponding level of employment; that is, at various times of the year, a great many in the AFF hired and contract labor force are unemployed and unable to find work. Finally, a large proportion of AFF workers are foreign-born, and a sizable "reserve labor pool" is in the countries of origin, including workers who may have temporarily returned to their homes.

For those reasons, it is useful to distinguish measures of "population" from determinations of "employment". *Population* refers to the number of people; *employment* refers to their working status. Employment is often measured in terms of full-time equivalent (FTE) workers on the basis of temporal averages, usually derived from 12 monthly reports. Thus, two people who find half-time jobs in the AFF sector for a full year will be counted as a single FTE worker in measures of employment.

Even for self-employed workers, the distinction is important. To illustrate, the Census of Agriculture asks farm operators to report the number of days on which they were employed off-farm. In the 2002 Census of Agriculture, more farm operators reported having worked at least some days off-farm than reported no off-farm work. The majority of those who said that they worked off-farm at all said that they did so for 200 or more days per year;[2] these farm operators might be counted twice in measures of employment, as would be the case for workers in any industry who "moonlight", holding two jobs at the same time.

HARNESSING THE QUARTERLY AGRICULTURAL LABOR SURVEY FOR AFF SURVEILLANCE

The Quarterly Agricultural Labor Survey (QALS) is the only national survey of the agriculture workforce, conducted by the U.S. Department of Agriculture (USDA) and reported in the periodical *Farm Labor*. The QALS has recently been called the Farm Labor Survey (FLS). The survey is limited to farm employment. Initiated in 1910 and conducted with only a few interruptions nearly every year since then, the FLS is an employer survey that obtains reports of employment and other characteristics, such as wage rates paid and hours worked. A nationally representative sample of farm operators and agricultural service firms (mainly farm labor contractors) is contacted to determine the number of their hired farm

[2]United States Department of Agriculture. National Agricultural Statistics Service, *2002 Census of Agriculture. Summary and State Data*, Volume 1, Geographic Area Series, Part 51, June 2004. Table 55. Summary by Size of Farm: 2002, p. 69.

laborers during the week that includes the 12th day of the first month in each of the four calendar quarters (January, April, July, and October). Data on hired farm workers from other sources, such as the Census of Agriculture and the Census of the Population decennial population surveys, do not provide seasonal data on employed workers.

The data provided by the FLS are not available from any other source. It provides the only national data on farm labor employment and wage rates and also provides regional and seasonal data. It is the analogue for agriculture of the monthly Current Employment Statistics (CES) payroll survey of the Bureau of Labor Statistics (BLS), which is watched closely by policymakers and business economists. Agriculture is deliberately excluded from the CES survey. Unlike the CES, the FLS is based on reports for only 4 months, one in each calendar quarter.

The FLS is unique in that it seeks to survey a sample of all farm employers, no matter how small their payroll or number of employees. Other BLS data—such as the Census of Employment and Wages (CEW), which is based on quarterly unemployment insurance reports—are incomplete for agriculture because most small farms are excluded from the sample frame. (That is because many states specifically exclude small farm employers from unemployment-insurance [UI] coverage.) Nor is the FLS subject to the so-called small farm exemption that precludes the National Institute for Occupational Safety and Health from surveying farms that have fewer than 11 employees.

All types of farms are included in the FLS, both crop and livestock producers. Data are reported for the United States as a whole and for each of the 18 USDA crop regions, including separate reports for each of California, Florida, and Hawaii, which constitute crop regions in their own right.

The FLS relies on employer reports of their payroll, so all hired workers, irrespective of age, are represented. Reports compiled by BLS usually report employment only of persons who are at least 16 years old.

The FLS sample frame comprises a comprehensive list of farms maintained by USDA's National Agricultural Statistics Service (NASS) and an area frame (a random sample of parcels of farmland). The latter aspect is peculiar to the QALS: no other employment survey uses this method.

It is important that the FLS survey includes all types of employers of hired farm workers, such as crew leaders and labor contractors, who have been deliberately excluded from Economic Census coverage. The Census Bureau abandoned its Census of Agricultural Services, which had included farm labor contractors, after a failed effort in 1978. Agricultural service employers were first added to the FLS in 1987.

For many years, the FLS included determinations of the numbers of self-employed farm workers and unpaid family workers. However, it ended that com-

ponent of the survey in 2002 owing to budgetary constraints (Mark Aitken, USDA, private communication, February 19, 2007).

The FLS asks employers to provide information about wage rates and the numbers of field workers and livestock workers. The FLS provides annual average wage data on directly hired farm workers in each of the 50 states.

The data generated by the FLS are clearly limited to employment in each of 4 months of the year. No effort is made to determine how many people are employed year-round. However, respondents are asked to report the number of persons whom they expect to employ for 150 days or more and the number expected to be employed for less than 150 days.

Because the excellent sampling frame used for the survey (list and area frame) was developed for use by other NASS surveys, the FLS does not incur special sampling costs. In fact, it is an efficient data-gathering tool. Information is collected by telephone and processed with other survey data gathered by NASS; thus, statisticians and other resources are already shared.

The FLS provides excellent information on a regional and large-state basis that can be combined with data from other sources, such as the Agricultural Census, to estimate the numbers of farm workers in smaller geographic areas, such as counties. The FLS also can be combined with DOL's National Agricultural Workers Survey (NAWS) to make fine-grained estimates of the demographics of farm workers by region and large state. Those estimates can even be made by season. The age, sex, place of origin, migration patterns, housing patterns, education levels, and use of social services can be estimated by combining the NAWS and the FLS.

Furthermore, the FLS is used to support various other government programs. The NAWS itself uses FLS data to implement its sample and weight its results. The NAWS, FLS, and Agricultural Census are being used in various configurations, but always with a big role for the FLS, to allocate resources for the National Farmworker Jobs Program, the Migrant and Seasonal Head Start Program, the Legal Services Corporation migrant program, and the Migrant Health Program. Other agencies, such as the 1992 Commission on Agricultural Workers and the Congressional Budget Office, have used the FLS, usually in conjunction with other data sources, to describe the farmworker population. The H2A agricultural guest worker program uses the wage data from the FLS to set its adverse-effect wage rate for the visiting workers. Moreover, estimates from those data sources are used by farmworker programs and by state policymakers to design, implement, and obtain resources for their activities.

