Traumatic Injuries in Agriculture

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Between 1970 and 2000, the agriculture industry underwent many changes ranging from the increased use of technology to boost production to the slow, but constant erosion of the family farm in the United States. One aspect which has not changed over these 30 years is that agriculture remains one of the most hazardous industries in the United States (U.S. Department of Labor, Bureau of Labor Statistics, 1999). The occupational environment for this industry continues to present a wide variety of hazards to workers, including chemical exposures, noise, organic dusts, psychological stresses, and physical and mechanical exposures that may result in traumatic injury. Traumatic injury is unique in that there has been some level of farm-related surveillance activity at least since the 1930's, especially for traumatic fatalities, although the accuracy of the data was often questionable (National Safety Council, 1949; Burke, 1987).

In 1988, the National Coalition for Agricultural Safety and Health (NCASH) reported that "A sense of urgency¼arose mainly from the recognition of the unabating epidemic of traumatic death and injury in American farming¼" The NCASH report continued by noting, "Traumatic death and injury arise primarily from interaction with farm machinery, which accounts for over one-half of the agricultural traumatic deaths. The tractor has been identified as the predominant instrument of traumatic death and disabling injury¼Most of these deaths were the result of tractor overturns." Thus, for traumatic injury, the conclusion was reached that one-half of the traumatic injuries resulted from machinery and the most frequently involved item of machinery was tractors. The NCASH report noted that, "Other injuries result from inadequate farm building design and livestock handling. Again, injury-reducing design technologies are often available but are not widely used because of a lack of hazard recognition or because of economic constraints." Finally, the NCASH report stated "Agricultural injuries affect, in substantial numbers, children under the age of 16 and the elderly 65 and older." (National Coalition for Agricultural Health and Safety, 1989, pp.19). Traumatic injury was and is arguably the leading cause of identifiable death and injury of agricultural workers. This report will attempt to provide a limited review of important background agricultural traumatic injury surveillance activities and update the status of traumatic injury and death among agricultural workers in the U.S.

History of Fatal Occupational Injury Surveillance in Agriculture

The surveillance of occupational fatalities in the agriculture industry was initiated by the National Safety Council (NSC), which provided annual estimates of agricultural work deaths sporadically during the 1940's and then consistently from the 1950's forward (National Safety Council, 1949; National Safety Council, 1972). The NSC estimated work deaths through the use of an algorithm that assigned a probability that a death was occupational, given the cause of

death. The NSC also obtained additional information on farm-related deaths through the collection of farm-related death certificates from various State Agricultural Safety Specialists across the United States (National Safety Council, 1972). For most of the 1970's and early 1980's, these NSC data represented the best source of agricultural fatality data in the United States.

Beginning in 1985, the National Institute for Occupational Safety and Health (NIOSH) initiated the National Traumatic Occupational Fatalities (NTOF) surveillance system, which is a census of death certificates in the United States for work-related external causes of death of workers sixteen years of age and older (NIOSH, 1993). NTOF data were collected beginning with calendar year 1980 and are still being collected by NIOSH. Agricultural deaths in the NTOF are determined based on the usual occupation field on the death certificate. The NTOF provided the first census-based effort for counting occupational fatalities in the United States, and provided unique information on occupational fatalities during the 1980's and early 1990's. The NTOF provided an improvement over the NSC fatality data by attempting to count all occupational deaths occurring in the United States in a uniform way.

The Bureau of Labor Statistics (BLS) initiated their own census-based fatality surveillance system in 1992 called the Census of Fatal Occupational Injuries (CFOI). The CFOI uses a multiple record approach to identify work-related deaths in the United States, thus improving the capture rate of occupational fatalities (Toscano, 1993); independent source documents, or a source document and a follow-up questionnaire are used for determining work-relatedness. In addition, because multiple records are used, the specifics about each death are usually better than what is possible from death certificates, alone. This includes a better classification of the industry in which a specific fatality occurred. Given the advantages of the multiple record approach, the CFOI currently represents the best measure of agricultural occupational fatalities in the United States.

