

Article

Summary of Indiana Farm Fatalities Involving Individuals 55 Years and Older—1988–2017

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Abstract: Agriculture has historically been one of the most hazardous of all occupations, with a variety of potential safety risks to workers and even higher risks documented for older agricultural workers. This study was undertaken to document and summarize Indiana farm work-related fatalities involving persons 55 years and older over the 30 year period from 1988 to 2017. Data were mined from the Purdue University Agricultural Safety and Health Program’s Fatality Database that dates back to the 1960s. A total of 388 fatalities involving persons 55 years and older was documented. The average age of the victims was 69.3 years old, and an overwhelming majority of the cases involved males (96.1%). The average number of deaths per year has remained fairly consistent, though it has occasionally been erratic, with an unanticipated increase in the number of documented fatalities over the period 2012–2017. There appeared to be a direct positive correlation between the level or intensity of agricultural production in a county and the frequency of fatalities. The type of fatal injury most commonly reported was crush/run-over, with 229 cases (59%). The most common agent or source of injury involved was tractors, with 157 cases (40.5%). Another noted contributing factor was the high frequency of incidents in which the victim was reported to be working alone at the time of death. Findings will be used to develop evidence-based injury prevention strategies, including the development of agricultural safety training materials and methods more relevant to older farmers. A special emphasis should be placed on reducing the risk of tractor and farm machinery overturns, especially when older, non-roll over protection structure (ROPS) equipped tractors are being operated.

Keywords: agriculture; aging; farmer; fatal injury; farm fatalities

1. Introduction

The purpose of this summary was to identify the primary contributing factors of Indiana farm work-related fatalities involving agricultural producers 55 years of age and older. It was anticipated that findings would provide a detailed look at documented characteristics and trends of fatalities over the 30 year period from 1988 to 2017, with an analysis of selected causative factors. The research was undertaken in response to the recent upward trend in the number of annual fatalities documented within this age group.

Review of Literature

The average age of U.S. farm operators has been on the rise for the past 30 years, with the average going from 50.5 in 1982, to 58.3 in 2012, and to 59.4 in 2017 [1–3]. The three highest age categories for principal operator—55 to 64 years old, 65 to 74 years old, and 75 years and older—showed an increase of 1.9%, 7.6%, and 5.8% from 2007 to 2012 and 28.8%, 45.0%, and 35.1% from 2012 to 2017, respectively [1,2,4].

Farming is well documented as a dangerous profession for all ages. The Census of Fatal Occupational Injuries (CFOI) reported in 2016 that farmers, ranchers, and other agricultural managers of all ages had a fatal injury rate of 23.1 per 100,000 full-time equivalent workers, as compared to the all-worker fatal injury rate of 3.5 [5]. The injury rate has been reported to be even higher for older farmers, with a fatality rate of 45.8/100,000 reported for farmers 55 years and older between 1992 and 2004 [6].

The increased risk of injury due to aging has been well documented. All of the senses and functions of the body go through changes with age. Mobility issues, such as those caused by arthritis, increase the risk of injury with age [7,8]. The risk of eye injuries and diseases that impair vision increases with age [9]. Age-related hearing impairments are common and are considered the second most common handicapping condition in the United States [10]. Cognitive changes also take place, with reaction times slowed in comparison to younger adults [11].

Older farmers, however, have generally been shown to have a lower risk of obtaining a non-fatal injury as compared to younger farmers [12–14]. In a study of farmers 50 years and older, Marcum et al. (2011) found that an incremental increase of 10 years for a farmer reduced their non-fatal injury risk by 15% [13]. Salminen (2004) conducted a literature review that looked at the risk of occupational injuries for younger workers across industries, including agriculture [12]. He found that older farmers who had sustained injuries were more likely to die from their injuries.

Summaries of farm-related occupational fatalities have often reported large representations of older farmers [6,15–19]. Voaklander et al. (1999), for example, found that 36.5% of all farm fatalities during 1991–1995 in Canada were 60 years or older and that the fatality rate per 100,000 increased with age [16]. Gorucu et al. (2017) found that 34% of Pennsylvania farm fatality cases from 2010 to 2014 consisted of farmers 65 years and older, even though this age group only accounted for 22.6% of the farm household populations [19]. Another study by Cheng and Field (2018) found that about half of the fatality cases in Indiana since 2012 have been farmers 60 years or older [15].

