Injury and Illness Surveillance of U.S. Agricultural Workers

Assessment of Recommendations and Actions

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Preface

The Agriculture, Forestry and Fishing (AgFF) Program of the National Institute for Occupational Safety and Health (NIOSH) has a long history of occupational injury and illness surveillance among U.S. agricultural workers. In 2012, an independent panel review of the AgFF Program was conducted for the period 2006–2011. The panel review highlighted many program accomplishments, and it offered recommendations for improving surveillance but little guidance about how to prioritize and achieve the recommendations. In 2015, NIOSH entered into a contract with the RAND Corporation to identify, assess, and prioritize actions available to the AgFF Program for responding to the recommendations contained in the review report. This is the final report intended for NIOSH and its agricultural surveillance partners. The report describes the actions that could be taken to address panel recommendations directly related to surveillance and assesses the overall achievability of each action, based on criteria relating to feasibility and desirability.

The research reported here was conducted in the RAND Infrastructure Resilience and Environmental Policy program, which performs analyses on urbanization and other stresses. This includes research on infrastructure development, infrastructure financing, energy policy, urban planning and the role of public-private partnerships, transportation policy, climate response, mitigation and adaptation, environmental sustainability, and water resource management and coastal protection. Program research is supported by government agencies, foundations, and the private sector. This program is part of RAND Justice, Infrastructure, and Environment, a division of the RAND Corporation dedicated to improving policy- and decisionmaking in a wide range of policy domains, including civil and criminal justice, infrastructure protection and homeland security, transportation and energy policy, and environmental and natural resource policy. Questions or comments about this report should be sent to the project leader, Ramya Chari (Ramya_Chari@rand.org). For more information about RAND Infrastructure Resilience and Environmental Policy, see www.rand.org/jie/irep or contact the director at irep@rand.org.

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Summary

Agriculture remains one of America's oldest and most valued industries, but it is also one of the most hazardous. According to the Bureau of Labor Statistics (BLS) Survey of Occupational Injuries and Illnesses, in 2015, almost 36,000 farmworkers experienced an injury event (5.8 per 100 full-time workers).[1] An estimated 1,900 farmworkers suffered an illness event (31.8 per 10,000 full-time workers). These rates were higher than those experienced by workers in other hazardous occupations, such as fishing and hunting (4.2 injuries per 100 full-time workers), forestry and logging (2.2 injuries per 100 full-time workers and 5.6 illnesses per 10,000 full-time workers), mining (1.4 injuries per 100 full-time workers and 7.5 illnesses per 10,000 full-time workers), and construction (3.4 injuries per 100 full-time workers and 8.6 illnesses per 10,000 full-time workers).[2] In addition, about 400 fatalities (8.3 percent of total deaths across all industries)[3] occurred while working on farms, compared with 23 (0.5 percent) and 120 (2.5 percent) fatalities in fishing and hunting and mining worker populations, respectively.[4] Children working on farms are a particularly vulnerable population for agriculture-related illness, injury, and death. In 2012, an estimated 7,780 household youth experienced injuries on farms.[5] These statistics reveal a stark reality: The small population of workers directly responsible for feeding, clothing, and fueling the nation are shouldering a heavy public health burden.

The National Institute for Occupational Safety and Health's (NIOSH's) Agriculture, Forestry and Fishing (AgFF) Program provides leadership to prevent harm to workers in the three named sectors.[6] Since its inception, the AgFF Program has spearheaded numerous surveillance initiatives to understand the magnitude of injuries and illnesses in agricultural worker populations, identify vulnerable groups, and evaluate the effectiveness of interventions. In 2012, the program underwent a review from an independent panel convened to evaluate progress in pro-

[1] BLS, "Industry Injury and Illness Data," web page, last updated May 10, 2017 (see the SNR05, SNR08, and SNR10 summary news release tables).

[2] BLS, "Industry Injury and Illness Data," web page, last updated May 10, 2017 (see the SNR05, SNR08, and SNR10 summary news release tables).

[3] All industries include private-sector wage and salary workers, government workers, and self-employed workers (excluding farms with fewer than 11 employees).

[4] BLS, "2015 Census of Fatal Occupational Injuries (CFOI): Current and Revised Data," web page, last updated June 23, 2017 (see the Excel files "Industry by Event or Exposure, 2015" and "Industry by Private Sector, Government Workers, and Self-Employed Workers, 2015").

[5] National Children's Center for Rural and Agricultural Health and Safety, "2014 Fact Sheet: Childhood Agricultural Injuries in the U.S.," Marshfield, Wisc., 2014.

[6] NIOSH, "Agriculture, Forestry, and Fishing," web page, last updated July 11, 2017.

gram relevance and impact.[7] The panel report included several recommendations for NIOSH to improve agricultural injury and illness surveillance. In certain instances, the panel suggested specific activities to perform to improve surveillance, include vulnerable populations, and extend NIOSH research to address emerging health issues faced by farmworkers. However, the panel report itself was unclear regarding how NIOSH should prioritize recommendations and actually implement activities. In 2015, NIOSH contracted with the RAND Corporation to assess options for action in response to panel recommendations. The goal of this report is to provide NIOSH with an assessment of the feasibility and desirability of carrying out actions to meet surveillance-related recommendations given current AgFF Program resources and priorities.

Many possible actions for meeting recommendations were contained in the panel report, and we conducted literature reviews and targeted interviews to detail how actions could be implemented and identify barriers to their achievement. Table S.1 describes the surveillance-related recommendations and actions. For each action, we determined whether it could be achieved through (1) an extramural funding mechanism, (2) partnership engagement or partner capabilities, and (3) direct action by NIOSH.

We also constructed two versions of actions achievable through an extramural funding mechanism: an ideal version and a satisfactory version. The ideal version refers to our estimation of the types of tasks and time frames needed to either fully achieve the action or ensure that implementation results in meaningful impacts on improvement of farmworker health and safety. The satisfactory version refers to tasks and time frames that may result in lesser (compared with the ideal), but still acceptable, impacts. Different costs and timelines were estimated based on the two versions.

We applied criteria to the actions that were relevant for assessing feasibility (costs and other resources, partnership engagement, information availability and accessibility, policy barriers, and timelines) and desirability (relevance to program priorities, information quality, and action impacts). For all criteria except costs and resources, we constructed an ordinal five-point rating scale based on defined attributes of the criterion relevant to the accomplishment of an action. Low values (1–2) reflected adverse or unfavorable conditions for an action, as contrasted with high values (4–5), which reflected favorable conditions for action achievement. Because we lacked information on planned allocation of resources within the AgFF Program, for the costs and resources criterion, we presented general estimates and a descriptive assessment of implications. For each action, we calculated average scores across criteria for three conditions: achievability (average of all feasibility and desirability criteria), feasibility (average of the feasibility criteria), and desirability (average of the desirability criteria).

Overall, we find that direct action and extramural funding mechanisms tend to show higher achievability and feasibility than do actions that depend on partner capabilities for implementation. Actions that depend on partner engagement, resources, or capabilities may have lengthier timelines for establishing or building partnerships and negotiating agreements (including data use and data-sharing). In addition, there is uncertainty about the availability and accessibility of information that could be obtained through such partnerships. When we focused on desirability, however, the results are more mixed. Top actions are associated with all three implementation mechanisms.

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[7] NIOSH, *Comments on the Agriculture, Forestry, and Fishing (AgFF) National Research Program Sponsored by the National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC)*, Washington, D.C., June 2012.

Table S.1
Surveillance-Related Recommendations and Actions Inferred from the 2012 Review Report

Recommendation	Action
R1: Develop standard definitions to help improve knowledge and understanding of populations at risk of worksite exposures	1.1: Develop concise definitions of populations at occupational exposure risk, and profile them by agriculture commodity specialization, demographic factors, work organization patterns, worksite tasks across various enterprise types, and knowledge or use of emerging technologies.
R2: Focus surveillance efforts on very large and nonfamily farms	2.1: Conduct an assessment of data sources for providing information on very large farms and nonfamily farms.
R3: Expand the scope of knowledge on hired farmworker risk for occupational illness and injury	3.1: Collaborate with the National Agricultural Worker's Survey to field supplementary modules on occupational health outcomes among hired farmworkers and perform specific analyses on variability of risk.
R4: Improve surveillance coverage and knowledge of child agricultural worker populations	4.1: Improve the validity of the Childhood Agricultural Injury Survey by extending the sample to include labor aggregators. 4.2: Collaborate with the National Agricultural Worker's Survey to field a supplementary module targeted at children who work as hired farmworkers on crop farms.
R5: Establish a comprehensive understanding of data sources relevant to NIOSH agricultural surveillance-related programming	5.1: Reevaluate the surveillance mechanisms of USDA's NASS surveys for usefulness in NIOSH activities. 5.2: Identify and evaluate the potential of existing data sources (including those currently or recently used by NIOSH) for illness and injury surveillance of agricultural workers.
R6: Reconsider analytical and reporting approaches for conveying child agricultural worker safety and health risks	6.1: Identify feasible, desirable alternatives to five-year age groupings for child agricultural workers (<18 years old). 6.2: Stratify data pertaining to children into at least three divisions: those employed within agricultural enterprises, those self-employed, and unpaid family workers contributing effort within agricultural enterprises.
R7: Identify context in reports and analyses authored by NIOSH or regional centers	7.1: When reporting on surveillance activities, NIOSH and Ag Centers should provide information on agricultural enterprises, known operational worksite characteristics, and other useful descriptors that provide context for understanding occupational cohorts at risk.
R8: Address emerging issues in animal agricultural production practices	8.1: Establish partnerships to monitor zoonotic diseases in animal and human populations. 8.2: The National Children's Center should monitor developments in alternative animal production systems and develop guidelines for children and youth workers within these systems.

NOTE: Ag Center = Agricultural Safety and Health Center; NASS = National Agriculture Statistics Service; USDA = U.S. Department of Agriculture.

To prioritize actions, we first excluded actions achievable through direct action. These actions all revolve around NIOSH performing new analyses or issuing new reports with existing data; NIOSH AgFF Program leadership indicated that, given resource constraints, these kinds of activities would only be done on an as-needed basis or on request. Because NIOSH already has a plan for addressing these actions, we performed a ranking exercise to determine the relative achievability, feasibility, and desirability of the remaining actions. Table S.2 presents the average criteria rating scores ranked by average achievability score. The table also displays estimated action costs per year and proposed duration. Based on these rankings, we determined the following action categories:

- **high priority** (high and moderate scores in combination): 1.1, 5.2
- **moderate priority** (moderate scores on both or high/low combination): 3.1, 4.1
- **low priority** (low on both feasibility and desirability scores): 4.2, 8.1, 8.2.

Table S.2
Average Criteria Rating Scores for Actions (excluding the direct action mechanism)

Action	Mechanism	Cost per Year[a]	Duration (years)	Achievability Score	Feasibility Score	Desirability Score
1.1: Develop definitions and taxonomy	EXF	$150K	1	4.00	4.20	3.67
		$170K	1			
5.2: Evaluate sources of surveillance data	EXF	$175K	2	4.00	3.60	4.67
		$160K	5			
3.1: Field the National Agricultural Worker's Survey and hired worker survey	PART	$330K	3	3.88	3.40	4.67
4.1: Improve validity of the Childhood Agricultural Injury Survey	PART	$1 million	1	3.50	3.20	4.00
8.2: Monitor alternative animal production systems through the National Children's Center	PART	$175K	2	3.38	3.20	3.67
		$170K	3			
4.2: Field the National Agricultural Worker's Survey and child injury survey	PART	$330K	6	3.13	3.00	3.33
8.1: Partner for zoonotic disease	PART	Unknown	Uncertain	3.13	3.00	3.33

NOTE: EXF = extramural funding; PART = partnership.

[a] The two costs reflect the satisfactory version of an action (upper row) and the ideal (lower row).

The results of our assessment suggest that NIOSH should prioritize two actions based on their feasibility and desirability:

- **1.1:** Develop concise definitions of populations at occupational exposure risk, and profile them by AgFF commodity specialization, demographic factors, work organization patterns, worksite tasks across various enterprise types, and knowledge or use of emerging technologies.
- **5.2:** Identify and evaluate the potential of existing data sources (including those currently or recently used by NIOSH) for illness and injury surveillance of agricultural workers (includes actions 2.1 and 5.1).

When estimated total costs are factored into the assessment, action 1.1 exhibits better overall value, but we note that action 5.2 is considered highly desirable. Action 1.1, however, falls on the lower end of the cost spectrum while also exhibiting high feasibility and moderate desirability. Both actions are achievable through extramural funding mechanisms, including contracts, cooperative agreements, or grants. For action 5.2, our assessment suggests that cooperative agreements would allow for strong collaboration between NIOSH and research partners while also offering flexibility to carry out complex projects that may yield unexpected findings. We considered action 1.1, however, to be well suited to a contract mechanism because it is a clearly defined project that could be carried out in a relatively short time frame.

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Abbreviations

Ag Center	Agricultural Safety and Health Center
AgFF	Agriculture, Forestry and Fishing
BLS	Bureau of Labor Statistics
CAIS	Child Agriculture Injury Survey
CDC	Centers for Disease Control and Prevention
CIPSEA	Confidential Information Protection and Statistical Efficiency Act
CWCS	Center for Workers' Compensation Studies
DOL	Department of Labor
EPA	Environmental Protection Agency
ETA	Employment and Training Administration
FLSA	Fair Labor Standards Act
FOA	funding opportunity announcement
FY	fiscal year
GCFI	gross cash farm income
GDP	gross domestic product
IPPC	International Plant Protection Convention
NASS	National Agricultural Statistics Service
NAWS	National Agricultural Workers' Survey
NCC	National Children's Center
NCEZID	National Center for Emerging and Zoonotic Infectious Diseases
NIOSH	National Institute for Occupational Safety and Health
NORA	National Occupational Research Agenda

OIE	World Organization for Animal Health
OISPA	Occupational Injury Surveillance of Production Agriculture
OSHA	Occupational Safety and Health Administration
SENSOR	Sentinel Event Notification System for Occupational Risk
SOII	Survey of Occupational Injuries and Illnesses
USDA	U.S. Department of Agriculture

CHAPTER ONE

Introduction and Project Background

Agriculture remains one of America's oldest and most valued industries, forming the bedrock of many state and regional economies. Through the production of food and fiber, agriculture and agriculture-related industries have contributed more than $800 billion annually to the U.S. gross domestic product (GDP) in the last few years.[1] Farms alone contributed almost $200 billion of the total sum each year. According to the 2012 Census of Agriculture carried out by the U.S. Department of Agriculture (USDA), there are an estimated 2.1 million farms currently in operation, and these farms employ about 2.6 million workers (defined as sole proprietor, partner, or hired laborer).[2] The number of farms in the United States has declined since peaking in the mid-1930s at 6.8 million; perhaps more strikingly, the percentage of the U.S. labor force working on farms has markedly diminished.[3] In recent years, however, the employment of hired farm labor has shown some stability, hovering at 1 million workers (with some fluctuations).[4]

Although the number of farms and agricultural workers has declined, the agricultural sector continues to rank among the most hazardous industries nationally, with farmworkers experiencing high rates of fatal and nonfatal injuries and illnesses. According to the Bureau of Labor Statistics (BLS) Survey of Occupational Injuries and Illnesses (SOII), in 2015, almost 36,000 farmworkers engaged in animal and crop production experienced an injury event (5.8 per 100 full-time workers).[5] An estimated 1,900 farmworkers suffered an illness event (31.8 per 10,000 full-time workers). These rates were higher than those experienced by workers in other known hazardous occupations, such as fishing and hunting (4.2 injuries per 100 full-time workers), forestry and logging (2.2 injuries per 100 full-time workers and 5.6 illnesses per 10,000 full-time workers), mining (1.4 injuries per 100 full-time workers and 7.5 illnesses per 10,000 full-time workers), and construction (3.4 injuries per 100 full-time workers and 8.6

[1] U.S. Department of Agriculture (USDA), "Ag and Food Statistics: Charting the Essentials; Ag and Food Sectors and the Economy," web page, last updated May 5, 2017.

[2] USDA, "Ag and Food Statistics: Charting the Essentials; Farming and Farm Income," web page, last updated August 30, 2017; Bureau of Economic Analysis, "Regional Data: Annual State Personal Income and Employment; Full-Time and Part-Time Wage and Salary Employment by Industry (SA27, SA27N)," web page, undated.

[3] USDA, "Ag and Food Statistics: Charting the Essentials; Farming and Farm Income," web page, last updated August 30, 2017; USDA, "Trends in U.S. Agriculture," web page, last updated April 18, 2017.

[4] Thomas Hertz, "Hired Farm Labor Held Steady in Great Recession," U.S. Department of Agriculture, December 1, 2011; USDA, "Farm Labor: Background," web page, last updated September 27, 2016.

[5] BLS, "Industry Injury and Illness Data," web page, last updated May 10, 2017 (see the SNR05, SNR08, and SNR10 summary news release tables).

illnesses per 10,000 full-time workers).[6] In addition, about 400 fatalities (8.3 percent of total deaths across all industries)[7] occurred while working on farms, compared with 23 (0.5 percent) fatalities in fishing and hunting and 120 (2.5 percent) in mining worker populations.[8]

While concerning, these numbers for agricultural workers are likely an undercount, because the SOII excludes farms with fewer than 11 employees.[9] And although U.S. agriculture has been trending toward regionalization and consolidation of small farms into large production entities, small family farms still compose the vast majority of farms in the nation.[10] Children (under the age of 18) working on these farms are a particularly vulnerable population for agriculture-related illness, injury, and death. In 2012, an estimated 7,780 household youth experienced injuries on farms.[11] These statistics reveal a stark reality: The small population of workers directly responsible for feeding, clothing, and fueling the entire nation are shouldering a heavy public health burden.

The Role of the National Institute for Occupational Safety and Health in Agricultural Injury and Illness Surveillance

Some of the agricultural injury, illness, and fatality statistics cited above are the outputs of large and sophisticated data collection efforts carried out on a national scale to enumerate the extent of injuries and illnesses in agricultural worker populations. These efforts represent a form of public health surveillance, defined by the World Health Organization as "the continuous, systematic collection, analysis and interpretation of health-related data needed for the planning, implementation, and evaluation of public health practice."[12] More specifically, occupational health surveillance is defined by the National Institute for Occupational Safety and Health (NIOSH) as the tracking of "work-related injuries, illnesses, hazards, deaths, and exposures [to] guide efforts to improve worker safety and health, and to monitor trends and progress over time."[13] Surveillance can thus be considered the cornerstone of occupational health and safety, allowing for a number of critical activities, including (1) estimating the magnitude of a problem and characterizing the populations affected; (2) identifying vulnerable populations with unique health and safety risks or new and emerging health concerns; (3) monitoring and detecting changes in health or exposure status over time; (4) evaluating the effect of interventions or changes to programs, policies, and practices on worker safety and health; and (5) pro-

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6 BLS, "Industry Injury and Illness Data," web page, last updated May 10, 2017 (see the SNR05, SNR08, and SNR10 summary news release tables).

7 All industries include private-sector wage and salary workers, government workers, and self-employed workers (excluding farms with fewer than 11 employees).

8 BLS, "2015 Census of Fatal Occupational Injuries (CFOI): Current and Revised Data," web page, last updated June 23, 2017 (see the Excel files "Industry by Event or Exposure, 2015" and "Industry by Private Sector, Government Workers, and Self-Employed Workers, 2015").