Despite the differences in these three approaches in assessing occupational deaths, there is a high degree of agreement among these data systems on the major issues associated with agricultural fatalities. Based on the NSC, NIOSH, and BLS surveillance data, it is evident that the agriculture industry has historically had both a high rate and a high number of occupational deaths when compared with other industrial sectors in the United States (National Safety Council, 1992; Myers and Hard, 1995; National Safety Council, 2000). Based on these data, or similar death certificate-based research, the most common cause of occupational agricultural death has consistently been identified as machinery, especially farm tractors (Bobick and Jenkins, 1992; Hard et al., 1999a; Murphy, 1990; Murphy, 1985; Myers, 1989; Myers and Hard, 1995; National Safety Council, 1992; Wilkinson and Field, 1990). Other usual causes of death include motor vehicles, animals, electrocutions, falls, and mechanical suffocations.

Other aspects of agricultural fatalities have also been consistently reflected in the literature. Older farmers and farm workers, while not consistently defined among different authors, have been identified at highest risk for work-related agricultural fatalities (Bobick and Jenkins, 1992; Hard et al., 1999a; Murphy, 1990; Myers, 1989; Murphy, 1985; Myers and Hard, 1995; Myers et al., 1999; Purschwitz and Fields, 1986; Wilkinson and Field, 1990). Similarly, much attention has been focused on youth under the age of 20 years who work in agriculture and have a higher

risk of fatal occupational injury compared to other working youth (Castillo et al., 1994; Castillo et al., 1999; Derstine, 1996; Hard et al., 1999b; Purschwitz, 1990; Shenker et al., 1995).

History of Non-fatal Occupational Injury Surveillance in Agriculture

The surveillance of non-fatal injuries has been less structured than surveillance systems for occupational fatalities. Since the 1970's, there have been a number of efforts initiated to assess work-related non-fatal injuries in the agriculture industry, but few have proven to be sustainable in the long term. Those systems that have been sustainable are state-based, rather than regional or national in nature. The first attempt to develop a national occupational injury surveillance system was conducted during the 1970's and early 1980's by the National Safety Council (Hanford et al., 1982). This system involved conducting three personal interviews with a farm operator over a one-year period. The survey used a standardized instrument developed by the NSC. Volunteers, usually coordinated by the State Extension Safety Specialists, conducted the surveys within participating states.

By 1982, a total of 31 States had conducted the NSC survey (Hanford et al., 1982), with an additional 3 States conducting surveys by 1985 (Hoskins et al., 1988a). However, at about the same time, it became apparent to the NSC and the Extension Safety Specialists conducting the surveys that the system was not sustainable. The success of the survey relied heavily on a statewide network of volunteers, and a system for training these volunteers to identify, recruit, and keep farm operations in the survey. In addition, the volunteers needed to collect and return survey data in a timely fashion. By the mid-1980's, this approach was no longer working as volunteers became too few to maintain the data collection effort.

In 1987, a new approach for conducting combined fatal and non-fatal injury surveillance in the agricultural industry was demonstrated by the University of Minnesota through the initiation of the Olmsted Agricultural Trauma Survey (OATS) (Gerberich et al., 1991, 1992). The OATS was a telephone interview-based survey of farm operators in Olmsted County, Minnesota. The farm operators were identified using a list frame of farms maintained by the U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS). Adult farm operators were interviewed and asked to report injuries that had occurred on their farming operation, or to their family members, as well as to identify farming-related exposures within the last calendar year. Injury information collected through the OATS was compared with medical records maintained by the Mayo Clinic. In general, the results of the telephone survey were found to provide a realistic view of the injury occurrences on farms in Olmsted County, and provided an effective means of collecting these data (Gerberich et al., 1990).