It has also been reported that common aging related changes in the body, such as arthritis, hearing and vision impairment, and mobility or medication usage, could increase the risk of sustaining specific types of farm-related work injuries [13,14,20,21]. In the study of how arthritis, mobility, and farm tasks affected injuries among older farmers, Heaton et al. (2012) found that farmers with mobility issues were twice as likely to be injured by a farm-related task [14].

Even considering the higher risk of potential injuries, there seems to be limited attention given to agricultural safety material that is designed and oriented for older farmers. An example would be tree cutting and chainsaw safety materials developed and disseminated by organizations such as extension programs. The majority of the publications reviewed did not mention any potential issues to worker safety due to age-related changes in the body or other challenges more specific for the older farmer population involved in chainsaw operations [22–26]. A review of the images contained in these publications and related audio–visual material found that most depicted younger workers.

Nationally, the documentation of farm-related fatalities, has, in general, also been problematic for several reasons including: The lack of federal or state reporting requirements for farms with less than 11 hired workers [27,28]; the lack of a central site for documenting and storing farm fatality data; and the nature of current reporting protocols that may not document a fatality when the injuries to the victim resulted in death sometime after the injury occurred. This lack in reporting requirements and inadequacies in the classification process contributes to the historical failure of the Bureau of Labor Statistics' (BLS) records of national farming fatalities to include fatalities that occur on smaller farms relying primarily on family labor or with few employees [29]. The BLS data were also known to combine their data of farming fatalities with fatalities that may not be occupational-related, such as operating all-terrain vehicles (ATVs) on farm land, or unrelated occupations, such as fishing, forestry, and hunting [15]. Another source of federal fatality data was the Census of Fatal Occupational Injuries (CFOI), which gathers descriptive data and counts of fatalities nationally [30]. A concern regarding the completeness of farm fatalities reported through the CFOI is that the individual was required to

have been employed at the time of the incident, generally excluding children and unpaid family labor, such as retired family workers [31]. Historically, the CFOI has significantly under reported Indiana farm-related fatalities.

2. Methods

The data used were drawn from the Purdue University Farm Fatality Database and previously published in annual summaries by the Purdue Agricultural Safety and Health program (PUASHP). A total of 1452 reported farm work-related fatalities have been recorded by PUASHP in Indiana since 1970. A variety of sources have been used to document these incidents, including death certificates, news clippings, web searches, obituaries, and post-incident interviews with family members, extension educators, first responders, expert witnesses in litigation, and others associated with the incidents. The general information included the date, county, age, sex, type of incident, and a short narrative of the incident. For this study, only data of confirmed fatalities of farmers 55 years and older that occurred during the period from 1988 to 2017 were extracted for review. The definition of an older worker used, as being workers over the age of 55, was taken from current published studies, including the National Institute for Occupational Safety and Health (NIOSH), that found that farm workers, aged 55 years and older, were at higher risk of injury and death [6]. No follow-up investigations of individual cases were conducted by the authors other than the review of original sources.

The coding sheet used for classifying the data was adapted from previously published coding sheets and the Farm and Agricultural Injury Code (FAIC) [27,32–34]. The coding sheet helped to categorize the fatality cases to allow for summarization by reported type of fatal injury and the contributing agents. FAIC codes were not used due to a lack of sufficient data for the majority of reported cases [34].

Limitations

The primary limitation of the summary relates to the comprehensiveness of the data due to the data collection and documentation methods. As noted, since there is no official centralized site where these data are gathered, PUASHP used a variety of sources to identify cases and related information. For more recent years, the data were compared with the Indiana Department of Labor's annual summary of work-related fatalities to identify any differences. These differences were generally due to the different criteria used by the U.S. Department of Labor to fulfill federal reporting requirements, such as excluding children under 16 who are often not identified as being involved in work-related activities. The use of on-line reports or media "clippings" can also be problematic, since these reports are not always reliable due to the abilities of the individual doing the reporting [15,27,29]. Though the data are not recognized as comprehensive, they remain the best possible representation of Indiana farm-related fatalities.