Recently, the Congressional Research Service relied on the FLS to determine that there was, as of 2006, no national shortage of hired farm laborers. Citing the annual FLS reports for the period 1990-2006, the official report to Congress demonstrated that hired farmworker employment varied only slightly throughout the

TABLE E-1 Directly Hired Farm Workers and Agricultural Service Workers in the United States, 2006

Week	Workers, 150 Days or More	Workers, Less Than 150 Days	Agricultural Service Workers	Total, All Hired Farm Workers
Jan. 8-14, 2006	512,000	102,000	180,000	794,000
Apr. 9-15, 2006	581,000	139,000	241,000	961,000
Jul. 9-15, 2006	630,000	246,000	320,000	1,196,000
Oct. 8-14, 2006	592,000	205,000	280,000	1,077,000

SOURCE: USDA, *Farm Labor.*
See *http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1063.*

17-year period (Levine, 2007). Table E-1 presents the latest findings of the FLS, covering all 4 sampling weeks of 2006. It is possible that some individual workers may be double-counted because they performed jobs for two or more employers during a sampling week, but effect is probably small, especially because a majority of the reported employment is accounted for by persons working directly for farm operators for 150 days or more (sometimes described as regular or permanent employees).

NATIONAL CENSUS OF POPULATION AND HOUSING

The most comprehensive effort to enumerate the U.S. population and its characteristics is the decennial Census of Population and Housing (commonly referred to as the Census). The Census is important in its own right but also because additional surveys—such as the Current Population Survey (CPS), the American Community Survey (ACS), and the Hired Farm Work Force Report—have relied on its sample frame. The Census 2000 Special Equal Employment Opportunity (EEO) Tabulation also relied entirely on an analysis of Census data and provided detailed occupation and education data.

As further described below, the Census data and surveys based on its sample frame are probably accurate with respect to self-employed workers in the AFF sector and for most regular or year-round workers in this sector. However, it is well established that the Census does not accurately enumerate a great many hired and contract farm laborers, as was officially delineated by its senior administrator in 1994.[3] Scholarship has also demonstrated that deficiency (Gabbard et al., 1993).

[3]Letter from Everett M. Ehrlich, Administrator, Economics and Statistics Administration, U.S. Department of Commerce, October 24, 1994.

The Census relies primarily on a mail-return short form requested of all American households and a long form from a random sample of about one-sixth of them. For literate English-speakers who reside in a dwelling with a physical address, the response rate is quite high. In contrast, for non-literate, low-income, non-English speaking immigrants, who may be undocumented or reside in informal dwellings that lack physical addresses, the response rate is low. The Census undercount is a continuing problem to which considerable effort and resources have been allocated in an effort to account for those missed by the mail-return forms.

As a result of those considerations, government programs that serve hired farm laborers no longer rely on Census figures to estimate the size of this component of the AFF workforce. As a consequence, the use of Census data to measure the number of American hired farm laborers by government surveys, such as the CPS and the ACS, that rely on the Census sample frame have also become suspect with respect to their ability to enumerate hired farm laborers.

In the decennial Census, employment status information is collected for the workweek before the reference date of April 1. The information is reported on the "long form", gathered from a roughly one-sixth sample of all households, or about 18 million of the 105 million households. The specific question determining *employment* status in the 2000 Census read as follows:

> LAST WEEK, did this person do ANY work for either pay or profit? Mark the "Yes" box even if the person worked only 1 hour, or helped without pay in a family business or farm for 15 hours or more, or was on active duty in the Armed Forces.[4]

Note the careful wording regarding possible unpaid work on a family farm. Inclusion of that phrase makes it possible for the Census to seek to enumerate unpaid family workers in the AFF sector.

However, the inquiry regarding *industry* of employment refers to either the current job or, if there is no current employment, the most recent job held, even if it was as far back as 1996. The question regarding industry status read as follows:

> Describe clearly this person's chief job activity or business last week. If this person had more than one job, describe the one at which this person had the most hours. If this person had no job or business last week, give the information for his/her last job or business since 1995.[5]

Similarly, the inquiry regarding *occupation* status refers to the respondent's industry status, clearly, albeit implicitly, referring to the most recent job since 1995.

[4]United States Department of Commerce. Bureau of the Census, *United States Census 2000*, Form D-2, Question 21, p. 6.

[5]Ibid. Question 27, p. 7.

TABLE E-2 Classes of Workers: Civilian Population 16 Years Old and Older Employed in Agriculture, Forestry, Fishing, and Hunting (AFFH)

Class of Worker, AFFH Sector	Total Workers, Male and Female
Self-employed in own business	836,417
Employees of private for-profit business	938,663
Unpaid family workers	75,938
Government workers	63,848
Private not-for-profit wage and salary workers	14,817
Total, all types of workers (above)	1,929,683

SOURCE: Census 2000, SF 3, Table P51.

Thus, the data on industry status and occupation status refer to the full population whereas the data on employment status refer only to persons employed during the 1-week period prior to April 1.

The data on the nation's employed workforce are summarized in Tables P49, P50, and P51 of Summary File 3 (SF 3), in which cross-tabs by sex are reported for all employed persons at least 16 years old by industry, occupation, and class of worker, respectively. A brief overview of the data on the AFF workforce derived from Table P51 is reported in Table E-2 above.

In addition, the Census reports include summary data on the size of the rural population and the size of the farm resident population. Finally, the Census long form has an intriguing inquiry regarding the sale of agricultural products. Specifically, for residents of a single-family dwelling or mobile home, respondents were asked to report "the actual sales of all agricultural products from this property" in 1999.[6]

OCCUPATIONAL CENSUS REPORT

The Census Bureau also prepares a Special Equal Employment Opportunity (EEO) Tabulation on behalf of the federal EEO Commission, colloquially known as the "Occupational Census" report. It is subject to the same limitations as the Census in seeking to enumerate AFF workers, but with respect to English-speaking persons who are long-term residents of a dwelling that has a physical address the findings are likely to be reasonably accurate. However, because of the Census undercount, it is likely that the Occupational Census does not accurately reflect the full population of hired farm laborers.