9 BLS, "Occupational Safety and Health Statistics," in *Handbook of Methods*, Washington, D.C., 2012.

10 USDA, *Family Farms: 2012 Census of Agriculture Highlights*, Washington, D.C., 2015.

11 National Children's Center (NCC) for Rural and Agricultural Health and Safety, "2014 Fact Sheet: Childhood Agricultural Injuries in the U.S.," Marshfield, Wisc., 2014.

12 World Health Organization, "Public Health Surveillance," web page, undated.

13 NIOSH, "Worker Health Surveillance," web page, last updated June 26, 2017.

viding direction for future research.[14] Without surveillance data, decisionmakers, practitioners, advocates, and researchers would lack an evidence-based foundation for developing or choosing among actions to reduce injury, illness, and death.

Agriculture-Related Programs and Surveillance Activities at NIOSH

The mission of NIOSH, established by the Occupational Safety and Health Act of 1970, is "to develop new knowledge in the field of occupational safety and health and to transfer that knowledge into practice."[15] NIOSH sums up its vision in three words: *safer*, *healthier*, *workers*. The institute is housed within the U.S. Centers for Disease Control and Prevention (CDC), within the U.S. Department of Health and Human Services. NIOSH is not a regulatory agency; the institute's major goals are to gather data, conduct research, and promote the translation of research to practice.

The NIOSH Office of Agriculture Safety and Health coordinates the Agriculture, Forestry and Fishing (AgFF) Program, which provides leadership to prevent work-related injuries and illnesses among workers engaged in the named sectors.[16] Concerned by the high rates of injuries and illnesses in agricultural settings, in 1990, the U.S. Congress passed Public Law 101-517, which directed NIOSH to develop an agricultural safety and health program that covered surveillance, research, and intervention activities.[17] Today, the AgFF Program covers a diverse set of safety and health risks across three industry sectors that represent a broad range of geographic areas, production characteristics, and worker demographics. While the three industries (agriculture, forestry, and fishing) all suffer from high rates of worker injury and illness, agriculture is the largest sector, by far, in terms of employment and economic output and is the focus of this report.[18]

The AgFF Program has gathered surveillance data through a number of different mechanisms since its inception (see Table 1.1). Early initiatives included a survey of the health of farm families and farm hazards and an active surveillance program carried out through community-based occupational health nurses.[19] As the AgFF Program grew, NIOSH pursued interagency agreements with federal agencies, such as USDA and the Department of Labor (DOL), to collect farmworker injury data through existing national surveys. The intended purpose of these surveys, which include surveys conducted in cooperation with the USDA National Agricultural Statistics Service (NASS) and the DOL National Agricultural Workers' Survey (NAWS), is to characterize the demographics, economics, employment, or production features of the nation's farms.[20] NIOSH also provides technical support and cooperative agreement funding

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[14] Centers for Disease Control and Prevention (CDC), *CDC's Vision for Public Health Surveillance in the 21st Century*, Atlanta, Ga., Morbidity and Mortality Weekly Report, July 27, 2012; NIOSH, "Worker Health Surveillance," web page, last updated June 26, 2017.

[15] NIOSH, "About NIOSH," web page, last updated June 15, 2016.

[16] NIOSH, "Agriculture, Forestry, and Fishing," web page, updated July 11, 2017.

[17] Public Law 101-517, Departments of Labor, Health and Human Services, and Education, and Related Agencies Appropriations Act, 1991, November 5, 1990.

[18] Bureau of Economic Analysis, "Regional Data: Annual State Personal Income and Employment; Full-Time and Part-Time Wage and Salary Employment by Industry (SA27, SA27N)," web page, undated.

[19] NIOSH, *NIOSH Agriculture, Forestry, and Fishing Safety and Health Program: National Academies Review*, Washington, D.C., 2006.

[20] USDA, "Agency Overview," web page, last updated July 11, 2017; DOL, "The National Agricultural Workers Survey," 2015.

Table 1.1
Example Agricultural Injury and Illness Surveillance Activities Funded or Used by NIOSH

Surveillance Activity (coverage years)	Coverage Area	Description
Funded or supported by NIOSH		
Occupational health nurses in agricultural communities (1990–1996)	CA, GA, IA, KY, ME, MN, NY, NC, ND, OH	Active case-based surveillance of illnesses and injuries for farmers, farmworkers, and family members in rural areas, as well as workplace exposure and health risks
Community Partners for Healthy Farming Surveillance (1996–2000)	CA, IA, KY, ME, MN, NY, ND, OH, OR, WI	Extension of occupational health nurses in agricultural communities that included a greater population of hired farmworkers
Farm family health and hazard surveillance surveys (1994–2000)	CA, CO, IA, KY, OH, NY	Population-based data for farmers and families on disease, injury, workplace exposures, and risk factors
National Traumatic Occupational Fatality Surveillance System (1980–2001)	National	Occupational traumatic injury fatalities ascertained through death certificate reviews and counts of agriculture work-related fatal injuries
Traumatic Injury Surveillance of Farmers (1993–1997)	National, regional, state	Population-based nonfatal injury survey (NASS) focused on farmers and farmworkers for all farms, regardless of the number of employees
Occupational Injury Surveillance of Production Agriculture (2001, 2004, 2009, 2012, 2014)	National, regional	Population-based nonfatal injury survey (NASS) focused on adult farmers and farmworkers (≥20 years) on all farms
Minority Occupational Injury Surveillance of Production Agriculture (2003, 2008)	National, regional	Population-based injury survey (NASS) focused on adult farmers and farmworkers (≥20 years old) on minority-operated farms
Childhood Agriculture Injury Survey (1998, 2001, 2004, 2006, 2009, 2012, 2014)	National, regional	Population-based injury survey (NASS) focused on nonfatal injuries to children (<20 years old) living on, working on, or visiting farms
Minority Childhood Agriculture Injury Survey (2000, 2003, 2008)	National, regional	NASS-based survey on nonfatal injuries in children (<20 years old) living on, working on, or visiting minority-operated farms
NAWS (1999, 2002–2004, 2008–2010, 2014–2015)	National	Population-based nonfatal injury survey using NAWS, focused on hired workers on crop farms (≥14 years old)
SENSOR—Pesticides (1987–present)	CA, MI, FL, LA, NC, IA, NE, NM, NY, OR, TX, WA	State-level case-based surveillance of acute pesticide-related occupational illness and injury with demographic and exposure characteristics (partnership with EPA)
Consumer Product Safety Commission National Electronic Injury Surveillance System (1997–present)	National	Hospital emergency department surveillance system that includes agriculture work-related nonfatal injuries
State-Based Fatality Surveillance Using FACE Model (1992–present)	CA, KY, MA, MI, NY, OR, WA	Active surveillance of all external causes of agriculture work-related deaths, with evaluations of selected cases
Initiated or carried out by partners		
BLS SOII (1972–present)	National	Population-based survey of work-related nonfatal injuries and illnesses that covers farms with ≥11 employees
BLS Census of Fatal Occupational Injuries (1992–present)	National	Census of occupational traumatic deaths in the United States, including counts of agriculture work-related fatal injuries

NOTE: EPA = Environmental Protection Agency; FACE = Fatality Assessment and Control Evaluation.

to 12 states for acute occupational pesticide-related illness and injury surveillance through the Sentinel Event Notification System for Occupational Risk (SENSOR).[21] In addition to funding data collection efforts, NIOSH relies on injury and illness data gathered through such sources as the BLS's SOII and Census of Fatal Occupational Injuries and the U.S. Consumer Product Safety Commission's National Electronic Injury Surveillance System.

The AgFF Program has devoted specific resources and efforts to address the needs of vulnerable agricultural populations, such as children and minority farmworkers. Children, in particular, have long been a special concern for the program. Rules for youth employment under the federal Fair Labor Standards Act (FLSA) differ for agricultural versus nonagricultural operations.[22] In agriculture, outside school hours, the minimum age for youth employment is 12 years with parental permission (for all occupations except those declared hazardous by the Secretary of Labor), as compared with 14 and older for nonagriculture work.[23] Under the parental exemption clause of the FLSA, youth of any age may be employed in any occupation on a farm owned or operated by their parents (or people standing in place of their parents). State laws vary in the degree to which they place restrictions tighter than FLSA provisions. Of note, the exemption allowing children to engage in hazardous occupations on farms owned by a parent does not apply to nonagricultural industries. Through the early 1990s, stakeholder efforts to raise awareness of farm-related risks to children culminated in NIOSH establishing the National Childhood Agricultural Injury Prevention Initiative in 1996.[24] Through the initiative, the AgFF Program has supported a wide range of activities to decrease child injury rates, including improved child injury and illness surveillance.

In addition to initiatives for childhood injury, in 1996, NIOSH and its partners released the National Occupational Research Agenda (NORA), providing a road map for occupational safety and health research for the next decade.[25] In 2006, NORA moved to a sector-based structure whereby ten NORA sector councils would be responsible for setting agendas for their specific sectors. In 2008, the NORA AgFF Council published a national agenda that consisted of seven strategic goals, of which five were specific for agricultural health and safety: (1) improve surveillance, (2) reduce deleterious health and safety outcomes for vulnerable workers, (3) engage in outreach and partnership development to promote the adoption of health and safety strategies in workplaces, (4) reduce traumatic injuries and deaths from hazards of production agriculture, and (5) reduce occupational causes of acute and chronic illness.[26]

In many ways, the debut of NORA is considered the second phase of the AgFF Program, because NORA provided structured guidance for research needs moving forward. However, stakeholder partnerships to advance agricultural surveillance and other types of research had been an integral part of the program since its beginning. In 1991, NIOSH established four

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[21] NIOSH, "Pesticide Illness and Injury Surveillance," web page, last updated March 27, 2017.

[22] DOL, *Child Labor Requirements in Agricultural Occupations Under the Fair Labor Standards Act (Child Labor Bulletin 102)*, Washington, D.C., June 2007.

[23] DOL, "State Child Labor Laws Applicable to Agricultural Employment," web page, last updated January 1, 2017.

[24] NIOSH, "Childhood Agricultural Injury Prevention Initiative," web page, last updated April 10, 2017.

[25] NIOSH, "About NORA: Partnerships, Research and Practice," web page, last updated July 27, 2016.

[26] National Occupational Research Agenda Agricultural, Forestry, and Fishing Sector Council, *National Agriculture, Forestry, and Fishing Agenda: For Occupational Safety and Health Research and Practice in the U.S. Agriculture, Forestry, and Fishing Sector*, Washington, D.C.: National Institute for Occupational Safety and Health, December 2008.

regionally distributed university-based centers for agricultural disease and injury research, education, and prevention.

Today, there are ten Agricultural Safety and Health Centers (Ag Centers) operating through cooperative agreements, including the National Children's Center (NCC) for Rural and Agricultural Health and Safety.[27] Through the Ag Centers, NIOSH has grown regional capacity to address agricultural safety and health issues. As shown in Table 1.1, given the diversity of farming operations and agriculture occupations, numerous surveillance approaches have been conducted to try to capture different populations of interest. By leveraging the resources provided by university research structures, NIOSH has encouraged the testing and development of new surveillance approaches on a regional scale. Table 1.2 describes a selection of Ag Center surveillance-related projects.

Current and Future Surveillance Challenges

In carrying out its original mandate, the AgFF Program has demonstrated considerable success in bringing attention to the magnitude and severity of injuries and illnesses in farmworker populations, growing national and regional capacity for data collection and intervention development, and effecting meaningful change through education and the institution of safer work practices.[28] These successes have occurred in spite of the challenges that the program has faced over the years. We briefly highlight three areas that contribute to difficulties in establishing an effective surveillance program for agricultural injuries and illnesses: (1) the diversity of the agricultural industry itself; (2) changing injury and illness patterns because of economic, technological, and environmental trends; and (3) continual resource constraints that inhibit long-term coordination and strategic planning.

First, as noted by a 2008 National Academies' panel charged to review the AgFF Program, agricultural production is characterized by "extreme diversity."[29] The diversity is evident in (1) work environments (e.g., geography and climates in which production occurs; farm size; production volume and sales; ownership; production techniques, such as conventional or organic; and commodities and specialization, such as specific crop or livestock types), (2) individual worker characteristics (e.g., racial/ethnic background, immigration status, language, age, gender, prior experience, and skill level), (3) employment characteristics (e.g., hired or contract worker, self-employed, family or other nonpaid worker, and part-time or full-time status), and (4) the hazards and exposures associated with different production practices (e.g., technologies or machines used, types of manual operations, pesticide and chemicals applications, and worksite tasks). These differences are challenging: In addition to creating a comprehensive surveillance approach, they manifest in variations in certain regulatory requirements that can create complications for reporting and identifying vulnerable populations. For example, farms employing fewer than 11 workers are exempt from enforcement of safety and health regulations by the Occupational Safety and Health Administration (OSHA) under the Occupa-

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[27] NIOSH, "Centers for Agricultural Disease and Injury Research, Education, and Prevention," web page, last updated October 3, 2017.

[28] National Research Council and Institute of Medicine, *Agriculture, Forestry, and Fishing Research at NIOSH: Reviews of Research Programs of the National Institute for Occupational Safety and Health*, Washington, D.C.: The National Academies Press, 2008.

[29] NIOSH, "Centers for Agricultural Disease and Injury Research, Education, and Prevention," web page, last updated October 3, 2017.

Table 1.2
Example Surveillance Projects Conducted by the Ag Centers

Ag Center (project source)	Coverage Area	Project Description
NCC for Rural and Agricultural Health and Safety (ongoing) (http://www.marshfieldresearch.org/nccrahs/filling-gaps)	National	Title: Filling the Gaps. The current project explores the promise of existing public health surveillance systems and data sets for providing information on child health and safety in agricultural settings. The specific focus is to examine the utility of these systems for identifying injury events that may be missed by other means and for providing risk factor and other contextual data surrounding injury events.
Northeast Center (ongoing) (http://necenter.org/agriculture/past-research/)	NY	Title: Fatality Tracking, Death Certificates and News Clips. The project established an ongoing agriculture fatality tracking system based on an annual death certificate review. Title: EMS as a Data Source for Non-Fatal Farm Injuries. The project is testing an approach for tracking farm-related injuries and fatalities through EMS pre-hospital care reports and monthly telephone surveillance with county-level officials for supplemental data collection.
Northeast Center (ongoing) (http://necenter.org/agriculture/past-research/)	ME, NH, VT, NY, NJ, MD	Title: New Surveillance Strategy for Farming and Forestry Injury. The project assessed electronic administrative data sets for utility in identifying agricultural injuries and fatalities. The data sets included inpatient and emergency department records, pre-hospital care reports, and death certificates. In addition, electronic news sources were reviewed for their potential as a supplemental source of agricultural fatality reporting.
Great Plains Center for Agricultural Health (http://www.public-health.uiowa.edu/gpcah/center-projects/surveillance-of-agricultural-injuries-and-fatalities/)	IA, IL, IN, KS, MI, MN, MO, ND, NE, OH, SD, WI (fatalities); IA (nonfatal injuries)	Title: Surveillance of Agricultural Injuries and Fatalities. The projects included establishing an agreement with the BLS Census of Fatal Occupational Injuries for fatality data specific to 12 Midwestern states (2005–2012), analyses of the Iowa trauma registry to identify broad-level and specific trends in nonfatal agricultural injuries, and the assessment of newspaper clippings of agricultural fatalities and injuries as a potential data source.
Upper Midwest Agricultural Safety and Health (2012–present) (http://umash.umn.edu/portfolio/surveillance-of-disease-and-injury-in-wisconsin-dairy-farmers-and-workers/)	WI	Title: Surveillance of Disease and Injury in Wisconsin Dairy Farmers and Workers. The project is focused on establishing an active surveillance system for tracking injuries and illness among dairy farmers and workers through surveys linked to state and electronic health records. In addition, the project is assessing the use of natural language processing for automated data mining of electronic medical records to identify farmers.
Upper Midwest Agricultural Safety and Health (2012–present) (http://umash.umn.edu/portfolio/surveillance-for-zoonotic-diseases-in-agricultural-workers-in-minnesota/)	MN	Title: Surveillance for Zoonotic Diseases in Agricultural Workers in Minnesota. The project tracks infectious diseases to describe the frequency of zoonoses among agricultural workers, their families, and others who may be exposed to animal agricultural settings and identify risk factors for exposure or illness.
Central States Center for Agricultural Safety and Health (2012–present) (http://www.unmc.edu/publichealth/cscash/research/projects.html)	Central seven-state region (ND, SD, NE, KS, MN, IA, MO)	Title: Surveillance of Agricultural Injuries in the Central States Region. The project collaborates with NASS to conduct an annual agricultural injury survey that provides data on injury rates, worker characteristics, and risk factors. The project also includes tracking of fatal and nonfatal agricultural injuries through press clippings.

NOTE: EMS = emergency medical services.

tional Safety and Health Act of 1970, including mandatory injury reporting.[30] In addition, 16 states provide exemptions for agricultural labor from workers' compensation provisions (with the exact conditions of the exemptions varying by state).[31] These states are Alabama, Arkansas, Delaware, Georgia, Indiana, Kansas, Kentucky, Mississippi, Missouri, Nebraska, Nevada, New Mexico, North Dakota, South Carolina, Tennessee, and Texas. While the exemptions are concerning from a safety and health standpoint, they also decrease the utility of otherwise rich sources of occupational injury and illness data. For instance, the SOII is based on OSHA reporting and excludes farms with fewer than 11 employees.

Worker compensation data would similarly be limited in population coverage while also exhibiting considerable variability across states. The data limitations for small farms is a particular issue for agriculture: According to the latest estimates from the 2015 Farm Labor Survey, about 45 percent of the nation's farms employ fewer than 11 hired workers (this estimate does not include migrant, seasonal, or unpaid workers).[32] In addition, 88 percent of U.S. farms are classified as small family farms by USDA, meaning that they have gross cash farm income (GCFI) of less than $350,000.[9] While some proportion of the small family farms will have 11 or more employees, given that these farms constitute the vast majority of U.S. farms, we can surmise that a significant percentage will fall under OSHA injury reporting thresholds and may be missing from potential injury and illness data sources.

Second, the agricultural landscape of the United States has changed dramatically. Both the size of the agriculture workforce and the number of farm-related injuries have declined over the past century. In 1900, 41 percent of the U.S. workforce was employed in agriculture, compared with about 1 percent today.[33] In 2002, agricultural GDP as a share of total GDP was 0.7 percent, down from 7.7 percent in 1930.[34] Technological developments, along with increased mechanization, increased the efficiency of farm production while reducing labor demand. In addition, changing consumer preferences and market forces contributed to increased specialization and scale of farm operations, leading to the agricultural sector of today, where high-value production is concentrated on a small number of large, specialized farms.[35] Since 1900, the number of U.S. farms has decreased by 63 percent, while average farm size has increased by 67 percent (from 1900 to 2002).[36]

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[30] DOL, "Standard Interpretations: Standard Number 1928.21," letter from Richard E. Fairfax to Michael J. Frenzel, July 16, 2007.

[31] R. A. McEowen, "Workers' Compensation and the Exemption for Agricultural Labor," Center for Agricultural Law and Taxation, Iowa State University, July 24, 2015.

[32] USDA, "Farm Labor: Previous Releases; 2015," web page, undated.

[33] Carolyn Dimitri, Anne Effland, and Neilson Conklin, *The 20th Century Transformation of U.S. Agriculture and Farm Policy*, Washington, D.C.: U.S. Department of Agriculture, 2005.

[34] Carolyn Dimitri, Anne Effland, and Neilson Conklin, *The 20th Century Transformation of U.S. Agriculture and Farm Policy*, Washington, D.C.: U.S. Department of Agriculture, 2005.