The introduction of the internet in recent years has increased access to information on fatality cases. This new flow of data, however, may distort the overall data set because it may mean that the increase in number of recent cases may be due to better reporting versus an actual increase in fatality cases as compared to past years. These additional cases during the latter part of the period studied could affect any projected trends. Online sources also appear to increase the risk of multiple reporting of the same incidents, with widely differing accounts that suggest multiple incidents when, in fact, all were reporting on the same incident [27,29].

3. Results

The total number of fatalities documented and used in this summary for the 30 year period was 388, making up 43.8% of all reported cases over the time period.

3.1. Age

The average age of the 388 older farmers was 69.3, while the average age of all documented fatalities during the same period was 49.0 years old. The average age of current farm owner/operators in Indiana is 57.4 years old [3]. The oldest victim reported was 93 years old.

The number of fatalities decreased rapidly with age, as seen in Figure 1. There were peaks at 69, 72, and 75, which offset the downward trend. When the ages were put into 10-year groups of 55–64 years, 65–74 years, and 75 years and older, as seen in Table 1, there was a fairly similar age distribution. The high percentage of victims over the age of 75 was not anticipated.

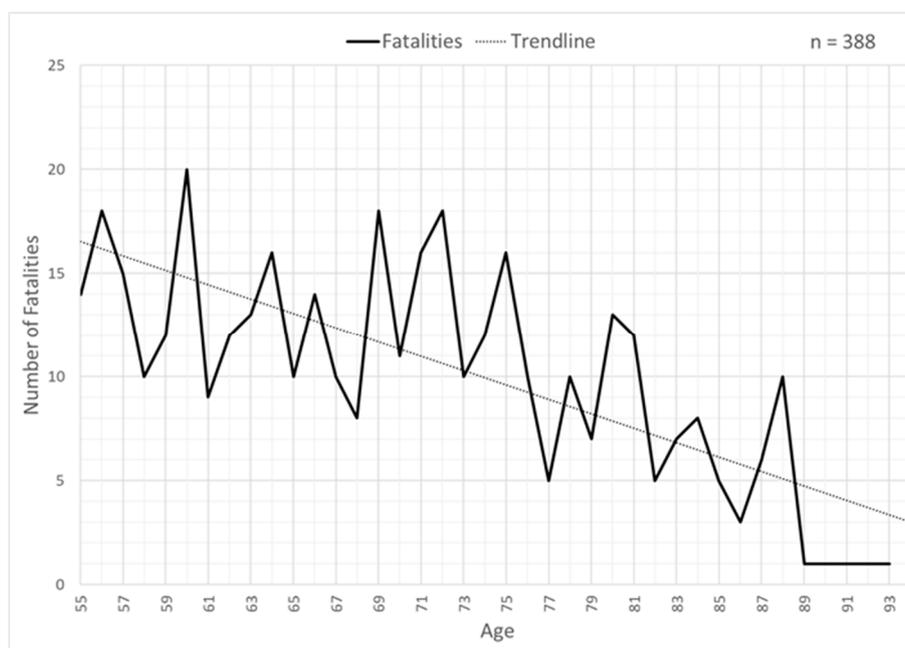


Figure 1. Age distribution of fatalities for ages 55–93.

Table 1. Breakdown of ages by group.

Category	Frequency	Percent
55–64 years old	139	35.8
65–74 years old	127	32.7
75 years and older	122	31.5
Total	388	-

3.2. Year

The distribution of fatalities per year is shown in Figure 2. The data shows variation over the 30 year period with a positive trend that is statistically significant over time for farmers 55 years and older, which is inconsistent with the negative trend for farm fatalities for Indiana farmers of all ages. The years with the highest number of fatalities were 2016 with 24, 2017 with 23, and a tie between 2015 and 1994 with 21 each. The years with the lowest number of fatalities were 2006 with four, 1993 with six, and a tie between 2005 and 1990 with seven each. The past five years, 2012 to 2017, have shown a strong positive trend, with some of the highest number of fatalities in 30 years.