[6]Ibid. Question 44(c), p. 9.

Table E-3 presents the EEO Occupational 1990 and 2000 tabulations for AFF occupational categories. It is important to note that the findings regarding hired farm laborers likely reflect a substantial undercount. Moreover, self-employed family workers are not represented in the table, because they do not correspond to an officially recognized occupation.

CURRENT POPULATION SURVEY

The CPS is a monthly survey of about 60,000 randomly selected occupied American households in 754 primary sampling units (out of the nation's roughly 3,000 counties, or groups of contiguous counties). Its main purpose is to determine changes in population, demographic characteristics, and economic status, especially employment and unemployment. In keeping with standard practices of the BLS, the reference week is the one that includes the 12th day of the month.

The BLS adopted the North American Industry Classification System (NAICS) in 2002, bringing its industry and occupation categories into conformity with those of all other federal agencies, including NIOSH (Bowler et al., 2003). One important change resulted from adoption of the NAICS: forestry, fishing, and hunting had been classified in the much broader "services" sector, separately from agriculture, but are now included with agriculture to form the new AFF sector.

TABLE E-3 Census Special Equal Employment Opportunity (EEO) Tabulations, United States, 1990 and 2000

Occupation	1990	2000
Farmers and ranchers	829,919	587,015
Farm, ranch, and other agricultural managers	257,446	201,980
First-line supervisors of farm, fishing, and forestry workers	55,503	57,440
Hired farm workers	797,405	806,075
Fishing and hunting workers	58,493	51,100
Forestry and conservation workers	20,431	18,980
Logging workers	115,524	105,675
Total, all types of occupations (above)	2,134,721	1,828,265

NOTE: Redefinition of some occupational categories in 2000 required combining some 1990 figures to correspond to the new definitions. Moreover, "Hired farm workers" were termed "Farm workers" in 1990 and "Miscellaneous agricultural workers, including animal breeders" in 2000.
SOURCE: *http://www.census.gov/hhes/www/eeoindex/eeoindex.html.*

As previously indicated, the Census sample frame, the Master Address File (MAF), updated with additional physical addresses, is used for the CPS. However, unlike the decennial Census, the CPS has no procedure for updating the MAF regarding informal dwelling locations that lack physical addresses. A cross-sectional statewide survey of hired farm laborers in California found that a substantial portion reside in informal dwellings that lack physical addresses (such as shacks, garages, and illegal trailers) and would probably be missed by the CPS (Villarejo and McCurdy, 2008).

About 70 percent of the CPS is conducted by telephone, using local residents of the areas to be covered. But community-based survey research indicates that one-fifth of dwellings occupied by hired farm laborers in California lacked landline telephone service (Villarejo et al., 2001); this may lead to bias in findings with respect to hired farm laborers in a telephone survey.

Another bias in telephone surveys of hired farm laborers is the reluctance of some workers to be interviewed by strangers asking personal questions. A recent analysis compared findings in California obtained from a statewide, population-based telephone survey of all adults with findings of a statewide cross-sectional household survey of hired farm laborers in which biliterate, bicultural staff conducted in-person interviews (Mines, 2005); the former survey appeared to be successful in reaching English-speaking, home-owning farm workers but failed to adequately include non-English speaking farm laborers who were renters.

The CPS employment-status findings are limited to people at least 16 years old (BLS, 2007b). Farm employment includes some workers under 16 years old and is legally permissible for persons as young as 12 years old and, in exceptional circumstances, even younger (DOL, 2004). Hence, the AFF workforce will be undercounted by an unknown amount in the CPS.

Employment and unemployment findings from the CPS are closely monitored by government officials and economists and are even cited by Wall Street analysts who regard them as indicators of the health of the American economy. It is generally agreed that the CPS findings are very accurate with respect to people who speak English and do not migrate to find work. But scholarship has demonstrated that the CPS does not accurately represent foreign-born, non-English speaking farm laborers (Mines, 1998; Larson et al., 2002). In that regard, the CPS suffers from the same deficiencies as the Census.

The annual March supplement to the CPS seeks to determine detailed demographic and other characteristics of the American population. Farm labor scholars have pointed out that March is not the best month in which to survey hired farm laborers working in the United States, and that the March supplement is likely to yield findings on ethnicity, race, and foreign-born status of hired farm laborers that differ substantially from those of the full population. However, it is likely that

the CPS accurately reports the employment status of other segments of the AFF workforce, especially self-employed workers and unpaid family workers. Thus, with the caveat that directly hired and contract workers are not properly enumerated in the CPS, the other segments of the AFF workforce are likely to be accurately determined.

In comparing the findings of the CPS with those of the FLS, it has been demonstrated that the FLS systematically reported hired farmworker employment about 30 percent higher than the CPS during the period 1984-1997 (Mines, 1998). The employer reports in the FLS are probably more accurate with respect to this segment of the AFF workforce than the partial sample obtained by the CPS.

A recent report by the Congressional Research Service provides updated information for the period after 1997 and confirms the earlier findings (Levine, 2007). As indicated in Table E-4, the FLS reports from employers regarding their hired farm workers are 29-55 percent larger than the findings from the CPS, as analyzed by the USDA Economic Research Service (ERS). Note that the ERS analysis includes hired farm workers at least 15 years old whereas findings published by the CPS are for workers at least 16 years old.

The committee has identified other survey efforts that could be considered for specific, limited, single-purpose use when conducting surveillance of AFF sectors, including the *Hired Farm Work Force* report, the Current Employment Statistics, and the Census of Employment and Wages. The 5-year Census of Agriculture is considered separately below.