Based on the success of the OATS, the University of Minnesota expanded the scope of the telephone survey approach to a 5-state random sample of farming operations in 1990 through a grant from the Centers for Disease Control and Prevention (Gerberich et al., 1993, 1994, 1995). This survey, known as the Regional Rural Injury Study-I (RRIS-I), covered the States of Minnesota, Nebraska, North Dakota, South Dakota, and Wisconsin. Some modifications were made to the survey procedures, including reducing the recall period for injury events and exposures to six months, but the sampling frame for identifying farms was still provided by

USDA, NASS. This type of data collection was shown to be an effective way to collect farm injury information over a large geographic area (Gerberich et al., 1992, 1993, 1994, 1995, 1996). The OATS and RRIS-I also demonstrated the usefulness of collecting these data directly from the farm operator, and the value of the USDA, NASS operators list for identifying farm operators in the five States.

A new survey, the RRIS-II (Gerberich et al., 2001), is being conducted by the University of Minnesota. RRIS-II follows the same methodology as the RRIS-I (Gerberich et al., 1993, 1996, 1998, 2001) and includes the same five States. The research design employs an eligible cohort of approximately 4,000 farm households, including children 19 years of age or less, and involves unique methods for collecting data, simultaneously, for both risk factors (using a case-control design) and incidence/consequences of agricultural injuries. The RRIS-II covers approximately 17,000 persons with an estimated 8,600 children 19 years of age or less. More detailed methodological procedures are available in Gerberich et al., 1996, 1998, and 2001.

During this same time period, the National Safety Council, Agriculture Division, in cooperation with the National Institute for Occupational Safety and Health, began assessing alternatives to the personal interview approach for collecting farm injury data used by the Council in the 1970's and early 1980's. The main objective was to develop a data collection system that would provide useful information on agricultural injuries occurring in the U.S., which was statistically representative, yet cost effective. The result of this effort was the NIOSH Traumatic Injury Surveillance of Farmers (TISF) survey conducted between 1994 and 1996.

The TISF was a stratified two-stage random sample of farm operations in the United States that used a mail survey instrument (Myers, 1997). Each year, a sample of States was selected within four geographic regions. Then farms were selected at random within States. The sampling frame used for the survey was the USDA, NASS farm list. The survey was designed to cover a three-year time period to allow for the survey to be conducted in each of the 50 States, while still allowing for the estimation of national and regional farm injury estimates in a given year. In general, results from the TISF reinforced the findings obtained from the OATS and RRIS-I surveys, and demonstrated that a national farm injury surveillance program was feasible using the USDA, NASS farm operators list as the basis for the surveillance effort.

In addition to these efforts, there were other State-based surveillance efforts undertaken during the 1990's dealing with agricultural injuries. NIOSH funded six States to conduct the Farm Family Health and Hazard Survey (FFHHS) project that was designed to conduct basic health screening, injury surveillance, and hazard surveillance within each state (National Institute for Occupational Safety and Health, 1992). The States involved were California, Colorado, Iowa, Kentucky, New York, and Ohio. A major drawback to the FFHHS was that the States did not employ the same survey instruments or sampling designs, and, in some instances, did not represent the entire agriculture community within the State. These differences limited the ability to combine State results into meaningful larger data sets.

Other State surveillance efforts initiated during the 1980's include the Iowa Sentinel Project Researching Agricultural Injury Notification System (SPRAINS), and the North Dakota Department of Health Agricultural Injury Reportable Condition Notification System (Iowa

Department of Public Health, 1990; Shireley & Gilmore, 1995). SPRAINS is a hospital emergency department-based surveillance system conducted in a selected number of hospitals in the State of Iowa, which are to report agricultural injuries identified at these emergency departments. Cases are to be reported to the Iowa Department of Public Health. The North Dakota agricultural injury surveillance system is broader in nature in that agricultural injuries are considered a reportable condition within the State of North Dakota. As such, hospitals, physicians, and other medical facilities are required by law to report agricultural injuries to the North Dakota Department of Health. The North Dakota Department of Health developed a simple post card reporting system to assist hospitals and physicians in reporting these cases. Both of these systems are still being conducted by their respective States, and are considered valuable resources for monitoring agricultural injuries within their State. However, they have not expanded into surrounding States and, as such, are limited in their utility.