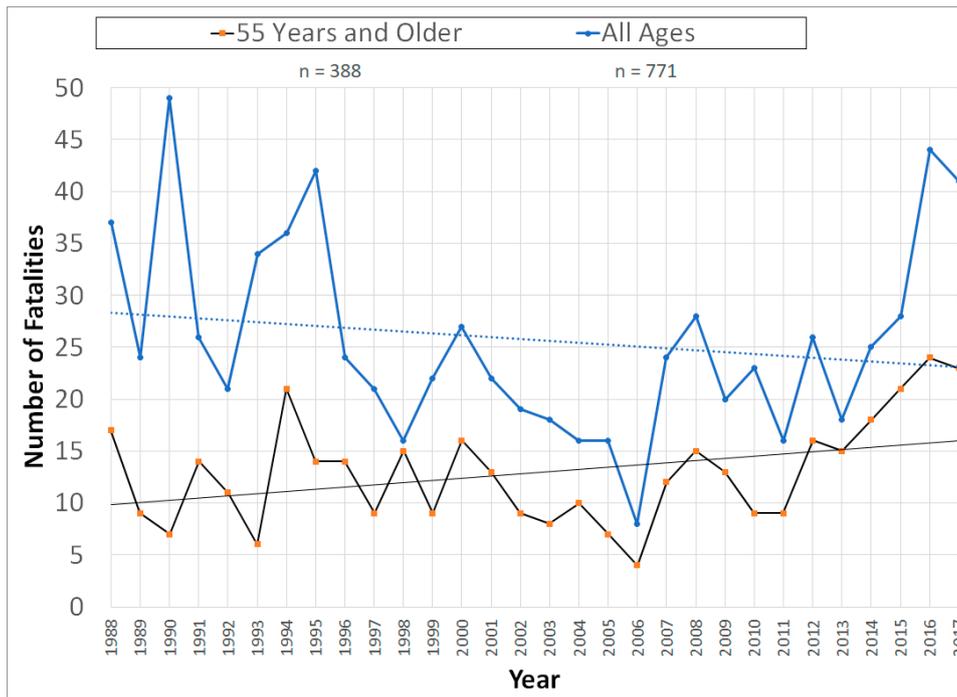


Figure 2. Number of fatalities per year.

3.3. Month

The distribution of fatalities per month, when known, as seen in Figure 3, showed a bimodal pattern. The two highest peaks were May with 59 fatalities (15.2%) and September with 53 fatalities (13.7%) reflecting the two periods of the year with the most intense agricultural production activities. The month with the lowest number of reported cases was March with 10 cases (2.6%), and the second lowest was February with 11 cases (2.8%). This monthly distribution also confirms other studies, indicating a distribution based upon seasonal work [19,35,36].

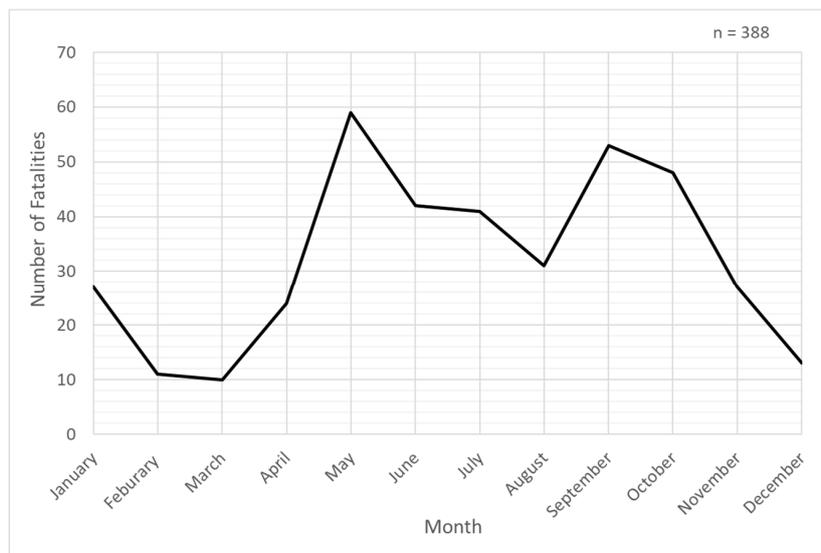


Figure 3. Number of fatalities per month.