[35] Carolyn Dimitri, Anne Effland, and Neilson Conklin, *The 20th Century Transformation of U.S. Agriculture and Farm Policy*, Washington, D.C.: U.S. Department of Agriculture, 2005; James M. MacDonald, Penni Korb, and Robert A. Hoppe, *Farm Size and the Organization of U.S. Crop Farming*, Washington, D.C.: U.S. Department of Agriculture, August 2013.

[36] Carolyn Dimitri, Anne Effland, and Neilson Conklin, *The 20th Century Transformation of U.S. Agriculture and Farm Policy*, Washington, D.C.: U.S. Department of Agriculture, 2005.

Along with changing economics, the agricultural industry has also witnessed declines in injuries and illnesses across child and adult worker populations. According to data from the Child Agriculture Injury Survey (CAIS), from 1998 to 2012, the rate of childhood agricultural injuries (including child residents, visitors, and hired workers on farms) decreased by 61 percent.[37] According to SOII data, for farms with more than ten employees, injury rates for crop and livestock operations decreased by 41 percent and 53 percent, respectively, from 1994 to 2013.[38] Trends from the NAWS show a similar pattern. In 1999 and 2002–2004, the hired crop worker injury rate per 100 full-time week-based equivalents was 4.3 (95 percent confidence level, 3.6–5.1). By 2008–2010, the rate had dropped to 2.9 (95 percent confidence level, 2.0–3.8).[39] As a result of these trends in employment and injury rates, broad-based national surveillance efforts have become increasingly resource-intensive. With decreasing injuries, existing national surveys require larger sample sizes to produce stable estimates and, therefore, greater resources to support survey efforts.

The third challenge faced by agricultural injury and illness surveillance is the decreasing resources the AgFF Program has received over time, along with an uncertain future for the program itself. Although decreasing injury trends are a positive phenomenon, agriculture still ranks as one of the most hazardous industries in the nation. However, given the limited resources of the AgFF Program, smaller workforce population and injury numbers increase the cost for the nationally representative survey approaches that NIOSH carried out through interagency agreements. A 2012 independent review of the AgFF Program noted that, in general, resources have been inadequate for the program to carry out its congressional mandate in agriculture.[40] From 1997 to 2006, program budgets averaged around $24 million. Funds were distributed among intramural programs (44 percent), extramural programs (25 percent) and the Ag Centers (31 percent).[41] Since 2006, the budget has remained relatively stable at the same levels, but in recent years the balance between intramural and extramural expenditures shifted, with most resources now flowing from NIOSH to external groups. This shift may reflect the extreme uncertainty that the AgFF Program has been operating under for the past few years.

From fiscal year (FY) 2012 to FY 2017, the President's Budget proposed eliminating the AgFF Program in its entirety, citing concerns over its effectiveness and impact, as well as the relevance of the program to the mission of CDC, as opposed to alignment with DOL or USDA.[42] While the overall program continued to be supported in final budget appropriations, over time, there has been a shift in surveillance activities. Rising costs, because of the decreasing size of the agricultural workforce and decline in injury and illness rates, led NIOSH to

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37 NCC, "2014 Fact Sheet: Childhood Agricultural Injuries in the U.S.," Marshfield, Wisc., 2014.

38 BLS, "Industry Injury and Illness Data," web page, last updated May 10, 2017 (see summary report, table 1, "Incidence Rates of Injuries and Illnesses—1994," and supplemental news release table SNR05, "Incidence Rate and Number of Non-Fatal Occupational Injuries by Industry and Ownership, 2013").

39 NIOSH, "Agricultural Safety: National Agricultural Workers Survey (NAWS); Hired Crop Worker Injury Rate Tables," web page, last updated May 12, 2017.

40 NIOSH, *Comments on the Agriculture, Forestry, and Fishing (AgFF) National Research Program Sponsored by the National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC)*, Washington, D.C., June 2012.

41 NIOSH, *NIOSH Agriculture, Forestry, and Fishing Safety and Health Program: National Academies Review*, Washington, D.C., 2006..

42 Office of Management and Budget, "The Budget," web page, undated.

discontinue interagency agreements with USDA and DOL in FY 2015 to collect injury data through the NASS surveys and NAWS, respectively. In addition, advances in information technology and surveillance methods are providing opportunities to consider new options for carrying out surveillance activities. NIOSH is therefore currently exploring different surveillance options through both intramural and extramural mechanisms.[43]

Evaluation of AgFF Surveillance Programs

From 2005 to 2008, the National Academies, through the National Research Council and Institute of Medicine, conducted independent evaluations of eight NIOSH programs.[44] The goals of these reviews were to determine the impact and relevance of the programs and identify emerging issues. In 2008, an expert committee published its evaluation of the AgFF Program for the period 1990–2006, looking at the relevance of the program's work to improve worker safety and health and the impact of its research on reducing workplace illnesses and injuries.[45] Overall, the committee concluded that the AgFF Program had made meaningful contributions to improving worker safety and health in the agriculture sector. Examples included research on respiratory health risks and musculoskeletal disorders, the establishment of the Ag Centers, and tractor safety and child injury reduction initiatives. While the committee scored the relevance of the program high (4 out of 5), impact was scored lower (3 out of 5). Reasons for the lower impact score included a lack of documentation on program impacts and limited transfer activities to move research to real-world practice. Based on the review, the committee issued eight recommendations for improvement: (1) establish strategic goals for improvement in leadership, administration, and evaluation; (2) develop a cohesive program that provides national leadership in agricultural, forestry, and fishing safety and health; (3) implement a comprehensive surveillance system; (4) define, identify, and track populations at risk; (5) conduct research on the knowledge diffusion process; (6) improve stakeholder engagement; (7) implement integrative and interdisciplinary approaches in research practices; and (8) enhance awareness of national policies and impacts on worker populations.

The 2012 Independent Panel Review

In 2012, the AgFF Program underwent another program review for the period 2006–2011.[46] Although the second review was not conducted by the National Academies, many members of the original committee participated. The 2012 review recognized program improvements through high scores of 5 for relevance and 4 for impact. Scores were based on the high-priority research areas that the program conducted or supported, engagement in transfer activities, and

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[43] NIOSH, "Agriculture, Forestry and Fishing: Future of Agriculture Injury Surveillance at NIOSH," web page, December 11, 2014.

[44] NIOSH, "The National Academies Evaluation of NIOSH Programs," web page, last updated July 26, 2016.

[45] National Research Council and Institute of Medicine, *Agriculture, Forestry, and Fishing Research at NIOSH: Reviews of Research Programs of the National Institute for Occupational Safety and Health*, Washington, D.C.: The National Academies Press, 2008.

[46] NIOSH, *Comments on the Agriculture, Forestry, and Fishing (AgFF) National Research Program Sponsored by the National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC)*, Washington, D.C., June 2012.

progress made since 2006 in responding to the National Academies' recommendations and delivering positive worker health outcomes (e.g., reduction in child agricultural death rates and diffusion of technologies into worksites).[47]

In addition to program evaluation, the 2012 panel review also included recommendations for NIOSH moving forward. However, unlike the original National Academies evaluation, these recommendations were not explicitly issued. Instead the panel report discussed several surveillance-related issues faced by agriculture and offered either general directions forward or, in certain instances, specific activities to perform. The issues included (1) AgFF Program surveillance, (2) considerations of worksite size when targeting surveillance activities, (3) defining *populations at risk*, and (4) emerging animal agriculture production practices.

Project Goals and Objectives

In 2015, NIOSH entered into a contract with the RAND Corporation to identify and assess options for action in response to the 2012 panel recommendations. The goal of this report is to provide NIOSH with a practical assessment of the *feasibility* and *desirability* of carrying out actions to meet surveillance-related recommendations given current AgFF Program resources and priorities. Many actions for meeting recommendations were contained in the panel report, but without much guidance on how to prioritize or implement the actions. We conducted literature reviews and targeted interviews to detail how actions could be implemented and identify potential barriers to their achievement. For each action, we applied criteria relevant to assessing feasibility (costs and other resources, partnership engagement, information availability and accessibility, policy barriers, and timelines) and desirability (relevance to program priorities, information quality, and action impacts). The panel report contained a number of additional recommendations related to the communication of educational materials and priority research areas. We do not include our assessment of those recommendations in this report, because they are not directly related to surveillance.

This report presents the background, methods, and results of RAND's assessment of surveillance-related recommendations and is intended to inform decisionmaking by NIOSH leadership regarding surveillance strategies and future resource allocations. Chapters Two through Four describe our project approach: identification of recommendations and actions from the panel report (Chapter Two), development of scenarios for implementation of actions (Chapter Three), and our assessment of feasibility and desirability of actions (Chapter Four). Chapter Five presents detailed descriptions of the actions based on the evaluation criteria used to assess actions. Chapter Six describes our assessment of actions on feasibility and desirability and analysis of the consequences and trade-offs of implementing certain actions. Chapter Seven presents overall conclusions.

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[47] NIOSH, *Comments on the Agriculture, Forestry, and Fishing (AgFF) National Research Program Sponsored by the National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC)*, Washington, D.C., June 2012; NIOSH, *NIOSH Agriculture, Forestry, and Fishing Program: Plan to Implement the National Academies Program Evaluation Recommendations*, Washington, D.C., January 2011.

CHAPTER TWO

Project Approach: Identification of Recommendations and Actions

Our project approach consisted of the following tasks: (1) identification of recommendations from the 2012 panel report, as well as options for actions to meet recommendations; (2) development of implementation scenarios for each action; (3) development of criteria to assess feasibility and desirability of achieving an action; and (4) assessment of actions through the application of the criteria. This chapter focuses on the identification of recommendations and the development of actions and introduces the final list of actions we considered in the assessment.

The 2012 AgFF Program panel review offered numerous points of guidance for activities that NIOSH could carry out or champion but did not explicitly issue a concrete set of recommendations for NIOSH to pursue. Instead, the panel report discussed four major surveillance-related issues faced by agriculture and provided either general directions forward or, in certain instances, specific activities to perform. These issues included (1) AgFF Program surveillance, (2) considerations of worksite size when targeting surveillance activities, (3) definitions of *populations at risk*, and (4) emerging animal agriculture production practices.

Because the panel report was structured in more of a discussion format versus issuing a prioritized list of recommendations, a team of four RAND experts with backgrounds in public health and surveillance methods assessed the report independently and relied on individual judgment and an understanding of the context and background of the report to infer what constituted a recommendation. The four reviewers compared their individual assessments of potential recommendations, and disagreements between reviewers were resolved through discussion and consensus. We then grouped the final list of recommendations into four themes based on mechanism of action, as opposed to topic or content area. These themes were (1) define and characterize agricultural worker populations at risk; (2) review ongoing or new data sources for injury and illness surveillance in agricultural workers; (3) analyze, report, and communicate surveillance findings to address the needs of multiple stakeholders; and (4) build a foundation for addressing emerging issues in agricultural safety and health through partnership development and research. Table 2.1 presents the recommendations extracted directly or inferred from the review report.

We next defined the actions that NIOSH could take to achieve each recommendation. The majority of actions were extracted directly from the panel report. In addition, we detailed, clarified, or added actions based on a review of the 2008 National Academies' evaluation of the AgFF Program and the 2008 NORA—the National Agriculture, Forestry, and Fishing Agenda.[1] Table 2.2 displays the actions for each recommendation. The actions may not cor-

[1] National Research Council and Institute of Medicine, *Agriculture, Forestry, and Fishing Research at NIOSH: Reviews of Research Programs of the National Institute for Occupational Safety and Health*, Washington, D.C.: The National Academies

Table 2.1
Themes and Recommendations Inferred from the 2012 Review Report

Theme	Recommendation
Theme 1: Define and characterize agricultural worker populations at risk	Recommendation 1: Develop standard definitions to help improve knowledge and understanding of populations at risk of worksite exposures
Theme 2: Review ongoing or new data sources for injury and illness surveillance among agricultural workers	Recommendation 2: Focus surveillance efforts on very large and nonfamily farms
	Recommendation 3: Expand the scope of knowledge on hired farmworker risk for occupational illness and injury
	Recommendation 4: Improve surveillance coverage and knowledge of child agricultural worker populations
	Recommendation 5: Establish a comprehensive understanding of data sources relevant to NIOSH agricultural surveillance-related programming
Theme 3: Analyze, report, and communicate surveillance findings to address the needs of multiple stakeholders	Recommendation 6: Reconsider analytical and reporting approaches for conveying child agricultural worker safety and health risks
	Recommendation 7: Identify context in reports and analyses authored by NIOSH or regional centers
Theme 4: Build a foundation for addressing emerging issues in agricultural safety and health through partnership development and research	Recommendation 8: Address emerging issues in animal agricultural production practices

respond word-for-word with the panel report. We took license to summarize, edit, or change language for conciseness or inclusiveness. For example, action 2.1 in Table 2.2 is to conduct an assessment of different data sources that provide information on very large farms and nonfamily farms. This is in contrast to the panel report, which specifically noted that NIOSH "may have to consider targeting farm management companies and other types of non-owners/operators such as farm labor aggregators" to obtain data on large and nonfamily farms.[2] The nature of the language denotes a suggestion for NIOSH rather than a strong pronouncement that the stated sources are the only or even ideal sources for NIOSH to pursue. Therefore, we softened the language so that action 2.1 was inclusive of the report suggestions and also other potential sources that may be identified.

In general, we attempted to hew closely to the language of the panel report to define recommendations and actions. For most topics, the report already contained what we considered a recommendation (through defining an overarching need) and then specific activities that should be undertaken to address the need (e.g., recommendations 1, 2, 3, 4, 7, 8). In a few instances however, we deviated from the panel report. First, actions 6.1 and 6.2 were originally discussed under the report topic of improving knowledge of child populations (recommendation 4). However, because the actions focused more on reporting than data collection, we moved them to their own recommendation. Second, in recommendation 5, we added

Press, 2008; National Occupational Research Agenda Agricultural, Forestry, and Fishing Sector Council, *National Agriculture, Forestry, and Fishing Agenda: For Occupational Safety and Health Research and Practice in the U.S. Agriculture, Forestry, and Fishing Sector*, Washington, D.C.: National Institute for Occupational Safety and Health, December 2008.

[2] NIOSH, *Comments on the Agriculture, Forestry, and Fishing (AgFF) National Research Program Sponsored by the National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC)*, Washington, D.C., June 2012, p. 6.

Table 2.2
Actions Inferred from the 2012 Review Report

Recommendation	Action Item
Recommendation 1	1.1. Develop concise definitions of populations at occupational exposure risk, and profile them by agriculture commodity specialization, demographic factors, work organization patterns, worksite tasks across various enterprise types, and knowledge or use of emerging technologies.
Recommendation 2	2.1. Conduct an assessment of data sources for providing information on very large farms and nonfamily farms.
Recommendation 3	3.1. Collaborate with the NAWS to field supplementary modules on occupational health outcomes among hired farmworkers and perform specific analyses on variability of risk.
Recommendation 4	4.1. Improve the validity of the CAIS by extending the sample to include labor aggregators.
	4.2. Collaborate with the NAWS to field a supplementary module targeted at children who work as hired farmworkers on crop farms.
Recommendation 5	5.1. Reevaluate the surveillance mechanisms of USDA's NASS surveys for usefulness in NIOSH activities.
	5.2. Identify and evaluate the potential of existing data sources (including those currently or recently used by NIOSH) for illness and injury surveillance of agricultural workers.
Recommendation 6	6.1. Identify feasible, desirable alternatives to five-year age groupings for child agricultural workers (<18 years old).
	6.2. Stratify data pertaining to children into at least three divisions: those employed within agricultural enterprises, those self-employed, and unpaid family workers contributing effort within agricultural enterprises.
Recommendation 7	7.1. When reporting on surveillance activities, NIOSH and Ag Centers should provide information on agricultural enterprises, known operational worksite characteristics, and other useful descriptors that provide context for understanding occupational cohorts at risk.
Recommendation 8	8.1. Establish partnerships to monitor zoonotic diseases in animal and human populations.
	8.2. The NCC should monitor developments in alternative animal production systems and develop guidelines for children and youth workers within these systems.

action 5.2 (evaluate different data sources for use in surveillance), which was not included in the panel report, because of (1) overall need for such an assessment, as evidenced by sources beyond the panel report, and (2) as a complement to action 5.1 (evaluation of the NASS surveys) so that NIOSH would also have a thorough understanding of alternative data sources.

CHAPTER THREE

Project Approach: Development of Implementation Scenarios for Actions

While the panel report included potential actions that NIOSH could support or carry out to improve agricultural injury and illness surveillance, the report itself did not address how actions could be implemented. The mechanisms by which actions are implemented are critical to evaluating their overall feasibility. Therefore, for each action, we constructed a general implementation plan for how NIOSH might achieve the action. This plan has four components: (1) a brief description of how actions might occur, (2) potential partners, (3) amounts and types of resources needed, and (4) timelines for initiation and completion of action. Implementation scenarios were informed by two approaches: (1) discussions with NIOSH AgFF Program leadership and a small group of federal and nonfederal stakeholders and (2) targeted literature reviews used to supplement information obtained from NIOSH and stakeholder meetings.

We identified three common implementation mechanisms across the entire list of actions: (1) actions achievable through extramural funding mechanisms, (2) actions achievable through partner engagement and partner capabilities, and (3) actions achievable through direct NIOSH action. The majority of actions categorized into the first group resembled structured research projects focused on addressing specific questions. Actions falling into the middle group generally required partnering with federal or nonfederal entities for data collection, reporting, or expert-engagement activities. Finally, actions in the third group included activities for NIOSH to directly address through changes in data reporting. Table 3.1 groups actions by the three mechanisms.

Actions Achievable Through Extramural Funding Mechanisms

The AgFF Program houses a robust extramural program, and the balance of intramural and extramural activities has been heavily skewed toward extramural projects in the past decade. As with most federal programs, NIOSH typically has three extramural funding mechanisms at its disposal: grants, cooperative agreements, and contracts. While all three are realistic options for NIOSH, their use may be targeted toward the types of outcomes that NIOSH wants to achieve with each action. In the past, NIOSH has carried out some intramural research; however, at this time, the AgFF Program has shifted most research activities to extramural partners. Therefore, we focused mainly on extramural funding mechanisms as the primary means for achieving specific actions.

Table 3.1
Actions by Implementation Mechanism

Action	Description
Actions achievable through extramural funding mechanisms	
Action 1.1	Develop concise definitions of populations at occupational exposure risk, and profile them by agriculture commodity specialization, demographic factors, work organization patterns, worksite tasks across various enterprise types, and knowledge or use of emerging technologies.
Action 2.1	Conduct an assessment of data sources for providing information on very large farms and nonfamily farms.
Action 5.1	Reevaluate the surveillance mechanisms of USDA's NASS surveys for usefulness in NIOSH activities.
Action 5.2	Identify and evaluate the potential of existing data sources (including those currently or recently used by NIOSH) for illness and injury surveillance of agricultural workers.
Actions achievable through partner engagement and partner capabilities	
Action 3.1	Collaborate with the NAWS to field supplementary modules on occupational health outcomes among hired farmworkers and perform specific analyses on variability of risk.
Action 4.1	Improve the validity of the CAIS by extending the sample to include labor aggregators.
Action 4.2	Collaborate with the NAWS to field a supplementary module targeted at children who work as hired farmworkers on crop farms.
Action 7.1	When reporting on surveillance activities, NIOSH and Ag Centers should provide information on agricultural enterprises, known operational worksite characteristics, and other useful descriptors that provide context for understanding occupational cohorts at risk.
Action 8.1	Establish partnerships to monitor zoonotic diseases in animal and human populations.
Action 8.2	The NCC should monitor developments in alternative animal production systems and develop guidelines for children and youth workers within these systems.
Actions achievable through direct NIOSH action	
Action 6.1	Identify feasible, desirable alternatives to five-year age groupings for child agricultural workers (<18 years old).
Action 6.2	Stratify data pertaining to children into at least three divisions: those employed within agricultural enterprises, those self-employed, and unpaid family workers contributing effort within agricultural enterprises.