Recently, there has been an increased effort to develop agricultural injury surveillance systems for youth living, working, or visiting farms in the United States. This effort is an outcome of the NIOSH Childhood Agricultural Injury Prevention Initiative, which was initiated in 1997 (Castillo et al., 1998). To date, NIOSH has conducted three separate surveys to evaluate methods for collecting youth farm injury data. These include a 1999 farm operator survey conducted in cooperation with the U.S. Department of Agriculture (USDA), a 1999 national survey of farm workers in the U.S. through the U.S. Department of Labor (USDOL) National Agricultural Workers Survey (NAWS), and a case series follow-back study of youth farm injuries reported through the Consumer Product Safety Commission (CPSC) National Electronic Injury Surveillance System (NEISS). In addition, NIOSH, with cooperation from USDA, is conducting a minority farm operator survey for youth farm injuries in 2001.

Results of many of these surveys have appeared in several publications. Publications from the RRIS-I include studies that assessed the magnitude of and potential risk factors for tractor-related injuries (Lee et al., 1996), penetrating trauma injuries (Gerberich et al., 1996), machinery-related injuries (Gerberich et al., 1998), injuries among children (Gerberich et al., 2001), and a case-control study of dairy-related injuries (Boyle et al., 1997). Results from the NSC surveys have included a summary document of 31 State surveys (Hanford et al., 1982), a 35 State survey summary (Hoskins et al., 1988a), machinery-related injuries (Hoskins et al., 1988b), and tractor-related injuries (Hoskins et al., 1988c). Finally, summary results from the TISF surveys have been released (Myers, 1997; Myers, 1998).

Current Information on Agricultural Injuries and Fatalities

Several sources of data were utilized for this effort. These data include both national and regional data sources. Data were limited to production agriculture, which is that part of the agriculture industry associated with farming.

The Census of Fatal Occupational Injuries (CFOI) was used as the data source for occupational fatalities in agricultural production. Data were analyzed for the years 1992 through 1998. Fatality rates using the CFOI were calculated using employment estimates for production agriculture from the BLS Current Population Survey (CPS). The CPS is an employment survey based on a

monthly sample of households across the U.S. Employment figures only included information on workers who defined farming as their primary industry of employment and were 15 years of age or older. Additional information on the CPS is available from the U.S. Department of Labor, Bureau of Labor Statistics (1992).

The Traumatic Injury Surveillance of Farmers (TISF) was the data source used to assess the national perspective on non-fatal agricultural work injuries. A total of 36,270 farms participated in the survey over the 3 year time period, which provided injury data for the calendar years 1993 through 1995. Injuries were defined as any condition that resulted in ½ day or more of restricted activity.

In addition to these data sources, data collected in the RRIS-I in 1990 (Gerberich et al., 1993) and the more recent RRIS-II in 1999 (Gerberich et al., 2001) are also presented. An injury was defined as a physiologic traumatic event that resulted in: restriction of normal activities for at least four hours; and/or the use of professional medical care; and/or loss of consciousness, loss of awareness, or amnesia for any length of time. Injury data collected included type and severity of the injury together with the source, mechanism, and other potential contributing factors.

CFOI Results: There were 4,082 work-related deaths occurring in agricultural production from 1992-1998. Over half of these deaths occurred in crop production (Table 1). The overall agricultural production fatality rate was 25.8 deaths per 100,000 workers. The crop production farms had a fatality rate nearly three times greater than livestock farms (37.9 vs 14.1/100,000). There was no discernable trend for decreasing fatalities in production agriculture during this time period (Table 2).

Workers 55 years of age and older comprised about 52% of these agricultural fatalities (Table 3). These older workers had fatality rates that were 1.5 to 3 times higher than the next highest age group in production agriculture and were 6-13 times higher than the national average (5.0/100,000 workers) over this same time frame. Almost 6% of the fatal work-related injuries occurred to workers 19 years of age and younger, with about 2.5% of the deaths occurring to youth younger than 15 years of age (Table 3).