3.4. Gender

Of the 388 documented fatalities, 373 (96.1%) were males, and 15 (3.9%) were females in the same age range. Due to the recent upward trend in the number of female farmer fatalities, the data were

analyzed to see if there were any trends for older female agriculture workers. The dataset is small, with only 15 deaths over the 30 year period, so it was not possible to accurately infer trends, but the trend line from the available data shows that the number of female fatalities has been steady over the 30 year period. The number of female deaths per year (Figure 4) shows an increase of deaths during 2016 and 2017 [15]. The small increase in the number of female fatalities in recent years may be due to an increase in number of principal female farmers, increasing 235% from 2002 to 2017 [2,3]. However, the frequency of older females in fatal farm work incidents has historically been minimal and remains so.

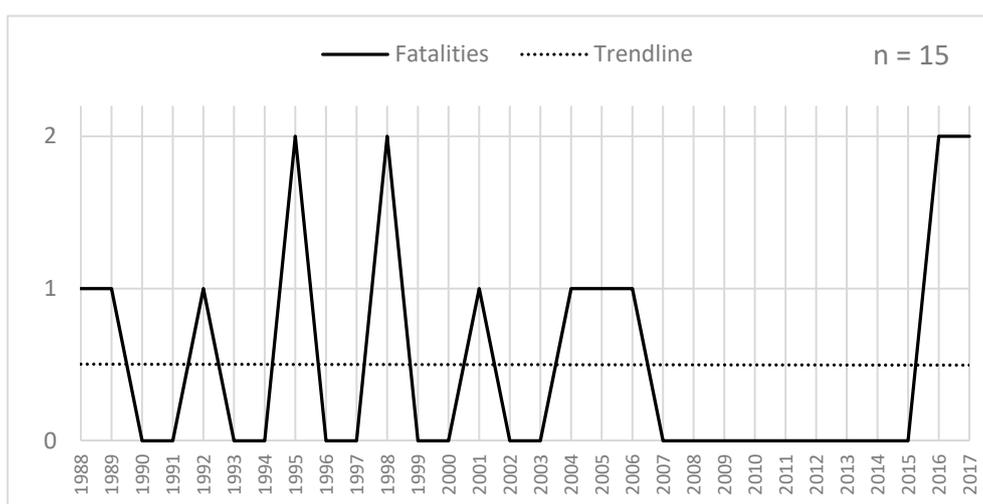


Figure 4. Female fatalities per year.

The types of fatalities that affected older females are shown in Table 2. The most common type of fatality was roadway related, with almost half of the 15 cases (46.7%). Tractors, including tractor rollovers, were the third highest with three cases (20%). Fourteen of the 15 documented fatalities involved the operation of or exposure to farm machinery and tractors.

Table 2. Breakdown of reported agent of fatal injury of female cases.

Category	Frequency	Percent
Roadway	7	46.7
Farm Machinery-related	4	26.7
Tractors	3	20.0
Smothering and Asphyxiation	1	6.6
Total	15	-

3.5. County

Fatalities were identified in almost all of Indiana’s 92 counties during the 30 year period. Only Scott, Union, Vermillion, and Warrick counties did not experience a documented farm fatality over the age of 55. The top five counties with the highest number of fatalities were Allen with 10 (2.6%); Harrison with 9 (2.3%); Lawrence with 9 (2.3%); Dubois with 8 (2.1%); and Morgan with 8 (2.1%).

Allen County has a large number of Amish/Old Order farm families, with the 10th largest Amish community in the United States as of 2017 [37]. Historically Amish/Old Order communities have represented a disproportionate share of farm-related deaths in Indiana [15]. There are 24 other counties with a high density of Amish/Old Order members, such as LaGrange and Elkhart, but these counties did not represent a disproportionate number of older fatalities [38]. Due to the tendency for Amish/Old Order farmers to retire from many more hazardous farm work activities at an earlier age due to their large families, the risk to older Amish/Old Order farmers may be less than might be anticipated [39]. In addition, the intensity of agriculture is an important part of the economy of those counties reporting

high numbers of farm fatalities, including Allen County, which had the state’s third highest total gross domestic agricultural product impact and the top producer of soybeans in the state for 2012 [40]. The county is home to 1725 farms, ranking second in the state [41]. The population of the county was 372,877 in 2017, reflecting a high mix between urban and agricultural use of land increasing the risk of roadway crashes involving farm equipment [42].