TABLE E-4 Hired Farmworker Employment, 1998-2006, Annual Average Economic Research Service (ERS) Analysis of Current Population Survey (CPS) (at least 15 years old) versus Farm Labor Survey (all ages)

Year	Hired Farm Workers, ERS (CPS)	Hired Farm Workers, QALS
1998	875	1,126
1999	840	1,162
2000	878	1,133
2001	745	1,125
2002	793	1,111
2003	777	1,072
2004	712	1,102
2005	730	1,062
2006	748	1,007

SOURCE: Levine, 2007, Table 1, p. CRS-10.

THE HIRED FARM WORK FORCE

The USDA ERS summary, *The Hired Farm Work Force*, sought to provide periodic reports on the demographic and economic status of the nation's hired farm laborers, but was discontinued after 1987 and replaced by the NAWS. The 2000 ERS report, *Profile of Hired Farmworkers, 1998 Annual Averages*, has indicated that those analyses have important limitations, associated mainly with the difficulty of enumerating Hispanic farm laborers (Runyan, 2000). The data for these reports were derived from the CPS and regarded by scholars with the same degree of skepticism as the CPS (Larson, 2002).

AMERICAN COMMUNITY SURVEY

The ACS is the most recent initiative of the Census Bureau. It is a monthly survey of 100,000 randomly selected households designed to replace the "long form" of the Census. A major portion of the sample is rotated each month, and this enhances the statistical power of the findings by accumulating data for a sequence of several months.

ACS uses the Census sample frame. Like those of the CPS, its sampling methods and survey methods lead to underreporting of hired farm laborers. However, the cumulative sample over many months yields findings that are more statistically stable than some findings of the CPS.

CURRENT EMPLOYMENT STATISTICS

The CES is a monthly survey of 160,000 businesses and government agencies, representing 400,000 worksites and seeks payroll and employment information for the week that includes the 12th day of the month. It is sometimes referred to as the payroll report of employment. All agricultural workers and self-employed workers are excluded. Therefore, the CES is not helpful for the purposes of the NIOSH AFF program.

CENSUS OF EMPLOYMENT AND WAGES

The BLS also compiles the CEW, which is based on the quarterly reports of monthly employment and quarterly total wages required of employers subject to unemployment insurance requirements. As in the case of other BLS employment data, *monthly employment* refers only to persons on the payroll during the pay period that includes the 12th day of the month.

The main problem in relying on CEW data for the AFF sector is that many farm employers are exempt from UI requirements. That follows from the fact that each state sets its own criteria for UI coverage. Many states, such as California and New York, have "universal" coverage, typically requiring every private-sector employer that pays at least $100 in wages or salaries in a calendar quarter to pay UI taxes. But many states specifically exempt farm employers that have quarterly payrolls below a specified threshold, typically $50,000. Thus, in effect, an unknown portion of the AFF hired farm labor workforce is not reported, because some employers are exempt from payment of UI taxes. Those workers are also ineligible for qualification to receive UI benefits.

CENSUS OF AGRICULTURE

The committee has specifically reviewed the use of the Census of Agriculture (CoA) as a sector-surveillance tool. It is part of the 5-year Economic Census and is based on responses to a mail-return census form that NASS sends to its master mail list of farm operators. The findings are regarded as the most comprehensive body of systematic data on farmers and the farm sector. Most important, nearly all findings are reported at the county, state, and national levels.

Farm operators report such factors as the number of days worked off farm, whether they consider their principal occupation to be "farmer", and whether they reside on farm. Age, sex, and other demographic features of farm operators are also reported.

Data are reported on hired-labor and contract-labor expenses, the number of directly hired workers, the number of persons employed for 150 days or more, and those employed for less than 150 days, at each geographic level. Cross-tabs of these data items are also available for each NAICS category of farms and for other standard measures of farm operators.

A given worker may find employment with two or more farm operators in the course of a single year, so the CoA's "number of workers" is more properly regarded as the number of farm *jobs*, not workers. Clearly, farm employment and the hired worker population cannot be determined from these data items (Gabbard et al., 1993).

NATIONAL AGRICULTURAL WORKERS SURVEY

The NAWS is a national cross-sectional survey of hired crop-farm workers; livestock workers are excluded. The survey is employer-based, and farm employers, whether farm operators or labor contractors, of all payroll sizes are included in the sample frame. In-person interviews, normally conducted away from the

worksite, with workers who agree to cooperate, are administered by professional staff members (bilingual, biliterate, and mostly bicultural). Three seasonal cycles of interviews are conducted in each federal fiscal year (FY) to provide persons who are employed in only part of each calendar year an opportunity to participate. The most recently published report of the NAWS is based on findings from 6,472 interviews conducted during FY 2001 and FY 2002 (DOL, 2005).

The NAWS was not intended or designed to enumerate workers or to provide quantitative reports of total hired crop-worker employment. Begun in 1988 by DOL, it was a response to the congressional mandate of the Immigration Reform and Control Act of 1986 (IRCA). The specific purpose of the NAWS under the IRCA mandate was to determine whether persons who were newly authorized for employment in the United States under the seasonal agricultural worker (SAW) visa program continued in farm work after their immigration status had been adjusted. If it were determined that persons holding SAW visas were leaving seasonal crop work and being replaced by unauthorized workers before federal FY 1992, a shortage of legally eligible workers would be officially declared, and a new replenishment agricultural worker (RAW) visa program would automatically be triggered. During the first 3 years of NAWS surveys, it was determined that the "exit rate" of SAW-visa holders from crop agriculture was negative, that is, more SAWs entered than left agricultural crop work in the United States each year. As a consequence, the RAW visa program was allowed to "sunset" because it was not needed.

The NAWS is an unusual survey in that it seeks to obtain detailed work and family histories; information on workplace compliance with labor regulations; current income, workplace and job conditions, and immigration status; and other hard-to-obtain information. Such information has been regularly gathered from NAWS participants in every federal fiscal year since the October 1988 start date. Owing to budgetary and policy considerations, the number of interviews conducted each year has varied considerably.

When combined with data from other sources, such as the Census of Agriculture or the FLS, the NAWS has been effectively used to provide otherwise hard-to-estimate numbers, such as estimates of the number of persons who qualify for participation in federal programs intended to serve migrant farm laborers. In addition, the NAWS conforms its sampling procedure to the same 18 USDA crop regions as form the basis of the FLS (and in fact uses FLS data to assist in determining the proportion of interviews required in each crop region). As a result, data are available for a few individual states, such as California, that are themselves distinct crop regions.