In general, grants and cooperative agreements allow for investigator flexibility in defining priorities and approaches, which may facilitate potentially creative solutions to defined problems. However, because NIOSH may have little control over research questions and study designs, there is a risk that, through both grants and cooperative agreements, NIOSH ends up funding projects that do not directly address the panel report recommendations. Although a cooperative agreement may somewhat mitigate the risk through increased collaboration between funder and awardee, the principal investigator will still ultimately drive the direction of research based on the objectives defined in the original proposal. A potential solution would be to issue a contract. Contracts are a mechanism through which the government procures services for governmental benefit.[1] A contract would specify the exact nature of the desired task while leaving some room for awardees to propose research approaches, but contracts offer less

[1] Office of Management and Budget, "Circular A-110 Revised 11/19/93 as Further Amended 9/30/99," web page, undated.

flexibility for responding to changes in the scope of work (e.g., as a result of unexpected preliminary findings) or for exploring new research directions that may arise. Table 3.1 provides some guidance for determining the fit of actions for different extramural funding mechanisms, and Table 3.2 presents potential extramural funding mechanisms for selected actions.

Cooperative agreements may function as a viable middle ground between grants and contracts. Because NIOSH is a research organization itself, it—and awardees—can benefit technically and programmatically from the collaborative nature of such agreements. The Ag Centers all operate under the cooperative agreement mechanism, which supports the potential success of this model for carrying out panel report actions and meeting recommendations. To increase the relevance of investigator proposals for accomplishing specific actions, the AgFF Program may consider an approach that was used for instigating NIOSH-defined priority research in forestry. In 2014, NIOSH issued a funding opportunity announcement (FOA) under the U01 cooperative agreement mechanism to conduct research related to agricultural injury and disease.[2] The FOA noted that any application that focused on occupational safety and health concerns in the AgFF sectors would be accepted, but it placed priority emphasis on research addressing forestry and logging, vulnerable populations, and research-to-practice efforts. The FOA thus allowed for any proposal that was responsive to AgFF occupational safety and health to be scored by peer reviewers but also enabled programmatic priorities to drive award decisions among high-scoring applications during secondary council reviews. For the purposes of responding to the panel report recommendations, a similar FOA approach could be used to outline a broad agenda in agriculture safety and health research while also defining new surveillance approaches as a programmatic priority.

We have described a general approach that NIOSH could pursue for addressing four of the actions arising from the panel report. Table 3.3 summarizes the three other elements of the action implementation plans: partnerships, resources, and timelines.

Table 3.2
Potential Extramural Funding Mechanisms for Selected Actions

Action	Extramural Mechanism	Rationale
Action 1.1. Develop concise definitions of populations at occupational exposure risk and profile them by agriculture commodity specialization, demographic factors, work organization patterns, worksite tasks across various enterprise types, and knowledge or use of emerging technologies.	Contract	The action is specific and appears to present a defined activity.
Action 2.1. Conduct an assessment of data sources for providing information on very large farms and nonfamily farms. Action 5.1. Reevaluate the surveillance mechanisms of USDA's NASS surveys for usefulness in NIOSH activities. Action 5.2. Identify and evaluate the potential of existing data sources (including those currently or recently used by NIOSH) for illness and injury surveillance of agricultural workers.	Grant or cooperative agreement	While the actions (particularly 2.1 and 5.1) detail specific tasks, greater flexibility would enable investigators to pursue creative methods for evaluating data sources and respond to unexpected challenges. Note that actions 2.1 and 5.1 could be incorporated into action 5.2.

[2] Department of Health and Human Services, "Agricultural, Forestry and Fishing Safety and Health Research (U01)," funding opportunity announcement, April 10, 2014.

Table 3.3
Implementation Plan for Actions Achievable Through Extramural Funding Mechanisms

		Partnerships			
Action	Extramural Mechanism	Possible Resource Partners	Possible Capability Partners	Resources	Timelines
Action 1.1	Contract	—	Ag Centers, research organizations	$150K–$250K	5 months for initiation; 1–1.5-year duration
Actions 2.1, 5.1, 5.2	Grant or cooperative agreement	NIOSH CWCS	Ag Centers (NCC), research organizations, federal and state data collection agencies	$350K–$800K	2 years for initiation; 2–5-year duration

NOTE: CWCS = Center for Workers' Compensation Studies.

We divided partnerships into two types: resource partners and capability partners. Resource partners are organizations that could help initiate an action through supplying resources or support. Capability partners are organizations responsible for carrying out the action or supporting the completion of the action (e.g., through supplying data or information). The category of resources includes general cost estimates for the total action, which encompasses direct and indirect costs typically associated with extramural partner institutions (e.g., labor, travel, computing, publications, and administrative overhead). We include ranges to account for uncertainty in estimates and also to provide a sense of the ideal version of an action and the satisfactory version. The ideal version refers to our estimation of the types of tasks and time frames needed to either fully complete the action or ensure that implementation results in meaningful impacts. The satisfactory version refers to our estimation of tasks and time frames that may result in lesser (compared with the ideal), but still acceptable, impacts. Table 3.3 also shows our estimates of timelines for action initiation (from developing an FOA to issuing an award) and action duration (time frame for achieving the satisfactory or ideal action). Our rationale for partners, resources, and timelines is presented in Chapter Five, where we provide greater detail on the individual actions.

Actions Achievable Through Partner Engagement and Partner Capabilities

Since the 1990s, the AgFF Program has worked extensively with USDA and DOL to collect agricultural worker injury and illness data. USDA's NASS conducts hundreds of surveys on a yearly basis to gather data on such issues as agricultural production, economics, work environments, and demographics.[3] Every five years, NASS also conducts the Census of Agriculture, providing comprehensive information for all counties in the nation. NASS surveys cover all farm types in the United States, with a *farm* defined as any operation with $1,000 or more of agricultural products sold within a calendar year.[4] Since 1993, NIOSH has worked with USDA to carry out various injury surveys (see Table 1.1). The partnership started with the Traumatic Injury Surveillance of Farmers (1993–1997), which served as the basis for the

[3] USDA, "Agency Overview," web page, last updated July 11, 2017.

[4] USDA, "Farm Household Well-Being: Glossary," web page, last updated September 1, 2017.

Occupational Injury Surveillance of Production Agriculture (OISPA) (2001–2014).[5] The first CAIS was conducted in 1998, and minority farmworker versions of the OISPA and CAIS were fielded multiple times between 2000 and 2010. A second important partner for NIOSH has been DOL's Employment and Training Administration (ETA), which carries out the NAWS, a continuous survey of hired crop farmworkers designed to monitor agricultural employment and working conditions. The NAWS collects detailed information on crop workers, including demographics; employment and migration; earnings, benefits, and worksite characteristics; health, safety, and housing; and income and assets, social services, and legal status. NIOSH has worked with DOL since 1999 to add injury modules to the NAWS.[6]

Because of the NASS surveys' and NAWS's prominence as sources of surveillance data, the panel report contained several actions focused on the surveys. However, NIOSH recently announced that it was discontinuing its interagency agreements with USDA and DOL—2014 would be the last year of injury and illness data collection through OISPA and CAIS, and data collection for the NAWS would end after the 2014–2015 cycle.[7] NIOSH is currently determining directions for surveillance; therefore, we still included the NASS and NAWS-focused recommendations in our assessment, because NIOSH may decide to again partner in the future.

Table 3.4 summarizes implementation plan components for the six actions achievable through partner engagement and capabilities. In addition to actions involving the NASS surveys and NAWS, this grouping also includes actions that require cooperation of the Ag Centers, scientific experts, or organizations engaged in monitoring zoonotic diseases. Resources under this grouping refer to payments to other agencies for services and labor or financial costs

Table 3.4
Implementation Plan for Actions Achievable Through Partner Engagement and Capabilities

		Partnerships			
Action	Overall Mechanism	Possible Resource Partners	Capability Partners	Resources	Timelines
Actions 3.1, 4.2	Partner outreach or development	DOL-ETA	DOL ETA (NAWS)	$1 million–$2 million	9 months for initiation; 3–6-year duration
Action 4.1	Partner outreach or development	USDA	USDA (NASS)	$1 million	6 months for initiation; 1-year duration
Action 7.1	Partner outreach	—	Ag Centers	Uncertain	Ongoing, as needed
Action 8.1	Partner outreach or development	USDA, NCEZID	OIE, IPPC, Codex, Ag Centers	Uncertain	Ongoing; 6 months for strategy development
Action 8.2	Partner outreach	—	NCC	$350K–$500K	Next Ag Center cycle

NOTE: IPPC = International Plant Protection Convention; NCEZID = National Center for Emerging and Zoonotic Infectious Diseases; OIE = World Organization for Animal Health.

[5] NIOSH, *NIOSH Agriculture, Forestry, and Fishing Safety and Health Program: National Academies Review*, Washington, D.C., 2006, Appendix A3.2-01.

[6] NIOSH, "Agricultural Safety: National Agricultural Workers Survey (NAWS)," web page, May 12, 2017.

[7] NIOSH, "Agriculture, Forestry and Fishing: Future of Agriculture Injury Surveillance at NIOSH," web page, December 11, 2014.

expended to initiate activities or build relationships. Chapter Five provides detail on the specific actions as well as our rationale for partners, resources, and timeline estimates.

Actions Achievable Through Direct NIOSH Action

The last grouping includes two actions intended to change the way NIOSH currently reports data on child injuries and illnesses. We elaborate on the actions in Chapter Five, but Table 3.5 shows that achieving these actions should not require any partnership activity. However, given the shift in surveillance direction and the decision to discontinue interagency agreements with USDA and DOL, redoing analyses and reissuing reports with updated estimates may put a strain on existing NIOSH resources. It is more likely that different types of analyses and reporting would be done on an as-needed basis or on request.

Table 3.5
Implementation Plan for Actions Achievable Through Direct NIOSH Action

		Partnerships			
Action	Overall Mechanism	Possible Resource Partners	Capability Partners	Resources	Timelines
Action 6.1	Direct action	—	—	Uncertain	As needed
Action 6.2	Direct action	—	—	Uncertain	As needed

CHAPTER FOUR

Project Approach: Criteria Development and Assessment of Actions

Criteria Development for Assessment of Actions

To carry out an assessment of actions, we developed criteria that were relevant to two conditions: the feasibility and the desirability of accomplishing actions given the current resources and priorities of the AgFF Program. The following criteria were used to assess *feasibility*: costs and other resources, partnership engagement, information availability and accessibility, policy barriers, and timelines. Three criteria supported our assessment of *desirability*: relevance to program priorities, information quality, and action impacts. For all criteria except costs and other resources, we constructed an ordinal five-point rating scale based on defined attributes of the criterion relevant to the accomplishment of an action. Low values (1–2) reflect adverse or unfavorable conditions for an action, as contrasted with high values (4–5), which reflect favorable conditions for action achievement. Development of criteria rating scales was informed by (1) discussions with NIOSH AgFF Program leadership and a small group of federal and nonfederal stakeholders and (2) targeted literature reviews. Because we lacked information on current or planned allocation of resources within the AgFF Program, for the costs and other resources criterion, we present general estimates (as opposed to an assessment intended to prioritize different actions based on cost in relation to available funds), along with a discussion of implications.

Feasibility Criteria

Cost and Other Resources

The actions described in Table 2.2 reflect a range of activities, from specific research projects to interagency partnerships for data collection. The costs associated with different actions are intended to reflect costs to NIOSH (or partners that may undertake aspects of activities). Because of the differences in the level of specificity in terms of implementation across actions, we used different approaches for generating cost estimates, depending on the action. Table 4.1 summarizes these approaches. Generally, for actions achievable through extramural funding mechanisms, we engaged in two activities. Because these actions tended to consist of defined research projects, the project team used similar projects with known costs as benchmarks. Following this process, we sent an information packet detailing the relevant actions to RAND researchers with expertise in contracts and grants management to obtain their input on potential costs. We combined the data from the team assessment and the expert input to develop final cost ranges.

Table 4.1
Summary of Approaches for Estimating Costs

Action	Cost Estimate Approach
Actions achievable through extramural funding mechanisms	
Actions 1.1, 2.1, 5.1, 5.2	Assessment of costs of similar initiatives; expert input
Actions achievable through partner engagement and partner capabilities	
Actions 3.1, 4.1, 4.2	Based on historical costs of past interagency agreements; expert input
Actions 7.1, 8.1	No estimates, because of uncertainty or lack of information
Action 8.2	Assessment of costs of similar initiatives; expert input
Actions achievable through direct NIOSH action	
Actions 6.1, 6.2	No estimates, because of uncertainty or lack of information

We employed a number of approaches for actions achievable through partner engagement and capabilities. For those actions focused on partnering with USDA or DOL on the NAWS or the NASS surveys, we based estimates on the costs of past interagency agreements that were provided by NIOSH, as well as expert input provided during interviews with staff at NIOSH, USDA, and ETA.[1] The agreements provided only an overall cost, with no breakdowns or itemizations of cost categories. Therefore, we assumed that increases in future survey costs would mirror past increases that occurred over time. Action 8.2 was more defined in terms of activities, so we were able to develop estimates through the assessment of costs of similar initiatives. Finally, four actions (6.1, 6.2, 7.1, and 8.1) were considered too uncertain regarding how the action might unfold to develop any cost estimates.

As stated, where relevant, we included a cost range to account for uncertainty in estimates and also to provide a sense of the ideal version of an action and the satisfactory version. The ideal version refers to our estimation of the types of tasks and time frames needed to either fully achieve the action or ensure that implementation results in meaningful impacts. The satisfactory version refers to our estimation of tasks and time frames that may result in lesser (compared with the ideal), but still acceptable, impacts. For actions achievable through extramural funding mechanisms, cost estimates include direct and indirect costs typically associated with extramural partner institutions, such as academic universities (e.g., labor, travel, preparing publications, and administrative overhead). For actions involving partnerships, costs may encompass payments to other agencies for services or labor or financial resources expended to initiate activities. We did not incorporate costs associated with start-up activities (e.g., labor time for drafting an FOA), because we lacked information to produce such estimates, but we note their capture in timeline estimates.

Partnerships

The two scales presented in Tables 4.2 and 4.3 were used to rate actions on the partnership criterion for resource and capability partner scenarios. The scales cover a range of partnership scenarios that incorporate the willingness or ability of partners to engage in an activity, the

[1] These interviews were conducted by phone in 2016.

Table 4.2
Partnership Scales

Rating	Resource Partnership Scenario
	Resource partnership scenario
1	No existing organizations or individuals are willing or able to partner on funding or resource-sharing.
2	Information is lacking on who the best or most relevant partners might be.
3	Potential partners exist, but relationships need to be initiated or built. Partners exist and are willing to engage on some aspects of the action but not all (or the most necessary) aspects of the action (e.g., will perform outreach but will not provide funding). Partners exist and are willing to engage, but constraints (e.g., regulatory, policy, timing) prevent the partnership from occurring.
4	Partners exist and are willing to engage but must first address surmountable constraints (e.g., regulatory, policy, timing).
5	Partners exist and are willing to engage with no constraints inhibiting partnership.
	Capability partnership scenario
1	No existing organizations or individuals can carry out or support completing the action.
2	Information is lacking on who the most relevant partners might be or how potential partners may best help.
3	Potential partners exist, but relationships need to be initiated or built. Potential partners exist, but they do not have a demonstrated track record (reliability is unknown). Reliable partners exist and are willing to engage, but no resources are available to support partnership activities. Reliable partners exist and are willing to engage, but constraints (e.g., regulatory, policy, timing) prevent the partnership from occurring.
4	Reliable partners exist and are willing to engage but must first address surmountable constraints (e.g., regulatory, policy, timing).
5	Reliable partners with strong capabilities exist and are willing to engage with no constraints inhibiting partnership.

extent to which partnerships already exist or need to be developed, and the existence of constraints or barriers to successful partnerships.

Information Availability and Accessibility

The information availability and accessibility criterion refers to the ease of collecting, reporting, or evaluating information or data. The treatment of data or information will vary across actions, ranging from the use of secondary sources for qualitative or quantitative analyses to primary-data collection through a variety of methods (e.g., surveys and focus groups). The extent to which information on a topic exists, is accessible to NIOSH or partners, and is available in forms that are relevant and usable is critical for the accomplishment of actions and associated recommendations. The scale in Table 4.3 was used to rate actions on the information availability and accessibility criterion.

Table 4.3
Information Availability and Accessibility Scale

Rating	Information Availability and Accessibility Scenario
1	There are no existing data or information available to address the action.
2	There are existing data, but it is not known what information exists that can be used to address the action or whether existing information can be accessed.
	Information or data are available but only in noncustomizable or nonrelevant forms.
	Information or data are collected, but access is nearly impossible because of existing barriers (e.g., legal or privacy issues and proprietary data).
	Primary-data collection is required to obtain information, but populations or settings are difficult to access.
3	Existing information, including raw or customized data, is available, but there are some constraints inhibiting access (e.g., significant costs and a lengthy process for access).
	Primary-data collection is required to obtain needed information, but target populations or settings are not particularly onerous to reach.
4	Existing information, including raw or customized data, is available with little constraints to access.
	Some information types are easily accessible, while other types are harder to obtain (e.g., primary data).
5	Raw or customized data are available at no cost or through public use data files.
	Information can be obtained easily through publicly available sources.

Policy

The regulatory and policy environment can play an important role in helping or hindering the accomplishment of actions. The rating scale for policy (Table 4.4) reflects the degree to which policies governing such issues as data confidentiality, data collection procedures, or the structure of extramural funding arrangements affect the achievement of actions. For example, the process of obtaining clearance under the Paperwork Reduction Act of 1995 through the Office of Management and Budget has the potential to slow down or block new data collection efforts. This would be relevant across many of the actions. In addition, the policy criterion includes other policy or regulatory research requirements, such as institutional review board review and the development of data-use and data-sharing agreements.

Timing

The timing criterion encompasses two components: (1) the time frame required for initiation of an action and (2) the duration required to complete or accomplish an action. The best scenario for the timing criterion is one where an action could be implemented almost immediately and time to accomplishment could occur within a reasonable time frame (e.g., zero to two years); see Table 4.5.

Estimates for timelines were developed similarly to cost estimates. For actions achievable through extramural funding mechanisms, we again used similar projects as benchmarks to determine potential timeline estimates. In addition, we relied on input from RAND researchers with expertise in grants and contracts management. We also relied on historical interagency agreements and partner (e.g., USDA and ETA) input for developing timeline estimates for actions relating to the NAWS and the NASS surveys. Finally, three actions (6.1, 6.2, and 7.1) were considered too uncertain regarding how and when the action might unfold to develop any timeline estimates.

Table 4.4
Policy Scale

Rating	Policy Scenario
1	Policy or legislative barriers make action impossible.
2	Policy or legislative barriers make action possible but highly unlikely.
3	Policy or legislative barriers exist, and it is uncertain whether they can be overcome.
4	Policy or legislative barriers are minor. Policy or legislative barriers exist but can be overcome without large investments of time and resources.
5	There are no policy or legislative barriers inhibiting action.