The largest identifiable source of fatal traumatic injury was tractors (37%), followed by trucks and harvesting machines. Together, these three sources of injury accounted for over half of the fatalities in agricultural production (Table 4). The most common injury events were "overturning vehicles/machines" with over 1/4 of the deaths attributable to this category, followed by "fall from and run over by vehicle or machinery" and, then, "caught in running equipment". These three injury event categories accounted for almost 40% of all the agricultural production deaths that occurred between 1992 and 1998 (Table 5).

Finally, Table 6 provides a further breakdown of the five leading sources of fatal injury in production agriculture by comparing the number of deaths that occurred to workers 55 years of age to all farm worker deaths. For each source of injury, older workers account for over 40 percent of all deaths. For tractors, agricultural mowing machines, and animals, older workers account for more than 60 percent of the deaths.

TISF Results: For the years 1993 through 1995, there were an estimated 518,903 injuries that occurred in production agriculture as reported in the TISF (Table 7). This represented an overall occupational injury rate for production agriculture of 7.5 injuries per 100 workers. There was no apparent difference in injury rates between crop and livestock production operations (Table 7). The specific types of farms that had the highest proportions of injuries were beef, sheep, or hog operations (37%), followed by cash grain operations (17%), dairies (14%), and field crop operations (8%). The regions of the U.S. that reported the highest proportions of injuries were the Midwest (45%), followed by the West (25%), South (22%), and Northeast (8%).
There were no large differences in injury rates among the age groups above 19 years of age (Table 8). Young workers (those less than 20 years of age) did have an injury rate less than ½ that of other age groups (Table 8). With regards to the gender of the injured workers, there was a 9:1 ratio of injuries for males compared with females seen in the TISF.

The majority of agricultural work injuries (61%) occurred to the operator of the farm or a farm family member, followed by hired labor (29%), and partners in the farm or their family members (6%). Ninety-five percent of these injuries were temporary, with an additional 4% being permanent in nature. About 80% of these injured workers sought medical attention, beyond first-aid, of some kind.

The highest proportions of injuries occurred during the months of August, July, June, and November. The primary types of work activity being conducted at the time of injury were livestock handling (29%) followed by farm maintenance (17%), and field work (16%). The leading sources of injury were equivalent for machinery and livestock (19%, each), followed by "working-surfaces" (8%) and "non-powered hand tools" (8%). The most common types of injury events associated with these injuries were being "struck by or against an object" (15%), followed by a "fall from an elevation" (13%) and having "contact with sharp object" (11%).
These injuries most commonly involved anatomical locations of the leg, knee, or hip (17%), followed by back (15%), and finger (12%). Finally, the leading nature of injury was a sprain or strain (26%), followed by fractures (18%), and cuts (17%).

RRIS-I Results: A total of 3,939 households, including 13,144 persons, participated in the full interviews; these accounted for 74% of eligible households. One in five farms (19.4/100 farms) reported a farming operation-related injury event; one in 17 persons in these households (5.8/100 persons) reported such an injury. Non-farming related injuries that may also impact the farming operation were reported by one in six farms (17.5/100 farms) and one in 17 persons (5.3/100 persons). Overall, there were two deaths in this population, during the one-year study period, associated with other causes.

The age and gender distribution of injuries revealed important differences. When the denominator of 100 persons was used, males (8.7/100 persons) had a rate of farming-related injuries 3.5 times greater than that for females (2.5/100 persons). The highest rate of farming-related injuries per 100 persons was identified among males, 30-39 years of age (15.8); for females, the highest rate was identified in the 25-29 year age group (5.4). Of particular importance, however, is the fact that when the denominator of hours worked was used, the highest rates per 100,000 hours worked was for males in the 5-9 (11.0) and 10-14 (8.0) year age

groups -- exposed groups for which data are not typically collected; among females, the highest rates were in the 10-14 (7.0) and 25-29 (8.0) year age groups. Across all ages, the overall rates were equivalent between males and females when hours of exposure were considered (5.0/100,000 hours worked).