The NIOSH AFF Program entered into an interagency agreement with DOL to add an occupational safety and health supplement to the NAWS for federal FY 1999 (three NAWS interview cycles, starting in October 1998 and concluding in

September 1999) supported by NIOSH funding. The interviews included inquiries specifically designed to probe the occupational safety and health status of hired farm laborers, and some of the queries were permanently added to the NAWS after the end of NIOSH supplementary support.

A NIOSH report on the findings of the occupational health supplement, by Andrea Steege and Sherry Baron, has been completed and has undergone extensive outside review. At this writing, the report is moving through the NIOSH internal approval process.[7]

EMPLOYMENT DATA ON INDIVIDUAL STATES

A number of important farm states, such as California and Washington, have universal UI requirements for virtually all private-sector workers. Thus, comprehensive employment data are regularly published or otherwise made available on workers in the major industry sectors, often at both the state and regional levels and sometimes also at the county level. Employment data are compiled for the pay period that includes the 12th day of each month of each calendar quarter with corresponding payroll summaries. For example, California publishes a monthly *Agricultural Bulletin* and an annual supplement providing annual average employment data for all the major NAICS categories related to farm employment (CA EDD, 2007). The findings are based on a random cross-sectional sample of firms that file quarterly reports to meet their UI obligations. Findings for the state as a whole and each of the state's six crop regions are reported.

The California findings can be compared with the findings for that state as determined by federal surveys, such as the FLS. Such a comparison can yield useful information on the effectiveness of coverage of federal and state surveys. Table E-5 shows one such comparison; it compares a special compilation of all individual quarterly reports submitted by farm employers (universal reporting), *Agricultural Bulletin* survey data, and FLS survey data on California employment by farm labor contractors. Because quarterly tax reports of employment and payroll by employers determines their UI tax obligations, whereas the FLS and the *Agricultural Bulletin* are based on self-reports of total employment, both surveys are likely to understate a substantial portion of farm-labor contractor employment in California.

WORKERS' COMPENSATION INSURANCE REPORTS

More than a dozen states require workers' compensation insurance coverage for nearly all private-sector employees. Some states, such as Washington, require the

[7]Sherry Baron, private communication, March 6, 2007.

TABLE E-5 Hired Farmworker Employment, Farm Labor Contractors, California, 2000: Comparison of Farm Labor Survey, *Agricultural Bulletin* Surveys, and ES202 Reports

Month and Week	Farm Labor (FLS)	Agricultural Bulletin (CA-EDD)	Universal Reports from All Employers
January 9-15	75,000	69,700	96,017
April 9-15	85,000	86,600	134,475
July 9-15	99,000	150,300	177,409
October 8-14	86,000	109,100	135,949

coverage through the public sector, in this case the Department of Labor and Industries. Other states, such as California, permit coverage through private insurance providers or through a public agency, the State Compensation Insurance Fund.

Actuarial reports are annual reports that summarize claim frequencies by occupational risk category. There are 14 nationally recognized risk categories related to agriculture, and claim records of exposure of all workers in each risk category (based on payroll totals) and numerous other details are regularly produced to enable insurance providers to base premium rates on claim frequency and experience.

Paid workers' compensation claims have been reviewed and analyzed to obtain reasonably accurate estimates of employment and estimates of the cumulative prevalence of injury and illness in hired farm laborers in California and other states (Villarejo, 1997). The actuarial agency responsible for rate-setting in California has used its own analysis of the surveillance data available from the records of paid claims to determine which factors are important in reducing workplace injuries and illnesses (WCIRB, 2002).

To illustrate the potential usefulness of those data for surveillance purposes, Table E-6 presents the 10-year summary of hired farm-laborer paid claims under workers' compensation insurance in California. It is not known whether all eligible persons filed such claims, but it is very likely that the most serious incidents, fatalities and permanent disabilities, resulted in payment under workers' compensation. The data in Table E-6 refer to all paid claims in the 14 classification codes that refer to on-farm work, both crop and livestock. The term "Claim Frequency Report (Level 5)" refers to summary information on paid claims through the fifth year following the policy year. It is necessary to carefully consider the number and actual costs associated with paid claims through a long period after the year in which the incident took place because some claims are initially challenged by the

TABLE E-6 Paid Claims Under Workers' Compensation Insurance, Hired Farm Workers, California, 1990-1999, Claim Frequency Report (Level 5)

Type of Claim	Number of Claims
Fatalities	455
Major permanent disability	12,932
Minor permanent disability	31,958
Temporary disability	68,357
Medical only/no indemnity payment to claimant	185,029
Total	298,731

SOURCE: Classification Experience Reports, 1990-1999 (Level 5), Workers' Compensation Insurance Rating Bureau of California, San Francisco, California.

employer or the insurer ("open claims") whereas others may involve lengthy, multi-year rehabilitation or medical treatment. Under California law, an occupational injury or illness that requires hospitalization or leads to loss of more than 3 days of work results in an indemnity payment in lieu of lost wages; if the number of lost workdays is lower, no indemnity is paid. Table D-6 does not show the actuarial analysis of the most serious incidents (those amounting to a loss of $5,000 as measured by combined medical and indemnity costs), which includes the nature of an injury, the nature of an accident, the body part injured, and other variables. The latter data could inform occupational safety research.

Surveillance of AFF workers would be best accomplished by thinking first in terms of all workers in each AFF sector. From there, it makes sense to consider surveillance of all five categories of workers—self-employed workers, unpaid family workers, directly hired laborers, contract laborers, other employees of large-scale firms—in each of the three AFF subsectors. Datasets on workers' compensation are reasonably reliable for surveillance of fatalities and serious injuries or illnesses among hired workers but less reliable for minor cases.