Table 4.5
Timing Scale

Rating	Timing Scenario
1	Lead time to implement action makes action impossible to achieve (e.g., lead time too short for effective planning).
2	Very lengthy lead time is necessary (e.g., partnerships need to be formed).
3	Lead time may be variable, such that initiation of the action is uncertain. Lead time is lengthy but standard for initiating the action (e.g., grant funding), but duration needed to accomplish action is long. Lead time is moderate, but duration needed to achieve action is lengthy.
4	Some lead time is required but would not create significant delays. Lead time is lengthy but standard for initiating the action (e.g., grant funding), and duration needed to accomplish action is moderate or short. Action can be implemented immediately or with some lead time, but duration of time needed to accomplish action is lengthy. Action can be implemented on an as-needed or on-request basis.
5	Action can be implemented immediately or within a time frame that presents no issues, and action can be accomplished within a reasonable time frame.

Desirability Criteria

Program Surveillance Goals and Priorities

Discussions with AgFF leadership were used to assess the extent to which actions supported or reflected existing AgFF Program goals and priorities. We worked closely with AgFF Program leadership to understand the criteria the program itself uses to determine its priorities. Important drivers of program priorities included recommendations already contained in the 2008 NORA,[2] as well as additional issues raised by the NORA sector council and other stakeholders. In 2016, after completion of the research phase of this project, NIOSH developed a framework for prioritizing research through an assessment of burden (what is the magnitude and severity of the problem and the societal costs), need (why is it important and appropriate for NIOSH to be involved), and impact (what significant outcomes for worker health and

[2] National Occupational Research Agenda Agricultural, Forestry, and Fishing Sector Council, *National Agriculture, Forestry, and Fishing Agenda: For Occupational Safety and Health Research and Practice in the U.S. Agriculture, Forestry, and Fishing Sector*, Washington, D.C.: National Institute for Occupational Safety and Health, December 2008.

safety are expected). Although we could not include this new prioritization framework in our assessment, applying the framework to our results could further inform future directions. For this project, actions were rated according to the scale in Table 4.6.

Information Quality

Information quality encompasses a broad range of information types (from qualitative to quantitative), collected through different means, and for different purposes. This criterion assesses the overall ability of an action to provide information that is of high quality to stakeholders and end users through scenarios that encompass issues of generalizability and analytical rigor. In cases where the action does not refer to the use of a specific data or information source, we assessed the potential of the collected information or data to be high quality; see Table 4.7.

Table 4.6
Program Surveillance Goals and Priorities Scale

Rating	Program Surveillance Goals and Priorities Scenarios
1	Action is considered complete.
2	Action is considered to be of moderate to low importance.
3	Action is considered to be important.
4	Action is considered to be very important.
5	Action is considered to be highly important.

Table 4.7
Information Quality Scale

Rating	Information Quality Scenario
1	There is no existing information available to address the action.
2	Sources of information or data do not fully support meeting the action (e.g., no categorization of worker type or farm size). Information collected would suffer from severe limitations, such as small number of respondents, small number of cases, long survey intervals, limited geography or population groups, and other issues of generalizability.
3	Data can be used to produce summary-level estimates but might not be in a form specific enough to conduct detailed analyses. The data may suffer from some limitations (described in rating 2); however, data strengths outweigh weaknesses. There is moderate potential for the information collected or produced to be of high quality (based on assumed methods and population coverage).
4	Data are high quality (e.g., collected regularly, have standardized protocols, have large geographic and population coverage, and allow for subgroup inferences) and are useful for many purposes but do not perfectly address the specific action. Information collected or produced has good potential to be of high quality (based on assumed methods and population coverage).
5	Data are high quality (see rating 4) and directly address the action. Information collected or produced has high potential to be of high quality (based on assumed methods and population coverage).

Action Impacts

The final criterion focuses on the impacts of actions on stakeholders and the potential for actions to provide useful information; see Table 4.8. Along with the program priorities and quality criteria, understanding the potential impacts and utility of actions is important for assessing the trade-offs and consequences among actions, particularly those that are determined to be feasible for NIOSH to accomplish.

Analysis and Assessment of Actions

Our assessment of the feasibility and desirability of accomplishing actions consisted of quantitative and qualitative components. For the quantitative components, three members of the RAND team with expertise in public health surveillance, epidemiology, and program evaluation individually applied the criteria rating scales to each of the actions. Assessors compared ratings and determined points of agreement and disagreement. Disagreements were resolved through discussion among the entire team until consensus was obtained. Once ratings were finalized, for each action, we calculated average scores across criteria for three conditions: feasibility (average of the feasibility criteria), desirability (average of the desirability criteria), and overall achievability (average of all feasibility and desirability criteria). In addition, we ranked actions determined to be feasible according to their values, which we considered to be average desirability per estimated cost.

The ratings were then used to inform the qualitative component of our analysis. We first used results to perform a descriptive assessment in which we characterized the actions in a number of ways. Questions that guided our approach included the following:

- Which actions are most feasible? Which are least feasible?
- Which actions are most desirable? Which are least desirable?

Table 4.8
Action Impacts Scale

Rating	Action Impacts Scenario
1	Action would have definite negative consequences for stakeholders (e.g., eliminating data, reducing the value of existing information, creating hardships or harm).
2	Action has strong potential for negative consequences and uncertain positive impacts. Action would severely decrease the utility of existing information or create barriers to access.
3	Action has some potential for negative impact that could be mitigated through precautionary steps (e.g., robust training and data safeguards). Action would moderately decrease the utility of existing information or create minor barriers to access. Action would not have any discernible negative effects but would have uncertain positive impacts (might not provide additional value to end users or stakeholders).
4	Action would have minimal potential for negative impact and strong potential for positive impact (e.g., increase the utility of existing information and provide easier access), but barriers to proper implementation may limit impact.
5	Action has strong potential for positive impacts (e.g., provide new and greatly improved information to users) and little to no downsides.

- Which actions are highly desirable but show little feasibility?
- Which actions are highly feasible but show little desirability?

The descriptive assessment was used to determine a pared list of actions that balanced feasibility and desirability. We removed actions achievable through direct NIOSH action from consideration, because NIOSH AgFF Program leadership indicated that these would be carried out on an as-needed or on-request basis. Therefore, we focused the assessment on actions for which there were no existing plans for achievement.

Focusing on the pared list of actions, we performed a consequences and trade-off analysis that qualitatively examined the trade-offs of implementing actions. Although we obtained from NIOSH estimates of the overall program budget ($25 million in FY 2016), given the continual uncertainty regarding future resources, NIOSH was unable to provide guidance for allocation of funds across various spending categories (e.g., extramural or surveillance funding). Therefore, instead of using a cost ceiling that would have bound our analysis and acted as a guide for selecting among actions, we simply created multiple scenarios of actions (or sets of actions) to compare and assess expected trade-offs.

We tried to mitigate the inherent subjectivity in our assessment approach through three independent raters. Throughout the entire process, including the descriptive assessment and consequence and trade-off analysis, we followed the same procedure of individual assessments followed by group discussion and consensus-building. With this method, we were able to identify a range of perspectives for interpreting feasibility and desirability and determining the acceptability of various trade-offs between actions.

CHAPTER FIVE

Description of Recommendations and Actions

Tables 2.1 and 2.2 list the eight recommendations and 12 actions identified from the panel report. In this chapter, we provide descriptions of the recommendations and detail the strengths and limitations of each associated action using the assessment criteria as a framework (costs and other resources, partnerships, information availability and accessibility, policy, timing, program surveillance goals and priorities, information quality, and action impacts).

Theme 1: Define and characterize agricultural worker populations at risk

Developing standard definitions of *worker populations* and *work environments* for purposes of surveillance, research, and intervention among agricultural workers is important for making meaningful comparisons between different observations. However, agricultural production in the United States is characterized by extreme diversity in organizational patterns, farm size, geographic locations, characteristics of agricultural enterprises (such as production techniques and commodities), and the workforce employed. Therefore, constructing standard definitions can be challenging. Concise and current definitions used consistently across stakeholder groups can help characterize populations at risk and are thus essential for ensuring the proper development and targeting of surveillance, interventions, and the evaluation of health outcomes. Theme 1 includes one recommendation.

Recommendation 1: Develop standard definitions to help improve knowledge and understanding of populations at risk of worksite exposures

While the panel report provided direction by recommending that NIOSH focus on two priority populations—hired workers and children—in the future, new populations may be identified based on assessment of emerging trends or review of ongoing surveillance data. Standard definitions and guidance for their use are needed to ensure that surveillance activities, data analyses, and resulting communications rest on a solid foundation. One action is associated with recommendation 1.

Action 1.1. Develop concise definitions of populations at occupational exposure risk that are profiled by agriculture commodity specialization, demographic factors, work organization patterns, and agricultural enterprise characteristics. Enterprise characteristics should themselves be profiled by type of enterprise and use of emerging technologies.

The panel report offered specific guidance for NIOSH regarding developing a taxonomy for characterizing populations at occupational exposure risk. Ideally, a complete understanding of who is at risk would entail the development of an entire classification scheme whereby popula-

tions could be profiled by worker characteristics and work environments. Specifically, the panel report discussed profiling populations by demographic characteristics, specific AgFF commodity specialization, and work organization patterns. These factors are important to include because adverse occupational exposures will vary according to worker characteristics (e.g., age and gender), geographic location of operations, commodity specialization (e.g., fish farm, cereal crops, and type of livestock), and the specific tasks that are performed. Furthermore, the report notes that understanding the type of enterprise in which worksite tasks are performed (e.g., so-called conventional, organic, or natural farming) can provide surrogate information on the amount of labor or type of technologies involved, because organic or natural enterprises tend to require greater efforts to produce and market products. Finally, enterprise definitions that can also account for differences in the use of emerging technologies will provide information on changing worksite labor tasks and practices, which will have an effect on exposure and risk.

Basic approaches to addressing this action include (1) performing literature reviews on existing dictionaries and classification schemes to understand how different groups or industries currently classify agricultural surveillance factors, (2) a comparison of the similarities and differences between classification systems, (3) the development of a taxonomic system building on existing work, (4) vetting of the system with stakeholders, and (5) incentivizing uptake. Table 5.1 summarizes implementation plan components for action 1.1 and our assessment across criteria.

Partnerships: We did not identify any potential resource partners for this action. Such partners as EPA, the National Institutes of Health, USDA, and DOL were considered, but given the specificity of the subject matter, which generally falls under the NIOSH AgFF Program mission, it may be difficult to convince other entities to provide resources.

Capability partners: A number of research organizations have the capabilities necessary to carry out the development of a taxonomy for agricultural worker populations. These capabilities may include specific expertise and experience in agricultural injury and illness surveillance; access to analytical software, tools, databases, and libraries to support research activities; administrative support to fulfill contract requirements and monitor budgets; facilities and equipment (e.g., computing infrastructure) to facilitate efficient research activities; and managerial and supervisory support to ensure that projects run smoothly.

Cost and resources: We estimate that this action could cost approximately $150,000–$250,000. Costs are for funding of an extramural partner. The low end of the range reflects the heavy use of existing dictionaries to create a new taxonomic scheme. The high end of the range incorporates tasks to develop a strategy that promotes the uptake and use of the taxonomy.

Timelines: Based on NIOSH input, we estimated a five-month initiation time from concept development and release of a request for proposal to contract award. We estimated a

Table 5.1
Action 1.1's Implementation Plan

Action	Extramural Mechanism	Resource Partner	Capability Partner	Resources	Timeline
Action 1.1	Contract	—	Ag Centers, research organizations	$150K–$250K	5 months for initiation; 1–1.5-year duration

one-year to 18-month project duration because of the straightforward nature of the work and the accessibility of information needed to accomplish tasks.

Information availability and accessibility: The Dictionary of Terms for Agricultural Safety & Health Professionals was included as an appendix in the AgFF NORA.[1] The NORA also describes action steps to encourage the use of the dictionary among researchers and within new surveillance systems. While the dictionary offers broad coverage of agriculture terms, it is not specific to surveillance and is not structured in a way to directly allow for classification of worker populations by exposure-relevant characteristics. However, the dictionary, along with other dictionaries or glossaries for agricultural terms (e.g., the USDA's National Agricultural Library's Thesaurus and Glossary[2] and the AgroMedicine Dictionary[3]), can be modified or serve as a potential tool in the descriptive process. In addition, the Farm and Agricultural Injury Classification Code was developed to classify injuries in a manner relevant to exposures encountered during agricultural work and may be a useful reference source for developing definitions.[4]

Policy: We did not identify policy barriers specific to this action.

Program surveillance goals priorities: NIOSH AgFF Program leadership indicated that this action is an important priority issue.

Information quality: Based on the depth of existing work in this area, the potential quality of the information provided should be high.

Action impacts: The information gathered as a result of this action has the potential to be useful for multiple stakeholder types. A standard language across federal and state agencies, academic institutions, and end users would ensure that a comprehensive picture of injuries and illnesses among agricultural worker populations is being developed. While the potential utility of the action is great, in practice, it will be difficult to incentivize the uptake of common definitions across different groups. One reason for the difficulty relates to the variability inherent in agricultural work and worker populations, which manifests in different groups gathering data or characterizing populations for different purposes. A common taxonomy may lack the flexibility needed to serve the interests of all stakeholders. Where the taxonomy could be helpful is in establishing an ideal classification system if the ultimate purpose is injury and illness surveillance. However, given that surveillance data likely will be gathered through a piecemeal approach, relying on existing data sources created for reasons other than injury and illness estimations, it is uncertain how relevant an ideal classification system might be in practice.

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1 National Occupational Research Agenda Agricultural, Forestry, and Fishing Sector Council, *National Agriculture, Forestry, and Fishing Agenda: For Occupational Safety and Health Research and Practice in the U.S. Agriculture, Forestry, and Fishing Sector*, Washington, D.C.: National Institute for Occupational Safety and Health, December 2008.

2 USDA, "National Agricultural Library Glossary: F," web page, last updated December 1, 2016.

3 North Carolina Agromedicine Institute, *AgroMedicine Dictionary*, Greenville, N.C., undated.

4 D. J. Murphy, M. Purschwitz, B. S. Mahoney, and A. F. Hoskin, "A Proposed Classification Code for Farm and Agricultural Injuries," *American Journal of Public Health*, Vol. 83, No. 5, 1993.

Theme 2: Review ongoing or new data sources for injury and illness surveillance among agricultural workers

The 2008 National Academies report called for a comprehensive surveillance system.[5] However, given resource constraints and decreasing rates of agricultural worker injuries, a comprehensive and broad-based surveillance effort may not be feasible or warranted. In the absence of a comprehensive system, NIOSH must develop a strategy for determining priority populations, settings, or hazards or exposures to target; promising sources for obtaining worker safety and health data; and partnerships to engage for surveillance initiatives. The panel report offered an initial strategy for assessing surveillance systems and data sources through priority targets (very large farms and nonfamily farms, hired workers, and children). Theme 2 includes four recommendations.

Recommendation 2: Focus surveillance efforts on very large and nonfamily farms

Small farms compose the majority of farms in the United States. According to the 2007 Census of Agriculture, farms with less than $20,000 in annual production make up more two-thirds (69 percent) of all U.S. farms. However, these small farms generate less than 2 percent of total production of food and fiber.[6] This stands in contrast to the top 6 percent of farms, which accounted for an estimated 75 percent of production. In 2014, more than 98 percent of U.S. farms were family farms, of which most were small family farms with less than $350,000 in GCFI. While large-scale family farms (with $1 million or more in GCFI) accounted for about 3 percent of all farms, they had a disproportionate share of the value of production, at 47 percent. Additionally, nonfamily farms, composing about 1 percent of all farms, have an approximately 10 percent share of the value of production.[7] Large farms now dominate crop production in the United States, with most cropland on farms of at least 1,100 acres and many farms five and ten times that size.[8] Clearly, the trend in U.S. agricultural production has been to shift away from small farms to very large farms and nonfamily farms. Consequently, these types of farms now employ the vast majority of hired agricultural labor. For these reasons, the panel report declared that "NIOSH must focus, on the basis of sound public health principle, on this worksite setting [very large farms and nonfamily farms]."[9] Below we discuss the action item associated with this recommendation.

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5 National Research Council and Institute of Medicine, *Agriculture, Forestry, and Fishing Research at NIOSH: Reviews of Research Programs of the National Institute for Occupational Safety and Health*, Washington, D.C.: National Academies Press, 2008.

6 USDA, *2007 Census of Agriculture: U.S. Summary and State Reports*, Vol. 1, Washington, D.C., 2009.

7 USDA, Economic Research Service, "Distribution of Farms and Value of Production Varies by Farm Type," web page, last updated March 8, 2017.

8 James M. MacDonald, Penni Korb, and Robert A. Hoppe, *Farm Size and the Organization of U.S. Crop Farming*, Washington, D.C.: U.S. Department of Agriculture, August 2013.

9 NIOSH, *Comments on the Agriculture, Forestry, and Fishing (AgFF) National Research Program Sponsored by the National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC)*, Washington, D.C., June 2012, p. 6.

Action 2.1. Conduct an assessment of data sources for providing information on very large farms and nonfamily farms.

While many of the surveillance data sources that NIOSH currently uses have some coverage of very large farms and nonfamily farms, the panel report recommended expanding the sampling frame through which these farms are identified by targeting entities, such as farm management companies and farm labor aggregators. We incorporated our assessment of action 2.1 under action 5.2, which calls for a comprehensive evaluation of all potential data sources for agricultural injury and illness surveillance. For more detail on the performance of action 2.1 across criteria, we refer readers to the section on action 5.2.

Recommendation 3: Expand the scope of knowledge on hired farmworker risk for occupational illness and injury

Hired farmworkers include direct-hire and contract laborers (indirect hires) and are considered one of the most economically disadvantaged populations in the nation.[10] The average number of hired farmworkers in the United States is estimated at about 1 million, and they compose about one-third of individuals working on farms (the rest consisting of self-employed operators and family members). Large portions of hired workers may be recent immigrants or in the United States illegally, with poor English-language skills and literacy.[11] Given these farmworkers' vulnerability, the panel report recommended focusing on hired farmworkers as a priority for surveillance efforts. Action 3.1 addresses this recommendation.

Action 3.1. Collaborate with the NAWS to field supplementary modules on occupational health outcomes among hired farmworkers and perform specific analyses on variability of risk.

NIOSH has a long history of collaboration with the DOL's NAWS (see Table 1.1). Following the first occupational health supplement to the NAWS in 1999, three additional surveys have been conducted to gather data on hired crop workers' injuries (2002–2004, 2008–2010, 2014–2015). Although the future of NIOSH-NAWS collaboration is uncertain, there is a possibility of addressing this action by revisiting existing data from the previous NAWS injury surveys. Below we present two mechanisms for this action: (1) establishing a new interagency agreement with DOL for a continuation of NAWS injury surveys (with the intention to perform analyses on variability of risk) and (2) direct NIOSH action through performing suggested analyses on the previous survey data that NIOSH possesses. The panel report specifically recommended that NIOSH perform analyses on the variability of injury risk with the size of hired-worker employment per farm. See Table 5.2.

Resource partners: ETA provides infrastructure for survey development, data collection, and data processing for surveillance purposes.

Capability partners: For the partner mechanism, this action pertains specifically to partnership with DOL on the NAWS. Because NIOSH does not itself administer the survey, DOL retains the capabilities necessary for fielding and managing survey data and providing technical support. There are no capability partners for the mechanism of direct action.

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[10] USDA, "Farm Labor: Background," web page, last updated September 27, 2016.