The major sources/vehicles of injury for the farming-related injuries were livestock (30%), machinery, other than tractors (20%), and tractors (9%), accounting for 59% of the events. Among all of the farming-related injury cases, only 6% resulted in hospitalization which has implications relevant to the limitations imposed if only hospital-based surveillance is used; however, 80% were treated by a health care professional. Furthermore, the fact that substantial proportions of cases were actually restricted for a week or more (37%, with 19% restricted for a month or more) and/or had some type of persistent problem, including some permanent disabilities (25%), is very important when looking at the overall impact.

In the RRIS-I substudy of machinery-related injuries (Gerberich et al., 1998), rates were calculated for sociodemographic variables and various exposures pertinent to large farm machinery (excluding tractors). Multivariate analyses were conducted using logistic regression, based on a model developed a priori, and further confirmed using backward stepwise logistic regression. Among the total farming-related injury events (n=764), 151 (20 percent) were related to large machinery use (1,127 injured persons per 100,000 persons per year). Portable augers and self-propelled combines had the highest rates of 213 and 154 per 100,000 persons, respectively. Pull-type and self-propelled forage harvesters, elevators/conveyers, and portable grinders also were associated with elevated injury rates (126, 113, 112, and 98 per 100,000 persons, respectively). Through multivariate analyses, several variables were associated with elevated rate ratios that were important in both models: hours worked per week on the farm (40-59, 60-79, 80+); operation of an auger; field crops as the enterprise requiring the most time; and male gender. The majority of injury events occurred while persons were lifting, pushing, or pulling (21%), adjusting a machine (20%), or repairing a machine (17%). While only 5% of the cases were hospitalized, 79% required some type of health care. Among all injured persons, 34% were restricted from regular activities for one week or more and 19% were restricted for one month or more; 25% continued to have persistent problems.

Within the RRIS-I, a substudy of tractor-related injuries (Lee et al., 1996) was also conducted. Although tractors account for the majority of fatal farm injuries, little is known about the magnitude of this problem. Rates were calculated for sociodemographic variables and various exposures; logistic regression was used to calculate the rate ratios and respective confidence intervals. Among the total farming-related injury events (n=764), 65 (8.4 percent) were related to regular tractor (>20 horsepower) use (495 injured persons per 100,000 persons per year). The rates increased incrementally for those working between 20-39 hours and 60-79 per week (range, 529 to 1,430 per 100,000 persons). Among the 12 rollover events, there were three injuries. The majority of injury events occurred while persons were mounting or dismounting the tractor (42%). While only 7% of the cases were hospitalized, 83% required some type of health care. Among all injured persons, 43% were restricted from regular activities for one week or more and 20 percent were restricted for one month or more; 28% continued to have persistent problems. Another substudy, involving the case-control effort, Injury from Dairy Cattle Activities (Boyle et al., 1997), had a primary aim to identify which dairy cattle operation activities were associated

with either increased or decreased risks of injury. Activities addressed were: milking; feeding; cleaning barns; trimming and treating feet; dehorning; assisting with difficult calvings; and doing treatments. Through multivariate modeling, milking was found to have the greatest increase in risk for injury. Increasing rate ratios (1.0, 2.3, 5.5, 10.9, and 20.6) were found, respectively, with increasing hours per week spent at milking (0, 1-10, 11-20, 21-30, 31-63). An increased rate ratio was also identified for trimming or treating hooves (4.2).

RRIS-II and RRIS-II Surveillance Results: In the recent RRIS-II (Gerberich et al., 2001) effort, among 4,037 eligible households identified from the random sampling process in the five-state region, 94% participated; 16,759 persons of all ages were identified as members of these households and children (n=8600) accounted for 51% of these members. Among the children in this population, 207 incurred injuries related to their farming operation during 1999; animals were the primary source of injuries (36%). Initial univariate analyses of the case-control data, involving 207 cases and 766 controls who were 19 years of age or less, indicated increased odds ratios for: working with horses (2.7; 95% CI=1.88-3.96), beef cattle (2.2; 95% CI=1.62-3.08), dairy cattle (1.8; 95% CI=1.20-2.64), or swine (2.0; 95% CI=1.27-1.42); operating tractors (2.2; 95% CI=1.60-3.02); riding on tractors (2.2; 95% CI=1.61-3.04); and working with machinery (2.1; 95% CI=1.50-3.00). Through multivariate analyses, logistic regression will be used to model the dependence of injury on each exposure of interest and corresponding confounders. The RRIS-II Surveillance effort (Gerberich et al., 2001), that builds on the RRIS-II, involves collection of data for 2001 comparable to that in 1999 and provides a unique opportunity to not only identify the magnitude and consequences of the problem but will also enable identification of specific risk factors. This new method of surveillance will be important to not only monitor changes over time, including identification of new problems, but will also provide data essential for the development of appropriate prevention strategies and provide a basis for evaluation of any interventions.