F

Policies and Regulations Affecting the Agriculture, Forestry, and Fishing Workforce

> "The Congress hereby finds that the existence, in industries engaged in commerce or in the production of goods for commerce, of labor conditions detrimental to the maintenance of the minimum standard of living for health, efficiency, and general well-being of workers . . ."
>
> Fair Labor Standards Act of 1938 (29 USC 201 et seq.)

PUBLIC POLICY AND REGULATORY ADVICE

The National Institute for Occupational Safety and Health (NIOSH) is uniquely positioned to offer independent, scientifically founded assessments of the effectiveness of public policy with respect to risk factors in workplace injury or illness. The agriculture, forestry, and fishing (AFF) sector presents a distinctly difficult set of circumstances for making such determinations. This appendix describes the legal framework within which NIOSH research informs policy discourse in law and regulation, then reviews and evaluates NIOSH contributions to policy and regulation, and finally offers suggestions for new policy-oriented research initiatives.

The AFF sector differs markedly from most other industry sectors in which fixed-worksite "brick and mortar" facilities are the norm. First, because the AFF sector is based on production from natural resources, there are millions of individual worksites to consider: crop and livestock fields scattered throughout the nation,

vast forests, and seemingly endless open waters. Second, most of the more than 1 million businesses engaged in this sector are small, family-operated enterprises, a great many of which are part-time businesses or active only on a seasonal basis. Third, only businesses directly engaged in or producing commodities for interstate commerce have traditionally been subject to federal regulation owing to significant constitutional questions regarding federal jurisdiction. Finally, many, if not a majority, of the estimated several million people working as hired laborers in the AFF sector today are immigrants who are not authorized for employment in the United States, and this greatly complicates surveillance and arguably weakens a regulatory system based on self-reported complaints. Although the current number of hired farm workers is not accurately known, as of 1992 it was authoritatively estimated to be 2.5 million (U.S. Commission on Agricultural Workers, 1992).

It is important to note that federal policy regarding workplace safety and health in most industry sectors, including AFF, was relatively limited until enactment of the Occupational Safety and Health Act of 1970 (29 USC 651-678). That statute mandated establishment of the Occupational Safety and Health Administration (OSHA), a regulatory agency, and NIOSH, an independent research agency. The law explicitly directed NIOSH to conduct research, directly or through grants or contracts, related to occupational safety and health. It was expected that NIOSH, among its principal activities, would provide independent research to inform OSHA's regulatory decisionmaking.

Later, Congress intervened to weaken the original law, exempting "small farms" from OSHA *and* NIOSH jurisdiction. Specifically, the annual farming appropriations rider states that "none of the funds appropriated under this paragraph [OSHA funds] shall be obligated or expended to prescribe, issue, administer, or enforce any standard, rule, or order under the Occupational Safety and Health Act of 1970 which is applicable to any person who is engaged in a farming operation which does not maintain a temporary labor camp and employs ten or fewer employees."

The pattern of explicitly exempting large portions of AFF industries from federal laws that govern all other industries has a long history. The National Labor Relations Act of 1935 (29 USC 151-169), which affirms the right of most U.S. workers to engage in concerted action on their own behalf through organizations of their choosing, *does not apply* to any person employed as a hired farm laborer.

Federal governance of workplace conditions was first delineated by the Fair Labor Standards Act of 1938 (FLSA, 29 USC 201-219), which addresses such important occupational safety issues as child labor, wages and hours of work, and appropriate ages for operating hazardous machinery.[1] In general, "all employees of a farm are covered under the FLSA on an enterprise basis if the annual gross

[1]See 29 CFR Parts 500-870; *http://www.dol.gov/dol/allcfr/ESA/Title_29/Chapter_V.htm.*

volume of sales made or business done by the enterprise that owns the farm is not less than $500,000 . . . and the enterprise employs workers engaged in commerce, or the production of goods for commerce" (DOL, 2004).

Roughly one-fourth of U.S. farms (27 percent) directly hire farm laborers, but only one-ninth (11 percent) of farms with hired-labor expenses (60,646 of 554,434 farms) had cash receipts from the sale of agricultural commodities amounting to $500,000 or more in 2002 (USDA, 2004). An additional but unknown number of farm operators rely on indirectly hired farm laborers, described as contract labor, usually through a labor-market intermediary, such as a farm labor contractor. Thus, at least 89 percent of farms with hired or contract laborers are exempted from FLSA regulation by the farm-sales size limitation. However, farms subject to federal regulation account for over two-thirds (71 percent) of all direct-hire farm-labor payroll. It is not known what fraction of all hired and contract laborers are employed on farms that are exempted.

Much of the basis of exempting smaller-scale farming businesses from FLSA and OSHA regulation was originally motivated by an interest among policymakers not to unduly burden farms that were, at least in 1938, the major source of American food production. But the dominance of American agriculture by small farms has long since passed. According to the 2002 Census of Agriculture, if all farms are ranked in descending order by size of cash receipts from sales of agricultural commodities, the largest 6.7 percent of all American farms accounted for 75 percent of all farm sales. The 1987 Census of Agriculture reported that the largest 13.3 percent of all farms accounted for 75 percent of farm sales. Thus, size concentration in American agriculture has roughly doubled in just 15 years. Clearly, small farms have become less and less important.

STATUTORY EXEMPTIONS OF CHILD LABOR FROM THE FAIR LABOR STANDARDS ACT

Despite the clear delineation of which farms are subject to federal regulation, there are numerous additional statutory exemptions of various categories of hired farm workers from the protections of the FLSA (DOL, 2007a). Exemptions from the FLSA for agricultural workers include allowing children 14 and 15 years old to be employed for unlimited periods outside local school hours. Similarly, "minors who are at least 16 years of age may perform any farm job, including agricultural occupations declared hazardous by the Secretary of Labor, at any time, including during school hours" (DOL, 2007a).

Minors under 14 years old may also work in agriculture under any of the following statutory exemptions from the child labor provisions of the FLSA:

- Minors 12 and 13 years old may work outside school hours with written parental consent or on farms where parents are employed.
- Minors under 12 years old may work outside school hours with written parental consent on farms not subject to the minimum wage.
- Local minors 10 and 11 years old may work outside school hours under prescribed conditions to hand-harvest crops with short harvesting seasons for not more than 8 weeks from June 1 to October 15 on approval by the Secretary of Labor of an employer's application for a waiver from the child labor provisions for employment of such children.