[11] Jeffrey S. Passel and D'Vera Cohn, "Share of Immigrant Workers in Production, Construction Jobs Falls Since 2007: In States, Hospitality, Manufacturing and Construction Are Top Industries," Washington, D.C.: Pew Research Center, March 26, 2015; William Kandel, *Profile of Hired Farmworkers, a 2008 Update*, Washington, D.C.: Economic Research Service, U.S. Department of Agriculture, 2008.

Table 5.2
Action 3.1's Implementation Plan

Action	Overall Mechanism	Resource Partner	Capability Partner	Resources	Timeline
Action 3.1	Partner outreach or development	ETA	ETA (NAWS)	~$1 million	9 months for initiation; 3-year duration
Action 3.1	Direct action	—	—	Uncertain	As needed

Cost and resources: For the partnership mechanism, through review of past interagency agreements between NIOSH and DOL, we estimate that the cost of this action would approximate $1 million for an injury module to be added to the NAWS for a three-year period. The prior interagency agreement specified a sample size of 1,500 at a cost of approximately $700,000. We assumed that an increased sample size would be required in future years to generate stable estimates, at a cost of $250,000–$300,000. For the direct-action mechanism, resources expended will be uncertain, and we do not assign a fixed cost. If NIOSH already has data on hired worker employment per farm, then analyses could be performed or data assessed for feasibility in producing meaningful estimates (given small sample sizes). (NIOSH could also request the employment data from DOL if NIOSH does not already possess them.) Overall, however, the resources required to carry out these assessments may be too much given the reallocation of labor to different projects, because the DOL and USDA interagency agreements were discontinued.

Timelines: For the partnership mechanism, based on NIOSH input, we estimated a nine-month initiation period that reflects the time needed to put together an interagency agreement with DOL. The surveys are typically carried out in three-year intervals to amass a large enough sample size to perform statistical analyses. For the direct-action mechanism, NIOSH has indicated that, given resource constraints, new analyses on variability of risk could be carried out on request.

Information availability and accessibility: For the partnership mechanism, information is only available through an interagency agreement and primary-data collection. For the direct-action mechanism, NIOSH may already be in possession of the data or could obtain them directly from DOL.

Policy: Interagency agreements may require lengthy lead times and coordination to accommodate the ongoing priorities of the partner agency and regulatory requirements.

Program surveillance goals priorities: NIOSH AgFF Program leadership indicated that this action is a very important priority issue.

Information quality: Because NIOSH data are produced from the NAWS, a long-running and well-designed survey, we expect the quality of information to be high.

Action impacts: As with prior NAWS injury surveys, the data collected are highly useful and important for understanding the magnitude of injuries among hired crop workers and assessing trends in rates over time. Analyses on variability of risk would also be useful for developing interventions to reduce injury risks.

Recommendation 4: Improve surveillance coverage and knowledge of child agricultural worker populations

Child health and safety has been a long-standing priority of the AgFF Program. Under the FLSA, the minimum age for youth employment outside school hours is 12 in agriculture settings (with some restrictions), compared with 14 years in other types of worksites.[12] Under the parental exemption clause of the FLSA, youth of any age may be employed in any occupation on a farm owned or operated by their parents (or people standing in place of their parents).[13] Given their engagement in farm operations and lower experience or skill level, children in agriculture may face the same hazards affecting adults but exhibit greater vulnerability to injury and illness. The panel report offered two actions to address the recommendation.

Action 4.1. Improve the validity of the CAIS by extending the sample to include labor aggregators.

Since 1996, NIOSH has carried out the Childhood Agricultural Injury Prevention Initiative to promote the reduction of injuries and fatalities of youth on farms.[14] A major component of the initiative has been the ongoing surveillance of nonfatal injuries occurring among all youth exposed to hazards on farms. In 1998, NIOSH first collaborated with USDA's NASS to conduct the CAIS. Since the initial survey, the CAIS has been fielded six additional times (see Table 1.1). From 1998 to 2009, the CAIS found a 58 percent reduction in the number of injuries and a decline in rate from 16.6 injuries per 1,000 farms to 7.2 injuries per 1,000 farms.[15] While the declining injury rates are a success story, the panel report noted that the CAIS may not be providing an accurate assessment of child labor because of an incomplete sampling frame. The panel recommended that the validity of the CAIS be improved by extending the sample to include labor aggregators, for which a sample frame is already in use by the NASS surveys. To illustrate the magnitude of the issue, the panel report pointed to the NASS July 2011 quarterly survey of farms, which noted that direct-hire employment by farmers and ranchers was 836,000, while on-farm employment by labor aggregators was 350,000, or 30 percent of the overall total of hired farmworkers.[16] See Table 5.3.

Resource partners: USDA provides infrastructure for survey development, data collection, and data processing for surveillance purposes.

Table 5.3
Action 4.1's Implementation Plan

Action	Overall Mechanism	Resource Partner	Capability Partner	Resources	Timeline
Action 4.1	Partner outreach or development	USDA	USDA (NASS)	~$1 million	6 months for initiation; 1-year duration

[12] DOL, *Child Labor Requirements in Agricultural Occupations Under the Fair Labor Standards Act (Child Labor Bulletin 102)*, Washington, D.C., June 2007.

[13] DOL, "State Child Labor Laws Applicable to Agricultural Employment," web page, last updated January 1, 2017.

[14] NIOSH, "Childhood Agricultural Injury Prevention Initiative," web page, last updated April 10, 2017.

[15] NCC, "2012 Fact Sheet: Childhood Agricultural Injuries in the U.S. National Farm Medicine Center," Marshfield, Wisc., 2012.

[16] USDA, National Agricultural Statistics Service, *Farm Labor*, Washington, D.C., 2011.

Capability partners: This action pertains specifically to partnership with USDA on the CAIS. Because NIOSH does not itself administer the survey, USDA retains the capabilities necessary for fielding and managing survey data and providing technical support.

Cost and resources: We estimated that this action could cost about $1 million. The costs encompass USDA labor and resources surrounding survey development and testing, programming of data collection tools, training, development of communications materials and reports, data entry, and quality review. Costs are mainly driven by survey size, mode of administration (e.g., phone versus in person), and length of the data collection period. A review of prior interagency agreements showed that an increase in sample size of 25,000 increased costs by about 50 percent. We assumed that future surveys would require an increased sample size to produce stable estimates and that future surveys with NASS would cost approximately $1 million (for the CAIS and OISPA together).

Timelines: Because a sample frame has been developed for farm aggregators and is in use by the NASS surveys, we did not anticipate much additional time beyond the time required to put together an interagency agreement (six months per NIOSH input). Survey time frames are typically for one year.

Information availability and accessibility: The CAIS is a high-quality survey that has provided important data on childhood injuries since 1998. The NASS surveys already have a sampling frame that includes labor aggregators. Information is available only through an interagency agreement and primary-data collection.

Policy: Interagency agreements may require lengthy lead time and coordination to accommodate ongoing priorities of the partner agency and regulatory requirements. NIOSH has also noted that the Confidential Information Protection and Statistical Efficiency Act (CIPSEA) of 2002 has presented some constraints on future collaborations with USDA. CIPSEA establishes uniform confidentiality provisions across U.S. statistical agencies for information collected for statistical purposes.[17] The goal of the law is to ensure that information provided by participants in data collection efforts is used only for statistical purposes. While CIPSEA would not affect the collection of injury data by NASS, it may affect how NIOSH would obtain data. According to NIOSH, CIPSEA has resulted in additional requirements and restrictions in collaborations between NIOSH and USDA that did not exist previously.

Program surveillance goals and priorities: NIOSH AgFF Program leadership indicated that this action is an important priority issue.

Information quality: As the panel report noted, the NASS surveys are conceptually sound with strong sampling strategies, questionnaire design, data collection mechanisms, and data processing techniques. Because the CAIS is based on NASS survey procedures, the collected data are considered to be high quality.

Action impacts: Improved representativeness would increase the utility of CAIS data; however, there is uncertainty as to whether labor aggregators would be willing to discuss hired farmworker injuries or to assist with identifying individuals to respond. There is high potential for nonresponse.

[17] Public Law 107–347, Title V, Confidential Information Protection and Statistical Efficiency, December 17, 2002.

Action 4.2. Collaborate with the NAWS to field a supplementary module targeted at children who work as hired farmworkers on crop farms.

NIOSH has a long history of partnering with DOL to conduct injury surveys through the NAWS (see Table 1.1). Thus far, NIOSH has not developed a NAWS survey specifically aimed at characterizing child injuries and risks. According to NIOSH data tables for the CAIS, in 2012, there were 5,351 youth (<20 years old) injuries on crop farms, compared with 6,857 in 2009.[18] The majority of injuries in both years occurred in the ten to 15 age group. While the CAIS may be a rich source of child injury data, the NAWS is an employer-based, multistage probability sample survey that accounts for seasonal fluctuations in employment throughout the year. The NAWS also collects detailed data on demographic, social, and economic characteristics of hired workers. The NAWS focuses on hired crop workers ages 14 and older. See Table 5.4.

Resource partners: ETA provides infrastructure for survey development, data collection, and data processing for surveillance purposes.

Capability partners: This action pertains specifically to partnership with ETA on the NAWS. Because NIOSH does not itself administer the survey, ETA retains the capabilities necessary for fielding and managing survey data and providing technical support.

Cost and resources: The cost of developing and administering an injury survey through the NAWS surveys was estimated at about $2 million for a five- to six-year survey cycle, based on past interagency agreements (and assuming sample-size increases in the future). This cost covers payment to ETA and does not include labor and other resources expended internally within NIOSH to develop a child survey and perform analyses.

Timelines: Based on the process of finalizing an interagency agreement, we estimated an initiation time of nine months for this action. Because the number of child crop workers is small, it might take five to six years to collect enough data for statistical assessment of injury rates.

Information availability and accessibility: Because the NAWS surveys are ongoing, with multiple waves per year, they are a valid source for obtaining child injury data on crop farms. However, injury data are not routinely collected through the NAWS surveys and will only be collected if resources are provided. Overall, data are technically available and accessible, but there are resource barriers to actually obtaining the data.

Policy: Interagency agreements may require lengthy lead time and coordination to accommodate ongoing priorities of the partner agency and regulatory requirements.

Program surveillance goals and priorities: NIOSH AgFF Program leadership indicated that this action is an important priority issue.

Table 5.4
Action 4.2's Implementation Plan

Action	Overall Mechanism	Resource Partner	Capability Partner	Resources	Timeline
Action 4.2	Partner outreach or development	DOL	ETA (NAWS)	~$2 million	9 months for initiation; 5–6-year duration

[18] NIOSH, "Childhood Agricultural Injury Prevention Initiative: Childhood Agricultural Injury Survey (CAIS) Results," web page, last updated August 1, 2016.

Information quality: The data collected through the NAWS are considered high quality. However, because 14–17-year-olds are estimated to compose about 2–3 percent of all crop workers, it is likely that children in the NAWS surveys would need to be purposefully oversampled across a period of five to six years to produce a large-enough sample size for statistical analyses.

Action impacts: While the resulting information would provide new and useful data on the injury rates of child crop workers, there is the potential for adverse impacts on agricultural employer participation in the NAWS surveys if they became aware of the oversampling of children. Employers may be cognizant of the sensitivities to employing child laborers and therefore reluctant to participate for fear of negative repercussions, depending on survey findings. Any project that could result in a mistrust of the NAWS surveys by employers should be carefully designed to mitigate the risk that employers will stop NAWS participation in the future.

Recommendation 5: Establish a comprehensive understanding of data sources relevant to NIOSH agricultural surveillance-related programming

The 2008 *National Agriculture, Forestry, and Fishing Agenda* provided strategic research directions for the AgFF Program.[19] Intermediate goal 1.1 called for improving national and state-level surveillance by utilizing existing data systems or creating new databases to identify injuries, illnesses, hazards, and exposures within the AgFF sector. Action steps under this goal included assessing available surveillance systems and identifying gaps, expanding existing surveillance systems, and examining new data collection approaches (e.g., medical surveillance). Currently, no comprehensive catalog of existing data sources and surveillance efforts exists, but there is a large body of potential sources that could be assessed for their utility in injury and illness surveillance for agricultural worker populations (e.g., federal agricultural and occupational health surveys, state occupational health surveillance systems, trauma registries, death registries, claims data, workers compensation data, and electronic health records). Recommendation 5 includes two actions that we integrate, along with action 2.1, into one project (action 5.2) for implementation purposes.

Action 5.1. Reevaluate the surveillance mechanisms of USDA's NASS surveys for usefulness in NIOSH activities.

The panel report commended NIOSH's collaborations with USDA, noting that the NASS surveys are conceptually and operationally sound. Despite the surveys' strengths, the panel recommended that NIOSH reevaluate the usefulness of the NASS surveys for surveillance of agricultural worksite injuries because of various technical limitations. As with action 2.1, we consider action 5.1 to be a component of action 5.2. For more detail on the performance of action 5.1 across assessment criteria, see the section on action 5.2.

Action 5.2. Identify and evaluate the potential of existing data sources (including those currently or recently used by NIOSH) for illness and injury surveillance of agricultural workers.

We propose action 5.2 as a broad effort to systematically identify and evaluate potential injury and illness surveillance data sources at the organizational, state, and national levels. While

[19] National Occupational Research Agenda Agricultural, Forestry, and Fishing Sector Council, *National Agriculture, Forestry, and Fishing Agenda: For Occupational Safety and Health Research and Practice in the U.S. Agriculture, Forestry, and Fishing Sector*, Washington, D.C.: National Institute for Occupational Safety and Health, December 2008.

different sources have been assessed in individual efforts (e.g., workers' compensation), there has not yet been a comprehensive assessment of multiple data sources under a common evaluation framework so that comparisons can be made and trade-offs of different approaches clearly detailed. Action 5.2 would also encompass the work carried out by the Ag Centers (see Table 1.2), many of which, though regionally focused, may have relevance to other areas of the country or even nationally. We believe that actions 2.1 and 5.1 could be carried out as part of the scope of work for action 5.2.

One possible approach to this action would involve performing a comprehensive review of sources through literature reviews and expert engagement. Data sources could be assessed through an evaluation framework, using such criteria as sustainability, nonresponse and respondent bias, data completeness, ability to assess trends, ability to construct useful sampling frames, and utility of collected data. Comparative analyses would assess trade-offs among sources for surveillance purposes and recommendations would be made for improvements and a strategy forward. See Table 5.5.

Resource partners: Potential partners for this action may include institutions that champion certain data sources for broad-based use, such as NIOSH's CWCS. Workers' compensation has been discussed as a possible source for injury and illness data, and while there are many limitations to overcome (e.g., farmworkers are not covered in many states), an in-depth examination of when and where workers' compensation data may be most helpful should be incorporated into this action. Although CWCS is not likely to be a funding partner, it could help support outreach efforts and engage in technical tasks with grant or cooperative agreement awardees.

Capability partners: A number of research organizations have the capabilities necessary to carry out an evaluation of potential surveillance data sources. One promising partner is the NCC because it is already conducting a broad assessment of different data sources for child injuries and is also exploring the possibility of merging different data sets at the national level to obtain a fuller picture of child injuries and illnesses. As shown in Table 1.2, other Ag Centers are also engaged in research to examine the agricultural surveillance potential of different data sources. In general, important capabilities for achieving this action may include specific expertise and experience in agricultural injury and illness surveillance sources; access to analytical software; tools, databases, and libraries to support research activities; administrative support to fulfill grant requirements and monitor budgets; facilities and equipment (e.g., computing infrastructure) to facilitate efficient research activities; and managerial and supervisory support to ensure that projects run smoothly.

Cost and resources: We estimated the low range of this action to be $350,000 and the high range $800,000, based on Ag Center discussions and the level of evaluation performed. The low-end estimate reflects a comprehensive review of data sources, based on existing infor-

Table 5.5
Actions 2.1, 5.1, and 5.2's Implementation Plan

Action	Extramural Mechanism	Resource Partner	Capability Partner	Resources	Timeline
Actions 2.1, 5.1, 5.2	Grant or cooperative agreement	NIOSH's CWCS	Ag Centers (NCC), research organizations; federal and state data collection agencies	$350K–$800K	2 years for initiation; 2–5-year duration

mation, with the goal of creating a complete list of the universe of sources and doing a strong evaluation. The project would also assess trade-offs among sources. Not all sources will have publicly available technical information, so this work would require reaching out to individuals to gather information. The high-end estimate includes the low-end estimate tasks and, in addition to the evaluation, would involve obtaining data from the most-promising sources. This would enable a comparative analysis of injury and illness estimates, and the quantitative assessments could help NIOSH develop a strategy for using a patchwork of sources to create a national picture for prioritized farmworker populations.

Timelines: We estimated a two- to five-year project duration and note the need in some cases for developing relationships to facilitate data access.

Information availability and accessibility: Availability and accessibility will depend on the type of data. Some data sources will be readily accessible, but others may require payments, building relationships, or entering into negotiated agreements regarding data use.

Policy: Possible challenges may arise if data-sharing across agencies is pursued to carry out this action.

Program surveillance goals and priorities: NIOSH AgFF Program leadership indicated that this action is a very important priority issue.

Information quality: While the data under evaluation will likely be of variable quality, if a comprehensive and systematic evaluation scheme is used, we expect the outcome of this action (i.e., a comprehensive evaluation of the strengths and limitations) to be of high quality.

Action impacts: Given the need for new surveillance directions, this action would exhibit important impacts, particularly if it acts as a means for promoting collaboration across Ag Centers to disseminate promising practices or findings. In particular, such a project could help mitigate the negative stakeholder impacts that may result from the discontinuation of the NASS surveys and the NAWS and aid in NIOSH decisionmaking.

Theme 3: Analyze, report, and communicate surveillance findings to address the needs of multiple stakeholders

Many of the panel report recommendations focused on improving the utility of surveillance data through better coverage of priority populations and enhanced data quality. Theme 3, however, seeks to improve data utility through better analysis and communication efforts. Without proper interpretation and communication of data, results may not yield desired public-health impacts. One of the goals of surveillance is to support the development and evaluation of interventions designed to reduce worker injury and illness. To effect change, it is important to have a proper understanding of who exactly is at risk and why. To that end, theme 3 includes two recommendations that address the appropriate definition of vulnerable groups, identification of the context in which workers perform their jobs, and the development of communication materials to ensure that surveillance results are translated to practice.

Recommendation 6: Reconsider analytical and reporting approaches for conveying child agricultural worker safety and health risks

NIOSH has traditionally used grouped five-year age cohorts for children and youth (e.g., younger than ten, ten to 14, 15 to 19). The 15–19-year-old aggregation, however, includes individuals who would not be subject to federal child labor regulations for agricultural settings and does

not allow for assessment of differences across individual years, which may be important given the differing restrictions placed on 15- versus 16-year-olds in the FLSA. In addition to age groupings, according to the panel report, the majority (75 percent) of children working in agriculture are hired laborers as opposed to self-employed or paid or unpaid family workers.[20] This has implications for child protections under FLSA, as well as for identifying who is at risk. However, NIOSH data from the CAIS do not support the estimates cited by the panel report (which was based on a 1998 Government Accountability Office report).[21] CAIS data show that household youth accounted for about 66 percent of youths working on farms overall. For working youth younger than 16, 86 percent are household youth. Household youth account for 52 percent of farmworkers ages 16–17 and 48 percent of farmworkers ages 18–19.[22] Regardless, because NIOSH data are an important input into policy decisions regarding child labor on farms, it is important to ensure that reported data accurately reflect the realities of children's work practices. As described in actions 6.1 and 6.2, the panel report encouraged NIOSH to identify alternatives to its current age groupings for youth, as well as to explore stratification of data into at least three divisions: those employed within agricultural enterprises, those who are self-employed, and unpaid family workers contributing to agricultural enterprise.