Conclusion/Future Needs

Traumatic injuries continue to be a leading cause of death and morbidity for production agriculture. Data suggest that fatality rates, which showed some declines during the 1980's, were fairly constant during the 1990's. Changes in occupational non-fatal injury rates for this sector could not be assessed because of a lack of data. The main concerns identified in the 1989 NCASH report continue today-Tractors are the leading cause of farm-related death, due mostly to tractor overturns, older farmers continue to be at the highest risk for these farm fatalities, and traumatic injuries continue to be a main concern for youth living or working on U.S. farms. The main progress in addressing these injuries has been in the increased awareness that agricultural injuries are a major public health problem in the United States. Still, our ability to quantify the extent of agricultural injuries has only improved marginally since 1989. Progress was made during the 1990's in our ability to identify work-related deaths through the Bureau of Labor Statistics CFOI program; but by the end of the decade, there was still no comprehensive national surveillance system available to adequately address nonfatal injuries in production agriculture.

Past efforts to initiate nonfatal injury surveillance systems have been useful in alerting us to injury problems in production agriculture, but have not been sustained over time to allow us to gauge what, if any changes are occurring in the agriculture industry. New and improved surveillance designs show great promise in addressing new issues such as exposure-based rates for special populations such as youth, females, and older farm workers (Gerberich et al, 2001; Ruser, 1998). Still, these efforts will only be partially successful unless an ongoing process for collecting such data is maintained. Implementing and maintaining a non-fatal injury surveillance system comparable to the CFOI fatality system remains a key challenge in this decade.

Fatal and non-fatal traumatic injuries associated with agricultural production are a major public health problem that needs to be addressed through comprehensive approaches that include further delineation of the extent of the problem, particularly in children and older adults, and identification of the specific risk factors through analytic efforts. While these activities are in progress, additional endeavors will also be essential because of the numerous exposures involved that will require more intensive and specific investigations. Only through such efforts can appropriate prevention efforts be developed (Gerberich et al., 1992; Gerberich et al., 1994). Integral to this process is the incorporation of comprehensive surveillance systems that can be used to monitor the magnitude of the problem, over time, and evaluate the efficacy of any intervention efforts that are implemented (Gerberich, 1995). While surveillance is a key element for assessing the magnitude of the traumatic agricultural injury problem and identifying appropriate intervention strategies, based on quality risk factor information, it will not reduce injuries on its own. It is apparent that effective interventions are imperative in the alleviation of this major public health problem. Continued development of relevant surveillance systems and implementation of appropriate interventions are the primary challenges for the current decade.

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Table 1. Production Agriculture Occupational Deaths and Average Annual Fatality Rate per 100,000 Workers, 1992-1998, CFOI

Industry	Deaths	Rate
Crop	2,702	37.9
Livestock	1,228	14.1
Unknown	152	
Ag Production Total	4,082	25.8

Table 2. Production Agriculture and Private Industry Deaths, Fatality Rates, and Employment by Year, 1992-1998, CFOI

	1992	1993	1994	1995	1996	1997	1998	Total
Crop								
Employ	1,027,027	931,229	1,023,534	1,071,113	1,038,465	1,003,517	1,031,862	7,126,747
Deaths	407	400	443	364	337	373	378	2702
Rate*	39.6	43.0	43.3	34.0	32.4	37.2	36.6	37.9
Livestock								
Employ	1,247,485	1,181,018	1,342,952	1,331,556	1,252,546	1,233,360	1,121,110	8,710,027
Deaths	165	214	172	163	157	183	174	1228
Rate*	13.2	18.1	12.8	12.2	12.5	14.8	15.5	14.1
Ag Prod								
Employ	2,274,512	2,112,248	2,366,486	2,402,669	2,291,011	2,236,877	2,152,972	15,836,774