The other four counties, although not as highly ranked in the number of fatalities, have strong agricultural-based economies. An example of this would be the strong animal production that takes place in Lawrence County, a leading producer of beef cattle, and Dubois County, first in value of sales for turkeys for 2017–2018 [41]. There does appear to be a positive correlation between the level of agricultural production, especially livestock production, and the larger number of farm fatalities involving older farmers.

The distribution of fatal cases of farmers 55 years and older by county is shown in Figure 5, with each heart representing a farm work fatality that occurred during the period of 1988 to 2017. A geographic distribution of all documented Indiana farm fatalities from 1980 to 2017 can be found in a study by Cheng and Field (2018) [15]. The geographic distribution of incidents was divided in half between the northern and southern parts of the state, with the dividing line running along U.S. 40. The two regions were then compared, since the southern portion tends to have rougher terrain, greater proportions of timber land, and older and smaller farms due to the state being settled from the south to the north, which can be seen in Figure 6. The northern part of the state had 181 fatalities, and the southern portion had 160 fatalities, indicating no significant difference.

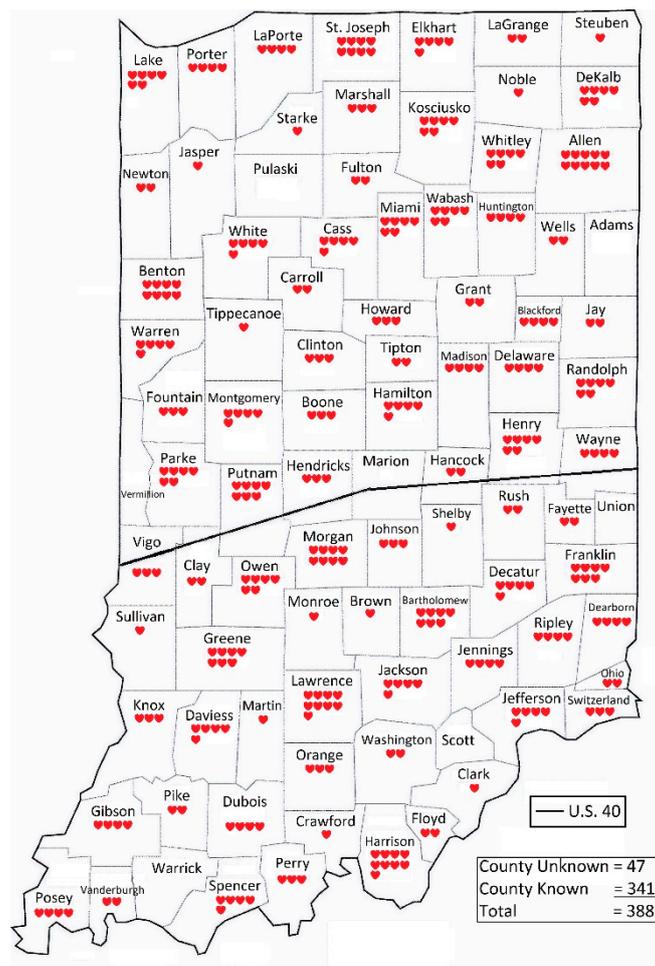


Figure 5. Distribution of fatalities per county.