Action 6.1. Identify feasible, desirable alternatives to five-year age groupings for child agricultural workers (<18 years old).

This action is easy to achieve because NIOSH is already in possession of data from the CAIS and has indicated that redoing statistical analyses for different age groupings is straightforward and technically simple. However, as indicated below, redoing analyses and issuing new reports with injury estimates for alternative age groupings may be difficult given NIOSH's resource constraints. See Table 5.6.

Resource partners: Because this work would be undertaken by NIOSH with existing data, there are no potential resource partners for this action.

Capability partners: We did not identify any capability partners for this action.

Cost and resources: We estimated that resources expended will be uncertain, and we did not assign a fixed cost. In this case, NIOSH has indicated that analyses could be carried out on an as-needed basis. However, we do not know when such a request might be made and the exact nature of such a request. Because NIOSH already has the needed data, different kinds of analyses could be performed. Therefore, given the uncertainty regarding how this action might

Table 5.6
Action 6.1's Implementation Plan

Action	Overall Mechanism	Resource Partner	Capability Partner	Resources	Timeline
Action 6.1	Direct action	—	—	Uncertain	As needed

[20] NIOSH, *Comments on the Agriculture, Forestry, and Fishing (AgFF) National Research Program Sponsored by the National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC)*, Washington, D.C., June 2012.

[21] Government Accountability Office, *Child Labor in Agriculture: Changes Needed to Better Protect Health and Educational Opportunities*, Washington, D.C., 1998.

[22] NIOSH, "Childhood Agricultural Injury Prevention Initiative: Childhood Agricultural Injury Survey (CAIS) Results," web page, last updated August 1, 2016.

unfold, we did not assign a cost estimate. Overall, however, the resources required to carry out these assessments may be too much given the reallocation of labor to different projects because the DOL and USDA interagency agreements were discontinued.

Timelines: NIOSH has indicated that, given resource constraints, new analyses with different age groupings could be carried out on request.

Information availability and accessibility: NIOSH is already in possession of the data but is not the owner of them. New analyses and reporting would require USDA approval.

Policy: Per NIOSH's interagency agreement with USDA, any new analyses and release of information would first require USDA approval.

Program surveillance goals and priorities: NIOSH AgFF Program leadership considered this action to be complete.

Information quality: Because the CAIS is based on NASS survey procedures, the collected data are considered to be high quality.

Action impacts: This effort would enhance the utility of childhood agricultural surveillance data. In particular, although overall childhood injuries have declined over the past decade, injuries among children younger than ten have been increasing during the past several years.[23] Several stakeholders have noted that it is crucial to have raw, deaggregated data or customizable data to accurately identify trends relevant for prevention.

Action 6.2. Stratify data pertaining to children into at least three divisions: those employed within agricultural enterprises, those self-employed, and unpaid family workers contributing effort within agricultural enterprises.

To accurately characterize the population of child workers at risk, the panel recommended parsing data across the three child-worker categories: hired, self-employed, and unpaid (family). If differences between groups exist, then interventions can be appropriately developed and targeted. NIOSH has released demographic data indicating whether children are hired or unpaid (family members).[24] According to NIOSH, it would be difficult to release existing data on children who are self-employed, given the small numbers of youth who would be the primary farm operator. See Table 5.7.

Resource partners: Because this work would be undertaken by NIOSH with existing data, there are no potential resource partners for this action.

Capability partners: We did not identify any capability partners for this action.

Cost and resources: We estimated that resources expended will be uncertain, and we did not assign a fixed cost. In this case, NIOSH indicated that analyses could be carried out on an as-needed basis. However, we do not know when such a request might be made and the exact nature of such a request. Therefore, we did not estimate costs for this action. As stated, NIOSH

Table 5.7
Action 6.2's Implementation Plan

Action	Overall Mechanism	Resource Partner	Capability Partner	Resources	Timeline
Action 6.2	Direct action	—	—	Uncertain	As needed

[23] NCC, "2014 Fact Sheet: Childhood Agricultural Injuries in the U.S.," Marshfield, Wisc., 2014.

[24] NIOSH, "Childhood Agricultural Injury Prevention Initiative: Childhood Agricultural Injury Survey (CAIS) Results," web page, last updated August 1, 2016.

has released demographic data from the CAIS for two of the strata recommended in the action and thus considers this action to be completed (barring additional requests).

Timelines: Unless there are specific requests for additional data to be stratified according to the action-item categories, NIOSH has no plans to do further reporting.

Information availability and accessibility: NIOSH is already in possession of the data.

Policy: We did not identify specific policy barriers related to this action.

Program surveillance goals and priorities: NIOSH AgFF Program leadership considered this action to be important.

Information quality: Because the CAIS is based on NASS survey procedures, the collected data are considered to be high quality. While NIOSH has reported on hired and unpaid (family) child workers through its demographic assessments, NIOSH cannot stratify injury data using the same categories because numbers would be too small to produce reliable estimates.

Action impacts: This effort has already enhanced the utility of childhood agricultural surveillance data by generating information on the type of child employment on farms, which may influence the types of hazards and exposures experienced.

Recommendation 7: Identify context in reports and analyses authored by NIOSH or regional centers

As discussed in recommendation 1, agricultural enterprises exhibit considerable complexity across populations (e.g., demographics), work environments (e.g., conventional versus organic farms), and worksite tasks (e.g., machinery operation). Reports that lack details on these contexts limit the ability to accurately define vulnerable groups and identify potentially hazardous work settings. Including these descriptions in reports will enable optimal comparability of surveillance data from different sources and will ensure that findings are appropriately targeted toward the correct occupational cohorts. One action is associated with this recommendation.

Action 7.1. When reporting on surveillance activities, NIOSH and Ag Centers should provide information on agricultural enterprises, known operational worksite characteristics, and other useful descriptors that provide context for understanding occupational cohorts at risk.

While this action focuses on future surveillance data that would be collected by NIOSH and the Ag Centers, we also assessed whether NIOSH could add these descriptors to existing data (e.g., from the NAWS or NASS surveys). NIOSH indicated that they are in possession of some of this contextual information, and in the past have provided details on farming operations and employment characteristics for hired workers and youth. See Table 5.8.

Resource partners: We did not identify any potential resource partners for this action because it is specific to NIOSH and the NIOSH-funded Ag Centers.

Table 5.8
Action 7.1's Implementation Plan

Action	Overall Mechanism	Resource Partner	Capability Partner	Resources	Timeline
Action 7.1	Partner outreach	—	Ag Centers	Uncertain	Ongoing, as needed

Capability partners: The panel report specifically called for NIOSH and the Ag Centers to carry out this action.

Cost and resources: We estimated that resources expended will be uncertain, and we did not assign a fixed cost. In this case, NIOSH indicated that information could be provided on an as-needed basis. However, we do not know when such a request might be made and the exact nature of such a request. There should be little cost associated with NIOSH providing the contextual information it already possesses (but has not yet reported publicly) on request, but it is difficult to estimate costs without more information on the exact requests.

Timelines: Timelines are also uncertain depending on future surveillance projects carried out by NIOSH and the Ag Centers. For existing data, unless there are specific requests for additional context to be given, NIOSH has no plans to do further reporting.

Information availability and accessibility: NIOSH is already in possession of some information for existing NASS surveys and NAWS data. For future surveillance efforts, contextual information availability will depend on the source used for gathering injury and illness data.

Policy: We did not identify specific policy barriers related to this action.

Program surveillance goals and priorities: NIOSH AgFF Program leadership considered this action to be an important priority.

Information quality: The ability to carry out this action depends on the overall quality and completeness of the data used. Some data sources may provide rich contextual information, but others, particularly those not focused on agricultural populations (e.g., hospital records), may lack basic descriptors of worksite operations and environments.

Action impacts: This effort would enhance the utility of surveillance data by ensuring proper characterization of populations at risk and proper interpretation of results and by enabling the identification of populations and settings for targeted interventions.

Theme 4: Build a foundation for addressing emerging issues in agricultural safety and health through partnership development and research

Agriculture, especially animal production, has been undergoing dramatic changes because of emerging technology and consumer demands. New or emergent threats could either directly result in harm to agricultural workers or create new conditions that will require adapting surveillance approaches. Theme 4 consists of one recommendation.

Recommendation 9: Address emerging issues in animal agricultural production practices

Action 8.1. Establish partnerships to monitor zoonotic diseases in animal and human populations.

According to the panel report, since 1980, more than 75 percent of new human infectious diseases on a global scale have been vector-borne or zoonotic. The emergence of zoonotic diseases arose from multiple factors, including global travel patterns, climate issues, interspecies pathogen transfer, and environmental degradation. Given their proximity to animal hosts, agricultural workers are canaries in the mineshafts for zoonotic disease outbreaks, according to the

panel report.[25] To mitigate these risks, the panel report encouraged NIOSH to form partnerships with varied groups, including OIE, IPPC, and the Codex Alimentarius Commission and to support partnership development between Ag Centers and state departments of agriculture (that house state veterinarian offices). These partnerships could help to monitor epizootics that could harm agricultural workers, particularly livestock workers.

A potential approach for this action is to develop a strategy for determining the types of partnerships needed based on desired outcomes, then prioritizing partner-development activities. See Table 5.9.

Resource partners: Potential partners with opportunities to facilitate outreach and support activities include USDA and NCEZID.

Capability partners: Partners specifically named in the panel report include OIE, IPPC, the Codex Alimentarius Commission, and the Ag Centers (which were recommended to partner with state departments of agriculture and veterinarian offices to develop means for data-sharing and communications).

Cost and resources: Ongoing partnership development will result in uncertain costs, so we do not present fixed estimates. Internal NIOSH resources should be expended to develop a strategy, however, for partnership development based on a list of desired (and prioritized) outcomes. For instance, if global travel is an immediate concern, then international partnerships should be prioritized. However, if state or regional effects are considered of high concern, supporting collaborative activities between veterinarian groups and Ag Centers should be given higher priority.

Timelines: We do not present fixed timeline estimates for partnership development because this should be an ongoing activity. Developing a strategy for partnership engagement, however, is a process that could take up to six months and should be based on program priorities.

Information availability and accessibility: This action focuses on partnership development; therefore, information-related criteria are not as directly relevant. Information availability is difficult to assess because it is unclear what kinds of data or information might be gathered or produced from new partnerships.

Policy: There are no relevant policy factors noted.

Program surveillance goals and priorities: NIOSH AgFF Program leadership indicated that this action is an important priority.

Information quality: Information quality is difficult to assess for this action because it is unclear what kinds of data or information might be produced from new partnerships.

Table 5.9
Action 8.1's Implementation Plan

Action	Overall Mechanism	Resource Partner	Capability Partner	Resources	Timeline
Action 8.1	Partner outreach or development	USDA, NCEZID	OIE, IPPC, Codex Alimentarius Commission, Ag Centers	Uncertain	Ongoing; 6 months for strategy development

[25] NIOSH, *Comments on the Agriculture, Forestry, and Fishing (AgFF) National Research Program Sponsored by the National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC)*, Washington, D.C., June 2012, p. 13.

Action impacts: Through developing partnerships, new information on preventing or mitigating zoonotic disease outbreaks could be obtained that would be of high utility to stakeholders.

Action 8.2. The NCC should monitor developments in alternative animal production systems and develop guidelines for children and youth workers within these systems.

The panel report noted that alternative animal production methods include new technology and livestock handling practices that require new models of injury prevention. In particular, so-called free-range housing and increased access outdoors may have implications for human health (zoonosis, water contamination, and other environmental changes). In addition to suggesting that NIOSH monitor the impact of these new systems on health and safety, the panel recommended that the NCC monitor developments and develop guidelines for youth working in these systems. The NCC provides services for youth living and working in agricultural environments; provides guidance for injury prevention interventions for children; offers the North American Guidelines for Children's Agricultural Tasks, which are designed to assist in identifying appropriate farm tasks for children;[26] addresses complex issues related to childhood injuries; and issues mini-grants to support pilot studies designed to prevent agriculture-related injuries and illnesses in children.[27] The NCC is the most appropriate partner for this task given that it is equipped to address complex and controversial issues related to childhood injuries and that alternative animal production occurs primarily on small local farms, where youth are likely to reside or work. See Table 5.10.

Resource partners: We did not identify any potential resource partners for this action because the subject matter appears highly specific to the mission of the NIOSH AgFF Program.

Capability partners: The NCC is one of NIOSH's Ag Centers. While the partnership is already in place, additional partner outreach may be required to better understand alternative animal production systems.

Cost and resources: We estimated a cost of about $350,000–$500,000 to study effects of alternative animal production systems, develop guidelines for children, and present a strategy for monitoring developments in these systems. These costs reflect the labor and resources needed to perform information-gathering tasks (e.g., literature reviews and engagement with subject-matter experts), develop and disseminate guidelines for widespread adoption and use, and craft a system for continuous monitoring of changes. These costs do not include maintenance activities, such as updating guidelines and continual monitoring.

Timelines: NIOSH cannot add this task to the existing scope of work of the NCC under the current cooperative agreement. Therefore, unless a specific sole-source or contract mecha-

Table 5.10
Action 8.2's Implementation Plan

Action	Overall Mechanism	Resource Partner	Capability Partner	Resources	Timeline
Action 8.2	Partner outreach	—	NCC	$350K–$500K	Next Ag Center cycle

[26] Marshfield Clinic Research Foundation, "About NAGCAT," web page, undated.

[27] NIOSH, "Childhood Agricultural Injury Prevention Initiative," web page, last updated April 10, 2017; NCC, "National Children's Center for Rural and Agricultural Health and Safety," web page, undated.

nism is released for the NCC to carry out this work, the action cannot be addressed until the next cycle of Ag Center cooperative agreements.

Information availability and accessibility: Alternative animal production systems are relatively new and evolving rapidly. There are hypotheses—e.g., increased risk of zoonotic diseases from so-called free-range livestock—about the potential injuries and illnesses associated with this new style of agriculture. However, there are limited data available on the number of alternative livestock production farms or their health effects.

Policy: There are no relevant policy factors noted.

Program surveillance goals and priorities: NIOSH AgFF Program leadership indicated that this action is an important priority.

Information quality: There are very limited or no data to support this action, and the NCC, with NIOSH support and collaboration, will need to collect data on the development of alternative animal production systems and health effects on youth in agriculture settings. Collected information has potential to be high quality if studies are designed well.

Action impacts: This action has the potential to provide a great deal of new information to users on the development of alternative animal production systems, with an emphasis on the effects of these developments on humans, particularly youth health.

CHAPTER SIX

Results of Action Assessment

Table 6.1 displays consensus ratings for each of the actions across evaluation criteria. Overall, for the 11 actions, the three raters agreed on almost 38 percent of the ratings for criteria (i.e., scored an action the same number on a criterion rating scale), and two out of three raters agreed on 43 percent of ratings. (There were originally 12 actions overall, but for the assessment, we assumed that action 5.2 encompassed actions 2.1 and 5.1. In addition, we considered two achievement mechanisms for action 3.1, through direct action and partnerships.) Disagreements tended to occur when raters interpreted ratings scales differently, written assessments of actions across criteria were unclear, or a rater had specific knowledge pertaining to an action that presented a different perspective. Through discussions, we reworked rating scales to ensure that language was specific and understandable. For the majority of disagreements, raters differed by one point. We encountered no situation where ratings diverged widely.

After finalizing ratings, we calculated average scores across criteria for three conditions: feasibility (average of the feasibility criteria), desirability (average of the desirability criteria), and achievability (average of all feasibility and desirability criteria). Table 6.1 shows calculated averages for each action ranked by achievability score. As a reference, feasibility criteria included costs and other resources, partnerships, information availability and accessibility, policy, and timing. Desirability criteria included program surveillance goals and priorities, information quality, and action impacts.

Overall, we found that direct-action and extramural funding mechanisms tended to show higher overall achievability than did actions that depended on partner capabilities for implementation. This trend becomes apparent when actions are ranked by feasibility score—all direct actions and the majority of extramural funding actions fall in the top half of the distribution, and all actions using the partnership mechanism reside at the bottom. When actions are ranked by desirability scores, however, the result is mixed. The top actions are associated with all three mechanisms.

For the next set of analyses, we excluded actions achievable through direct action. These actions all revolve around NIOSH performing new analyses or reporting with existing data. NIOSH AgFF Program leadership has indicated that, given resource constraints, these kinds of activities would only be done on an as-needed basis or on request. Because NIOSH already has a plan for addressing these actions, we performed a second ranking exercise to determine the relative achievability, feasibility, and desirability of the remaining actions. Table 6.2 presents the average criteria ratings scores ranked by average achievability. The table also displays estimated action cost per year and proposed duration.

As another way to visualize the results, two scatterplots show the relationship between actions scored on desirability and feasibility. Figure 6.1 displays a scatterplot for actions with

Table 6.1
Average Criteria Rating Scores for Actions

Action Summary	Mechanism	Achievability Score	Feasibility Score	Desirability Score
3.1: NAWS, hired farmworker injury reporting	DA	4.33	4.00	4.67
6.2: Stratify child data	DA	4.17	4.33	4.00
1.1: Develop definitions or taxonomy	EXF	4.00	4.20	3.67
5.2: Evaluate sources of surveillance data	EXF	4.00	3.60	4.67
3.1: NAWS, hired farmworker injury survey	PART	3.88	3.40	4.67
6.1: Identify alternative age groupings	DA	3.67	4.00	3.33
7.1: Provide contextual information in reports	DA	3.67	4.00	3.33
4.1: Improve validity of the CAIS	PART	3.50	3.20	4.00
8.2: The NCC monitors alternative animal production systems and develops guidelines	PART	3.38	3.20	3.67
4.2: NAWS, child injury survey	PART	3.13	3.00	3.33
8.1: Partnerships for zoonotic disease	PART	3.13	3.00	3.33

NOTE: DA = direct action; EXF = extramural funding; PART = partnerships.

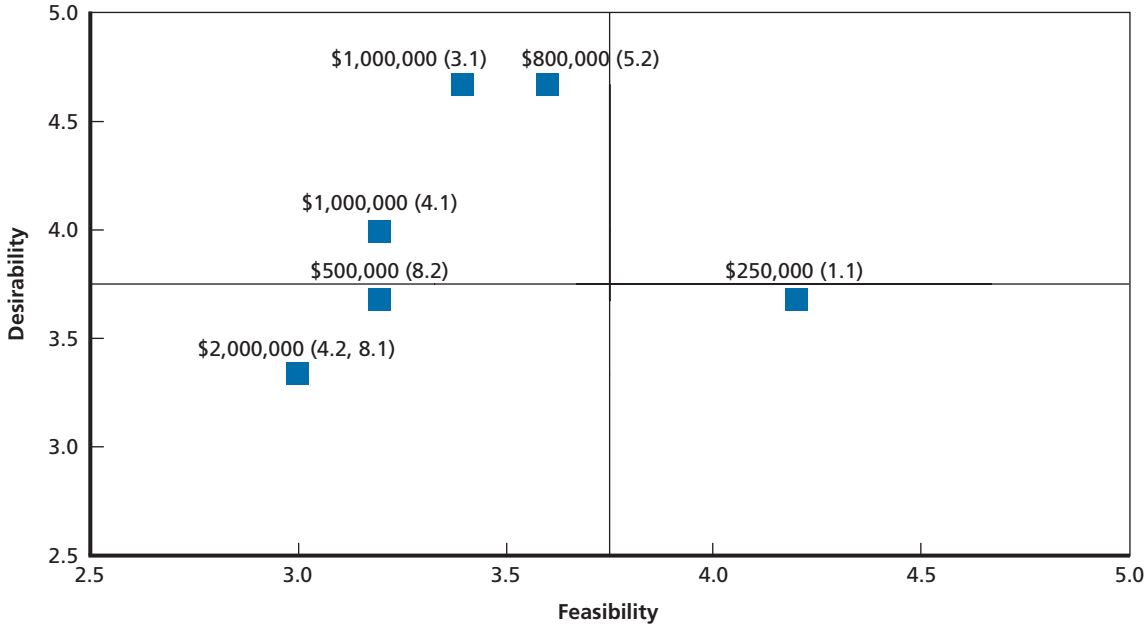
Table 6.2
Average Criteria Rating Scores for Actions, Excluding the Direct-Action Mechanism

Action Summary	Mechanism	Cost per Year[a]	Duration (years)	Achievability Score	Feasibility Score	Desirability Score
1.1: Develop definitions or taxonomy	EXF	$150K	1	4.00	4.20	3.67
		$170K	1			
5.2: Evaluate sources of surveillance data	EXF	$175K	2	4.00	3.60	4.67
		$160K	5			
3.1: NAWS, hired worker survey	PART	$330K	3	3.88	3.40	4.67
4.1: Improve validity of the CAIS	PART	$1 million	1	3.50	3.20	4.00
8.2: The NCC monitors alternative animal production systems and develops guidelines	PART	$175K	2	3.38	3.20	3.67
		$170K	3			
4.2: NAWS, child injury survey	PART	$330K	6	3.13	3.00	3.33
8.1: Partner for zoonotic disease	PART	Unknown	Uncertain	3.13	3.00	3.33

NOTE: EXF = extramural funding; PART = partnerships.