As described in a special report on child labor in agriculture prepared by the General Accounting Office (GAO, now the Government Accountability Office) in response to a specific request from Congress (GAO, 1998),

> a 13-year-old may not, under federal law, be employed to perform clerical work in an office but may be employed to pick strawberries in a field. A 16-year-old may not operate a power saw or a forklift in a warehouse but may operate either on a farm. . . . Under current law, a 14-year-old hired to work in a retail establishment may work only between the hours of 7 a.m. and 7 p.m. (9 p.m. in the summer) and may not work more than 18 hours in a school week or 3 hours in a school day; the same child may work an unlimited number of hours picking grapes as long as he or she is not working during school hours.

The GAO report concludes, "children may work in agriculture in circumstances that would be illegal in other industries."

Some may be under the mistaken impression that those statutory exemptions apply only to children of farmers or ranchers. It was undoubtedly the case in 1938 when the FLSA was enacted that the exemptions were intended mostly to benefit family-operated farms, but small-scale family farms are no longer the major factor in agricultural production, as was the case 70 years ago. In fact, most children who work in agriculture today are hired laborers. The GAO report finds that an estimated 155,000 15- to 17-year-olds worked in agriculture in 1997, and 116,000 of these were hired farm laborers; only 39,000 were self-employed and unpaid family workers (GAO, 1998).

EXEMPTIONS OF HIRED FARM LABOR FROM OVERTIME AND MINIMUM-WAGE RULES

Under the FLSA, employers are generally required to compensate workers at no less than 1.5 times the regular pay rate for any employment in any workweek after

40 hours. But the entitlement to receive overtime compensation *does not apply* to any worker employed in farming or to employees engaged in the transportation or preparation for transportation of fruits and vegetables from the farm to the place of first processing or first marketing within the same state. Also exempted from the overtime regulation are irrigators (often, irrigators in many western states are obliged by their employers to keep a round-the-clock watch during the period when water is delivered from a ditch or canal to a particular farm property).[2]

The FLSA also established a federal minimum wage rate. But only farm operators who used 500 worker-days or more of agricultural labor during any calendar quarter of the preceding calendar year are subject to the federal minimum wage provision unless their employees are otherwise explicitly excluded by statute.

Examples of additional hired workers statutorily excluded from federal minimum wage protection include

- Local hand-harvest workers who are paid a piece rate and who worked fewer than 13 weeks in agriculture during the preceding calendar year.
- Members of the employer's immediate family.
- Migrant hand-harvest workers 16 years old and younger who are employed on the same farm as their parents, or persons standing in place of their parents, and who receive the same piece rates as employees more than 16 years old working on the same farm.
- Workers engaged mainly in the range production of livestock.

Finally, the so-called "youth minimum wage" allows payment of a subminimum wage of $4.25 to any worker under 20 years old during his or her first consecutive 90 calendar days of employment with an employer (at this writing, the federal minimum wage is $5.85) (DOL, 2007b). That provision applies to all industry sectors, but agriculture is the only sector that allows very young children to be employed at all.

SUPERSEDING OF FEDERAL LAWS BY STATE WORKPLACE LAWS

California was arguably the first state to enact law addressing unhealthful conditions among AFF workers. In 1915, in response to public outcry over horrific labor-camp conditions at a northern California farm and a violent confrontation between several thousand workers and sheriffs at the camp, known as the Wheatland Hop Riot of 1913, the California legislature enacted the Labor Camp

[2]FLSA, Sec. 13(b)(12).

Act, setting minimum sanitary standards that farmers and others must meet when housing their employees.

It is important that when a state law governing workplace conditions differs from a federal law, the law that provides more protection or a higher standard applies. Thus, contrary to the OSHA small-farm exemption, California law does not exempt farms with 10 or fewer workers from occupational safety regulation by the California Division of Occupational Safety and Health (known as Cal/OSHA). Similarly, young child workers in the state are required to present prospective employers with currently valid work permits, signed by both local school authorities and a parent, to be eligible for employment. And California's state minimum wage, $7.50 per hour at this writing and scheduled to increase to $8.00 per hour on January 1, 2008, is applicable to all hired workers, including those employed on farms.

In contrast, California law regarding overtime pay in agriculture, although stricter than the federal provision excluding farm laborers, specifies compensation at 1.5 times the regular pay rate only on the seventh day after six consecutive 10-hour days of work. Virtually all other workers in California qualify for overtime pay after 8 hours of work on any day.

A comprehensive summary of federal and state laws governing hired farm workers was published in 1988 (Craddock, 1988). A number of new laws and regulations affecting farm labor workplaces in recent years make portions of that review outdated. There is no comparable review of law and regulation governing the forestry and fishing industries.

OTHER FEDERAL LAWS GOVERNING WORKPLACE CONDITIONS IN THE AGRICULTURE, FORESTRY, AND FISHING SECTOR

A number of other federal laws that govern workplace conditions authorize additional agencies to maintain compliance oversight of some AFF worksites. The U.S. Environmental Protection Agency, under the federal Worker Protection Standard, is responsible for ensuring safe workplace conditions when dangerous pesticides are mixed, loaded, or applied. The Migrant and Seasonal Agricultural Worker Protection Act (MSAWPA) authorizes the Department of Labor (DOL) to promote and enforce regulations covering a variety of workplace conditions, including transportation to and from work that is provided by farm employers or their agents, farm labor housing provided by farm employers or their agents, registration of farm labor contractors and their agents, and notice to workers of their rights and responsibilities under U.S. law.[3]

[3]Cf. 29 CFR Parts 500-501.

There may be some misunderstanding among NIOSH staff on this point inasmuch as the evidence package presented to the present committee states that the MSAWPA "provides that employment-related protection for migrant and seasonal agricultural workers is administered and enforced by the DOL Employment Standards Administration." In fact, the Wage and Hour Division of DOL's Employment Standards Administration has responsibility for enforcement of the FLSA provisions pertaining to agriculture for *all hired farm workers* (except those exempted by statute), not just those deemed "migrant and seasonal" under the MSAWPA.