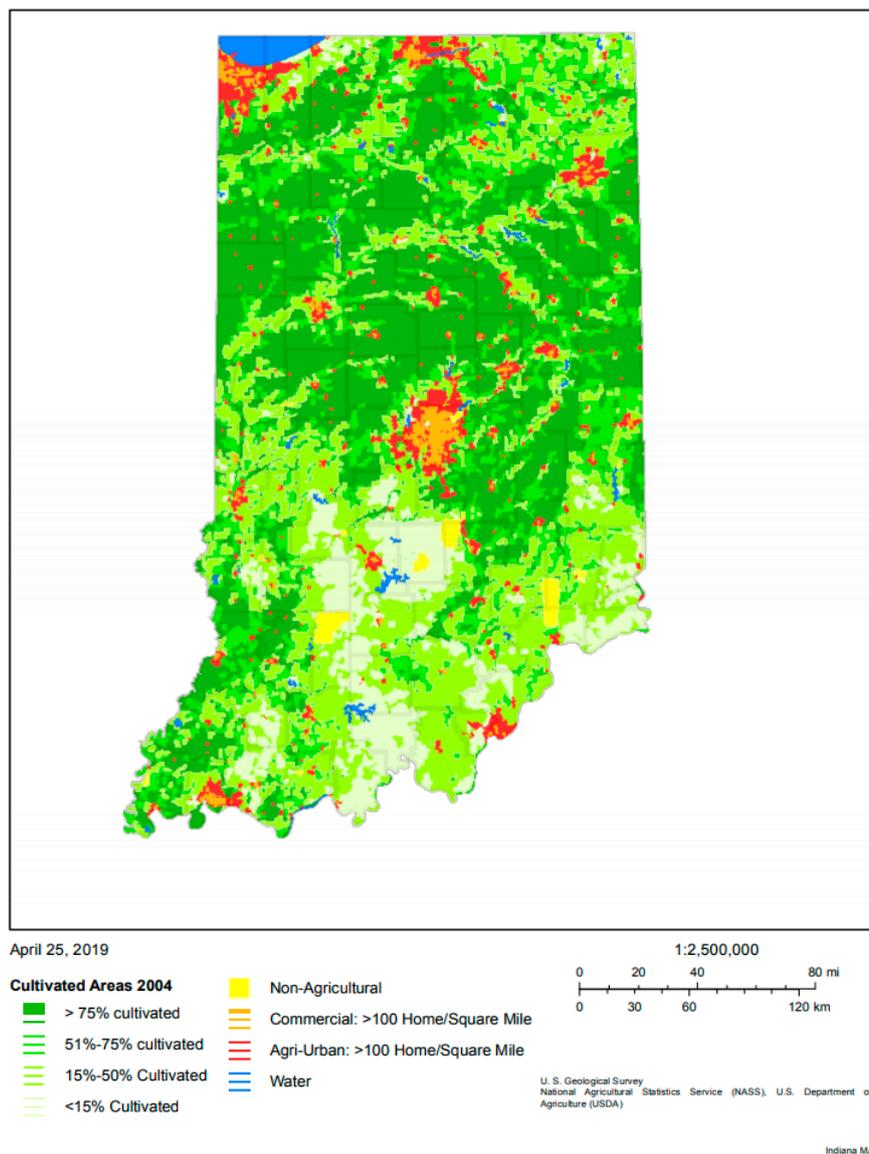


Figure 6. Map of Indiana’s agriculture-cultivated areas during 2004 [43]. Reproduced from IndianaMap, the name of the publisher: Indiana Geographic Information Council.

3.6. Reported Type of Fatal Injury

In the majority of cases, no official or medically determined cause of death was available. The reported, generally unofficial, types of fatal injuries were divided into ten categories based upon the terminology used in the reporting source. The distribution by type is shown in Table 3. The most common fatalities by far were caused by crushing/run-over injuries, accounting for over half of all cases (59%). The unknown category was high because some documented cases only reported the fatality but did not include any background information on type of injury, cause of death, or other causative factors.

Table 3. Breakdown of reported type of fatal injuries.

Category	Frequency	Percent
Crushed/Runover	229	59
Trauma from impact	61	15.7
Asphyxiation	15	3.9
Entanglement/Caught in machinery	13	3.4
Burns	12	3.1
Head Injury	9	2.3
Other	9	2.3
Drowning	5	1.3
Chemical Exposure	2	0.5
Unkown	33	8.5
Total	388	-

There was no attempt to pursue additional information on the reported cause of death, and access to official death certificates was limited to only the first decade of the study period. The “other” categories included: A work-related heart attack, fatal electrocutions, an unintentional on-farm shooting, strikes by lightning, heat, and bleeding out (with cause not identified).