[a] The two costs reflect the satisfactory version of an action (upper row) and the ideal (lower row).

Figure 6.1
Scatterplot Showing Relationship Between Feasibility and Desirability Scores for Actions: Ideal Version (excluding the direct-action mechanism)



NOTES: Cost estimates are shown for the ideal version of the action. Action 8.1 had the same feasibility and desirability scores as action 4.2 but did not have assigned costs. The $2 million cost estimate refers to action 4.2 only.

RAND *RR1500-6.1*

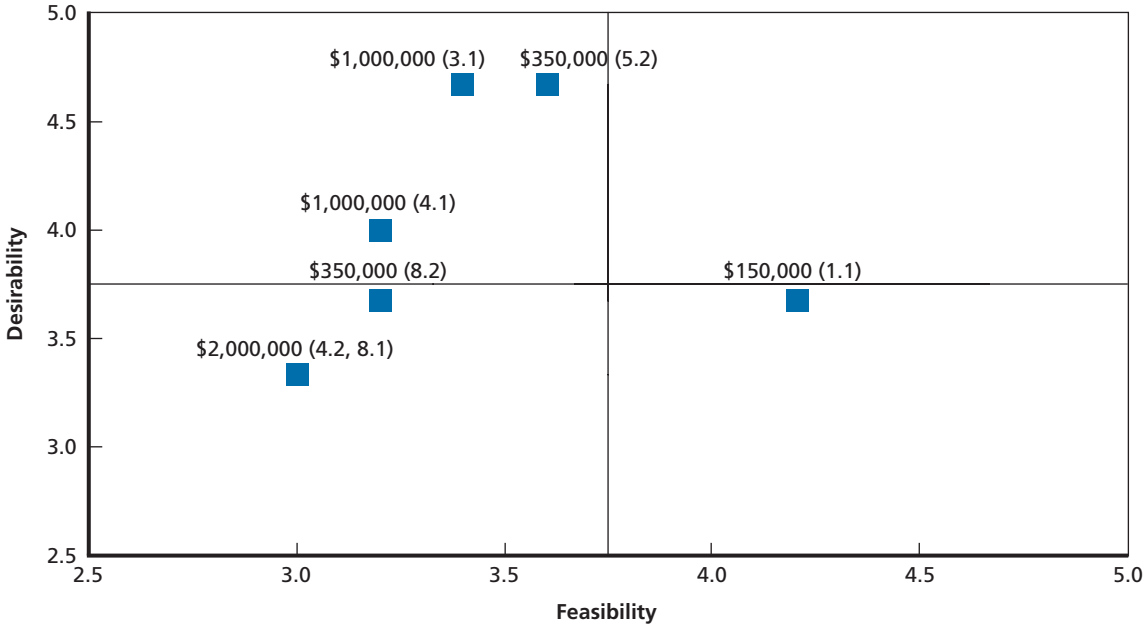
assigned costs for the ideal version, while Figure 6.2 displays a scatterplot for actions with assigned costs for the satisfactory version.

Based on these rankings and scatterplots, we determined the following action categories:

- **high priority** (high and moderate scores in combination): 1.1, 5.2
- **moderate priority** (moderate scores on both or high and low combination): 3.1, 4.1
- **low priority** (low on both feasibility and desirability scores): 4.2, 8.1, 8.2.

As stated, costs did not factor into the scoring process because we lacked information on the planned or desired allocation of resources within the AgFF Program or ceiling amounts for funds available to carry out different actions. Instead, Table 6.2 describes our assessment of costs per year for different actions, along with the proposed action durations. Overall, total costs range from a low of $150,000 to a high of $2 million. Many actions have two cost estimates associated with them. These costs reflect the satisfactory version of an action and the ideal version. The ideal version refers to our estimation of the types of tasks and time frames needed to either fully achieve the action or ensure that implementation results in meaningful impacts. The satisfactory version refers to our estimation of tasks and time frames that may result in lesser (compared with the ideal), but still acceptable, impacts (these two cost estimate

Figure 6.2
Scatterplot Showing Relationship Between Feasibility and Desirability Scores for Actions: Satisfactory Version (excluding the direct-action mechanism)



NOTES: Cost estimates are shown for the satisfactory version of the action. Action 8.1 had the same feasibility and desirability scores as action 4.2 but did not have assigned costs. The $2 million cost estimate refers to action 4.2 only.

RAND *RR1500-6.2*

types are reflected in the scatterplots). Taking into account multiple options for many actions, we determined the number of action options associated with the following total cost bins:

- $100,000–$499,999: four actions or options
- $500,000–$999,999: two actions or options
- $1,000,000–$5,000,000: three actions.

In the following sections, we describe the consequences and trade-offs across different actions, grouped by feasibility and desirability scores.

High-Priority Actions

Two actions were considered high priority, meaning that they had high scores in combination with moderate desirability or feasibility scores:

- **1.1:** Develop concise definitions of populations at occupational exposure risk, and profile them by AgFF commodity specialization, demographic factors, work organization patterns, worksite tasks across various enterprise types, and knowledge or use of emerging technologies.

- **5.2:** Identify and evaluate the potential of existing data sources (including those currently or recently used by NIOSH) for illness and injury surveillance of agricultural workers.

Both items scored high to moderate (5 to 3) across all criteria categories. Each can be achieved by an extramural grant or cooperative agreement. Action items achievable through extramural mechanisms generally tended to score higher in areas of feasibility than did action items achievable through partner outreach or development, particularly because of the lengthier or unknown timelines it would take to establish or build partnerships and negotiate agreements (including data use and data-sharing) and the uncertainty about information availability and access that could be obtained through such partnerships. While extramural funding mechanisms also require time and resources to initiate actions, there are existing and structured mechanisms in place to facilitate a straightforward exchange (i.e., funding for services). Compared with other potential extramurally funded action items, action 5.2 had favorable desirability assessments, scoring a 4 or 5 in all three categories, indicating potential for high impact if implemented. The impact of action 1.1 was scored less highly (3) because of uncertainty surrounding the potential use of action outputs.

Both high-priority actions were assessed under a low- and high-cost scenario, with the high cost being indicative of an ideal version of the action and the low cost capturing a satisfactory version of the action. The two versions differed in the level of effort and possible impacts. Action items will need to be evaluated individually to ascertain whether the ideal version would need to be implemented. For instance, to properly evaluate the potential value of existing data sources for injury and illness surveillance (action 5.2), the high-cost scenario may need to be implemented.

Our assessment involved many assumptions. Criteria for which we believe a greater degree of uncertainty exists include resource partnerships and information availability and accessibility. At this time, it is difficult to assess whether potential partners would be willing to assist in funding certain actions that cross mission areas. However, depending on whether it is easier (or harder) to develop resource partners, our ratings—and, therefore, feasibility rankings—could change. The second area of uncertainty relates to the information availability criterion. We assumed that it may be difficult to obtain certain data (e.g., state-level injury or illness data) or reach vulnerable populations for data collection. However, our assumptions may not align with the reality of carrying out these actions; therefore, our ratings may not be entirely accurate. Finally, we assumed that these actions have the potential for high impact, but, in practice, many barriers may limit the impact that is realized. These barriers may include unforeseen data limitations, poor recruitment numbers, or political or economic factors that cause administrative hardships.

High-Feasibility Actions

Only one action achieved what we considered to be a high feasibility score (greater than 4):

- **1.1:** Develop concise definitions of populations at occupational exposure risk, and profile them by AgFF commodity specialization, demographic factors, work organization patterns, worksite tasks across various enterprise types, and knowledge or use of emerging technologies.

Action 1.1 showed high average combined scores across all feasibility criteria, except for resource partnership, which scored a 2. This was due to the difficulty in determining whether other partners may be willing to fund this particular project in full or in part. Cost estimates for this action ranged from $150,000 (satisfactory version) to $250,000 (ideal version). While the ideal version would potentially be more impactful, the lower-cost, satisfactory option could still generate useful results for multiple stakeholders.

Many of the same assumptions and areas of uncertainty were discussed in the previous section, on high-priority actions. Specifically, for the feasibility criteria, uncertainties in resource partnerships and information availability and accessibility may drive how feasible accomplishing an action actually is in practice.

High-Desirability Actions

The top actions based on average desirability score are the following:

- **3.1:** Collaborate with the NAWS to field supplementary modules on occupational health outcomes among hired farmworkers and perform specific analyses on variability of risk.
- **4.1:** Improve the validity of the CAIS by extending the sample to include labor aggregators.
- **5.2:** Identify and evaluate the potential of existing data sources (including those currently or recently used by NIOSH) for illness and injury surveillance of agricultural workers.

Except for action 4.1, each of these actions scored very high (either a 4 or 5) on all three desirability assessment categories. Action 4.1 scored moderately (3) on action impacts. Every action that was considered highly desirable is expected to result in new, high-quality information.

Action 5.2 can be achieved through extramural grants or cooperative agreements, while actions 3.1 and 4.1 can be achieved through partnership actions. As discussed, achieving partnerships can involve lengthier or unknown timelines, as well as uncertainty about information availability and access. Therefore, it is not surprising that, when we remove feasibility from consideration, more partnership action items rise to the top of the list. This conditional assessment allows us to examine actions based solely on ideal wants or needs and potential impacts.

Again, there are specific assumptions and criteria for which a greater degree of uncertainty seems to exists. For the desirability criteria, as described in the section on high-priority actions, we assumed that these actions have the potential for high impact and for high-quality information to be produced. However, in practice, many barriers may limit both the impact and information quality that are realized. These barriers may include unforeseen data limitations, poor recruitment numbers, or political or economic factors that cause administrative hardships.

Finally, actions 3.1 and 4.1 were considered of high desirability but low feasibility because both require partnership actions. In general, these items scored lower in the areas of capability partners and policy. Given that both are both highly desirable, NIOSH may wish to consider spending some time to do a preliminary assessment of the feasibility of these actions. Once NIOSH confirms that few barriers exist for implementation, these actions could become higher priorities.

Low-Priority Actions

Three actions were considered lowest priority, having scored low in both feasibility and desirability:

- **4.2:** Collaborate with DOL's NAWS to field a supplementary module targeted at children who work as hired farmworkers on crop farms.
- **8.1:** Establish partnerships to monitor zoonotic diseases in animal and human populations.
- **8.2:** The NCC should monitor developments in alternative animal production systems and develop guidelines for children and youth workers within these systems.

Each of these actions would be achieved through a partnership mechanism and, therefore, tended to have lower feasibility scores. In particular, each of these three actions had a low score (2) in the category of information availability and accessibility, meaning that it was unlikely or uncertain if the information to achieve this item could be obtained. These actions also tended to score low or moderately (2 or 3) in other feasibility categories, such as resource partnerships and timing. There was considerable uncertainty in some ratings for actions 8.1 and 8.2, because the establishment of partnerships and monitoring developments are not as clear and structured as some of the other actions that propose actual projects to carry out or partnerships to pursue for the sake of achieving an objective (e.g., a partner for data collection through the NAWS surveys). Therefore, that uncertainty was reflected in our (lowered) ratings.

Alternative Ranking Schemes

We have presented a number of ranking schemes for prioritizing actions based on feasibility, desirability, and a combination of both. However, there are other ways to assess the information that may be helpful for decisionmaking. Table 6.3 displays actions ranked by estimated cost and includes both satisfactory and ideal versions of the various actions.

If decisions were based solely on cost, action 1.1 may be the most promising candidate regardless of version (satisfactory or ideal). Using a threshold of $500,000, satisfactory versions of actions 5.2 and 8.2 would also be potential candidates. While we do not recommend ranking by cost alone, because there are other important considerations, assessing the actions in different ways could help inform decisionmaking.

The other option for ranking is to simply use the overall achievability score, which encompasses the two high-priority areas but may also include action 3.1 as high priority, based on its moderate achievability score. Action 3.1 showed high desirability, but its low feasibility scores may indicate difficulty in accomplishing action tasks.

Conclusions

Overall, the results of our assessment suggest that AgFF Program leadership prioritize two actions based on their feasibility and desirability:

Table 6.3
Actions Ranked by Total Cost (low to high)

Action Summary	Mechanism	Version	Estimated Total Cost	Cost per Year	Duration (years)
1.1: Develop definitions or taxonomy	EXF	Satisfactory	$150K	$150K	1
1.1: Develop definitions or taxonomy	EXF	Ideal	$250K	$170K	1
5.2: Evaluate sources of surveillance data	EXF	Satisfactory	$350K	$175K	2
8.2: NCC monitors alternative animal production systems and develops guidelines	PART	Satisfactory	$350K	$175K	2
8.2: NCC monitors alternative animal production systems and develops guidelines	PART	Ideal	$500K	$170K	3
5.2: Evaluate sources of surveillance data	EXF	Ideal	$800K	$160K	5
3.1: NAWS, hired farmworker injury survey	PART	—	~$1 million	$330K	3
4.1: Improve validity of the CAIS	PART	—	$1 million	$1 million	1
4.2: NAWS, child injury survey	PART	—	~$2 million	$330K	6
8.1: Partnerships for zoonotic disease	PART	—	—	—	—

NOTE: EXF = extramural funding; PART = partnerships.

- **1.1:** Develop concise definitions of populations at occupational exposure risk, and profile them by AgFF commodity specialization, demographic factors, work organization patterns, worksite tasks across various enterprise types, and knowledge or use of emerging technologies.
- **5.2:** Identify and evaluate the potential of existing data sources (including those currently or recently used by NIOSH) for illness and injury surveillance of agricultural workers (includes actions 2.1 and 5.1).

Although we prioritized based on feasibility and desirability, AgFF Program leadership could assess the actions in different ways. For example, decisions could be based on (1) the lowest cost items; (2) the most-feasible actions regardless of desirability; or (3) the most-desirable actions, but scoped in a way that increases feasibility. In addition, program leadership could choose to pursue one or two actions that are considered highly impactful but also high cost and low in feasibility. Resources would be targeted to building partnerships or gathering the resources necessary to enhance the feasibility of accomplishing an action. Finally, our assessment did not weight criteria according to importance, as determined by AgFF Program leadership or program stakeholders. We assumed that each criterion was equally important, but, in reality, program leadership may have preferences for certain criteria to be weighted more heavily in the final ratings. Therefore, another option for the AgFF Program is to assign weights to the criteria and redo the assessment.

CHAPTER SEVEN

Conclusions

Although it is one of America's oldest and most valued industries, agriculture remains one of the most hazardous, with farmworkers experiencing high rates of injuries and illnesses. Since its inception in 1990, the NIOSH AgFF Program has spearheaded numerous surveillance initiatives to understand the magnitude of injuries and illnesses in agricultural worker populations, identify vulnerable groups, and evaluate the effectiveness of intervention measures. In carrying out its original mandate, the AgFF Program has demonstrated considerable success in bringing attention to the magnitude and severity of injuries and illnesses in farmworker populations, growing national and regional capacity for data collection and intervention development, and effecting meaningful change through education and institution of safer work practices. However, these successes have occurred in spite of challenges that the program has faced in instituting a comprehensive agricultural injury and illness surveillance program over the years. These challenges include the diversity of the agricultural industry itself; changing injury and illness patterns because of economic, technological, and environmental trends; and continual resource constraints that inhibit long-term coordination and strategic planning.

In the past decade, the AgFF Program has undergone two expert committee evaluations—one completed in 2006 for the period 1990–2006 and one completed in 2012 for the period 2006–2011. This report has summarized an analysis undertaken by the RAND Corporation to identify and assess options for action in response to the 2012 panel recommendations directly related to surveillance. The goal of this project was to provide NIOSH with a practical assessment of the *feasibility* and *desirability* of carrying out actions to meet recommendations, given current AgFF Program resources and priorities. This assessment involved a number of activities, including the identification of recommendations from the 2012 panel report, as well as options for actions to meet recommendations; the development of implementation scenarios for each action; the development of criteria to assess feasibility and desirability of achieving an action; and the assessment of actions through application of the criteria. For each action, criteria relevant to assessing feasibility (costs, partnership engagement, information availability and accessibility, policy barriers, timelines) and desirability (relevance to program priorities, information quality, and action impacts) were applied. Overall, 12 actions were identified from the panel report, and our assessment found two actions that had high feasibility and desirability scores:

- **1.1:** Develop concise definitions of populations at occupational exposure risk, and profile them by AgFF commodity specialization, demographic factors, work organization patterns, worksite tasks across various enterprise types, and knowledge or use of emerging technologies.

- **5.2:** Identify and evaluate the potential of existing data sources (including those currently or recently used by NIOSH) for illness and injury surveillance of agricultural workers (includes actions 2.1 and 5.1).

Also, a different prioritization scheme could be considered and would result in a different ranking of action items. While this evaluation prioritized based on feasibility and desirability, AgFF Program leadership could assess the actions in different ways. For example, decisions could be based on the lowest-cost items; the most-feasible actions regardless of desirability; or the most-desirable actions, but scoped in a way that increases feasibility. In addition, NIOSH could choose to pursue one or two actions that are considered highly impactful but also high in cost and low in feasibility. Resources would be targeted to building partnerships or gathering the resources necessary to enhance the feasibility of accomplishing an action. Finally, this assessment did not weight criteria according to importance, as determined by AgFF Program leadership or program stakeholders. We assumed that each criterion was equally important, but, in reality, program leadership may have preferences for certain criteria to be weighted more heavily in the final ratings. Therefore, another option for the AgFF Program is to assign weights to the criteria and redo the assessment.

Important limitations of this analysis should be noted. This assessment involved many assumptions, and several of the criteria we employed exhibit a great degree of uncertainty. These were most notable in the areas of resource partnerships, information availability, and action impact. Although we highlighted these assumptions throughout the report, it is important to note that changes in assumptions could greatly affect the overall evaluation. Additionally, the inherent subjectivity in our assessment approach must be considered. We attempted to mitigate this through a process of individual assessments from three independent raters, followed by group discussion and consensus-building. Despite these limitations, this assessment has identified actions that are both feasible and desirable and could be considered as future directions for ultimately improving injury and illness surveillance of agricultural worker populations.

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