Deaths	572	615	616	569	548	586	576	4082
Rate*	25.1	29.1	26.0	23.7	23.9	26.2	26.7	25.8
All Industry								
Employ**	118,492	120,259	123,060	124,900	126,708	129,558	131,463	874,440
Deaths	6,217	6,271	6,588	6,210	6,112	6,218	6,026	43,642
Rate*	5.2	5.2	5.3	5.0	4.8	4.8	4.6	5.0

*Per 100,000 workers:
**In thousands, from the Bureau of Labor Statistics Current Population Survey

Table 3. Production Agriculture Deaths and Average Annual Fatality Rates per 100,000 Workers by Age Group, 1992-98, CFOI

Age Group	Deaths	Rate
15-19	132	10.2
20-24	166	14.7
25-34	408	14.1
35-44	577	17.1
45-54	578	21.2
55-64	754	31.9
65+	1,363	65.9
Total	4,082	25.8

Table 4. Production Agriculture Deaths by Source of Injury, 1992-1998, CFOI

Source of Injury	Deaths	Percentage
Tractors	1,510	37
Trucks	390	9.6
Harvesting machines	180	4.4

Mowing machines	150	3.7
Animals	144	3.5
Other ag. machines	129	3.2
Ground	121	3.0
Bullets	115	2.8
Loaders	75	1.8
Trees, logs	74	1.8
All other sources	1,194	29.3

Table 5. Production Agriculture Deaths by Type of Injury Event, 1992-1998, CFOI

Type of Injury Event	Deaths	Percentage
Overturning vehicle/machine	1,051	25.8
Fall from & runover by veh/mach.	298	7.3
Caught in running equipment	277	6.8
Struck by falling object	234	5.7
Run over (pedestrian)	211	5.2
Fall to lower level	173	4.2
Struck by rolling objects	136	3.3
Assault by animal	129	3.2
Suicide	88	2.2
Caught in collapsing material	80	2.0
All other events	1,405	3.4

Table 6. Leading Sources of Fatal Injury in Production Agriculture and the Proportion of Deaths that Occurred to Workers 55 Years of Age and Older, 1992-1998, CFOI

Source of Injury	Farming Deaths		
	All Workers	55 and Older	Percent of Deaths 55 and Older
Tractors	1,510	969	64
Trucks	390	166	43
Harvesting machines	180	79	44
Mowing machines	150	107	71
Animals	144	92	64

Table 7. Nonfatal Injury Frequencies and Rates per 100 Workers for Agricultural Production Sectors, 1993-1995, TISF

	1993	1994	1995	Total
Crop				
Employment	931,229	1,023,534	1,071,113	3,025,876
Injury	93,553	56,437	82,556	232,546
Rate	10.0	5.5	7.7	7.7
Livestock				
Employment	1,181,018	1,342,952	1,331,556	3,855,526
Injury	107,581	65,503	113,273	286,357
Rate	9.1	4.9	8.5	7.4
Ag Prod. Sector				
Employment	2,112,248	2,366,486	2,402,669	6,881,403
Injury	201,134	121,940 1	95,829	518,903
Rate	9.5	5.1	8.1	7.5

Table 8. Nonfatal Injuries in Agricultural Production by Age Group, 1993-1995, TISF

Age Group	Avg. Employment	Avg. Injury	Rate*
<15	***	4,600	***
15-19	191,359	5,860	3.1
20-29	342,380	26,541	7.7
30-39	494,256	38,904	7.9
40-49	440,421	31,387	7.1
50-59	363,456	29,569	8.1
60-69	296,149	22,799	7.7
70+	166,781	12,279	7.4
Unknown	***	1,021	***
Total	2,293,801	172,960	7.5
*Per 100 workers			