The committee noted some additional possible misunderstandings regarding hired workers in the AFF sector. In discussions of child workers, AFF program descriptions consistently refer to children and adolescents under the age of 20 years with respect to both farm residents and youths performing work on farms. But *child labor* refers exclusively to children, legally known as "minors", that is, persons under 18 years old.

Another possible misunderstanding concerns enforcement of occupational safety regulations. The evidence package states, "OSHA lacks authority for most of the agricultural workforce since much of that workforce 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."[4] But FLSA statutory exemptions govern child labor on all farms, not only those on small farms. In some important farm states, such as California, OSHA has delegated regulatory authority to a state agency, in this case Cal/OSHA, which under state law authorizes inspections on all farms that employ hired workers, not only those employing more than 10 workers.

A more serious misunderstanding concerns the statement in the evidence package regarding the FLSA: "The Federal Fair Labor Standards Act applies to migrants and local residents regardless of farm size or the number of person-days of farm labor used on that farm. However, these standards do not apply to youth working on family farming operations."[5] Neither statement is true as written.

The AFF evidence package inappropriately makes the general statement that "regulating at the State level has been ineffective."[6] That is not true in California, Washington, and possibly other states. In fact, some would argue that state regulation in California and Washington is far more effective than federal regulation in states where only federal OSHA law applies.

Finally, a sweeping statement is made about the availability of data from workers' compensation insurance programs that is simply misleading: "Most farmers, ranchers, fishermen and agricultural workers are not covered by workers'

[4]NIOSH Evidence Package, p. 34.
[5]NIOSH Evidence Package, p. 67.
[6]Ibid, p. 68.

compensation insurance programs or are 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."[7] The situation is actually more nuanced than those statements in the evidence package suggest. California workers' compensation insurance data have been widely and successfully used for all the purposes mentioned (Villarejo, 1997).

FISHING AND FORESTRY-INDUSTRY WORKERS

Fishermen are subject to both OSHA and FLSA laws, with some statutory exemptions noted below. The entire industry is also subject to regulation under the Commercial Fishing Industry Vessel Safety Act of 1988 (CFIVSA, 46 USC Chapter 45), the first federal safety law to address the numerous occupational hazards in that industry.[8] The U.S. Coast Guard (USCG) has responsibility for enforcement of the CFIVSA but only to the extent that regulations have been promulgated. USCG has published an excellent summary of the regulations with a comprehensive list of citations to the applicable CFR standards (U.S. Coast Guard, 2001). Maritime-safety regulation governs dockside vessels and land-based fishermen, such as longshoremen and shipyard workers.[9]

OSHA has jurisdiction over fishing vessels within state territorial waters where USCG has not issued regulations. The general industry standards of the OSHA act apply to commercial fishing vessels.[10] In addition, OSHA jurisdiction applies to all vessels involved in longshoring operations, whether vessel to shore or vessel to vessel. But USCG is the lead federal agency on the water: its regulations preempt OSHA's.

The list of agencies with authority over one or another aspect of commercial fishing activities is long. Some fishing vessels also process their catch onboard while at sea, and this triggers regulation under the authority of the Food and Drug Administration. The U.S. Environmental Protection Agency governs the relationship between commercial fishing activities and their impact on the environment. A knowledgeable safety professional, responsible for a large commercial fishing operation, informed the committee that he could recall having representatives of four agencies onboard a 120-ft fishing vessel at one time.

Because OSHA and USCG have distinct responsibilities for vessel safety under different federal laws, separate shipboard inspections by each agency may allow some unsafe practices to be unintentionally overlooked. For example, during a

[7]Ibid, p. 68.
[8]Cf. 46 CFR Part 28.
[9]Cf. 29 CFR Parts 1915-1919.
[10]Cf. 29 CFR Part 1910.

compliance visit on a vessel, OSHA inspectors do not determine whether life rafts conform to CFIVSA regulations, which are subject to USCG authority, but will examine such issues as matters of fall-protection safety.

A complex set of occupational safety standards apply to the fishing industry, reflecting in part, the large variance in types of commercial fishing vessels. Regulations regarding specific types of lifesaving and other equipment, training, and workplace protective standards are determined by a vessel's size or the number of onboard personnel. Thus, shorter vessels or those carrying few workers are not held to the same standard as larger vessels with more workers.

Commercial fishing boat and diving operations with 10 or fewer employees have been exempted from OSHA safety inspections, as in agriculture, by an annual appropriations rider in Congress (Noll, 1994). Also statutorily exempt from the FLSA minimum wage requirement is "any employee employed in the catching, taking, propagating, harvesting, cultivating, or farming of any kind of fish, shellfish, crustacea, sponges, seaweeds, or other aquatic forms of animal and vegetable life, or in the first processing, canning or packing such marine products at sea as an incident to, or in conjunction with, such fishing operations, including the going to and returning from work and loading and unloading when performed by any such employee . . . "[11]

Forestry industry workers are subject to the OSHA act[12] and the FLSA. But forestry and logging workers employed by a firm with eight or fewer employees are exempt by statute from the overtime pay requirements of the FLSA.[13] States with major logging industries also have substantial regulatory and oversight responsibilities, as approved under agreement with OSHA. A number of states—for example, Idaho, Oregon, and Washington—have developed their own safety standards for forestry and logging workers. In fact, Oregon's logging code was established well before enactment of the OSHA act in 1970.

An unusual aspect of forest work is the contracting of some activities by private-sector employers and the USDA Forest Service to labor contractors. The employer of record in such a circumstance is often a very small business with small assets, if any. The vastness of forest activities makes it difficult to regulate or provide timely oversight of them. Many of the tasks performed by the workers are identical with agricultural tasks: planting, thinning, and weeding. MSAWPA regulation therefore applies to contract forest workers.

[11]FLSA, Sec. 13(a)(5).
[12]Cf. 29 CFR Part 1910.266.
[13]FLSA, Sec. 13(b)(28).

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