3.7. Type of Contributing Agent

The contributing agents involved were divided into ten different categories: Tractors, farm machinery-related, roadway, smothering and asphyxiation, falls, cutting and trimming trees, fires/burns/explosions, livestock, other, and unknown. Table 4 provides a distribution of the categories of agents when known. The most common agent involved, by far, was tractors, with 157 incidents (40.5%); farm machinery-related was the second highest, with 87 incidents (22.4%). Case information did not provide sufficient information to determine whether or not tractors involved were equipped with roll over protection structure (ROPS) or that the ROPS were in use at the time of incident. The five incidents in the other category included two cases of round bales rolling onto the victim, an unintentional shooting, a heart attack while attempting to remove a dead pig, and collapsing due to unknown issues, such as heat stress or a heart condition.

Table 4. Breakdown of type of contributing agent.

Category	Frequency	Percent
Tractors	157	40.5
Farm Machinery-related	87	22.4
Roadway	31	8
Cutting and trimming trees	27	7
Smothering and asphyxiation	20	5.2
Falls	18	4.6
Livestock	17	4.4
Fires, burns, and explosions	16	4.1
Unknown	9	2.3
Other	6	1.5
Total	388	-

Incidents were broken down further to better understand the primary causes of tractor-related fatalities, as seen in Table 5. The most common incident type largely involved tractor rollovers, with 86 cases (54.8%), or 22.1% of all documented incidents. The second most common incident type was tractor runovers, with 33 cases (21.0%), or 8.5% of all cases. The third most common was pinned against, between, or underneath a tractor, with 18 cases (11.5%), or 4.6% of all cases.

Table 5. Breakdown of fatal tractor-related incidents.

Category	Frequency	Percent	Percentage of All Cases
Tractor rollover	86	54.8	22.1
Tractor runover	33	21.0	8.5
Pinned against, between, or underneath the tractor	18	11.5	4.6
Fall from a tractor	17	10.8	4.4
Unspecified tractor incident	3	1.9	0.8
Total	157	100	40.5

The next breakdown made was the machinery-related incidents, as shown in Table 6. The most common incident type was “pinned against, between, or underneath an object or equipment,” with 27 cases (31.0%). The second most common was “equipment rollover,” with 16 cases (18.4%), and the third most common was “equipment runover,” with 14 cases (16.1%).

Table 6. Breakdown of fatal machinery-related incidents.

Category	Frequency	Percent	Percentage of All Cases
Pinned against, between, or underneath an object or equipment	27	31.0	6.9
Equipment rollover	16	18.4	4.1
Equipment runover	14	16.1	3.6
Entanglement in PTO driveline	9	10.4	2.3
Struck by flying, falling, or thrown material	8	9.2	2.1
Fall from equipment	4	4.6	1.0
Entanglement in other, non PTO components	4	4.6	1.0
ATV incident during farm-related work	4	4.6	1.0
Equipment incident, unspecified	1	1.1	0.3
Total	87	100	22.4

The breakdown of roadway incidents is shown in Table 7. The most common fatality type was “roadway collisions involving farm tractors or equipment,” with 21 cases (67.7%), and the second highest was “farm truck incident during farm work,” with six cases (19.4%). Based upon Indiana fatal motor vehicle crash data, the number of farmers involved in fatal work-related crashes, especially those involving farm trucks, is most likely under reported [44].

Table 7. Breakdown of fatal roadway incidents.

Category	Frequency	Percent	Percentage of All Cases
Roadway collision involving farm tractors or equipment	21	67.7	5.4
Farm truck incident during farm work	6	19.4	1.5
Roadway collision at railroad crossing	2	6.5	0.5
Roadway incident, unspecified	2	6.5	0.5
Total	31	100	8.0

The breakdown of incidents involving cutting and trimming trees is shown in Table 8. All of the cases fell under the category of struck by a tree or tree limb (27 cases), or 6.9% of all cases. No fatality cases were reported relating to injuries sustained during the operation of chainsaws.

Table 8. Breakdown of fatal cutting and trimming tree incidents.

Category	Frequency	Percent	Percentage of All Cases
Struck by a tree or tree limb	27	100	6.9
Chainsaw	0	0	0
Total	27	100	7.0

The smothering and asphyxiation categories of fatality cases are shown in Table 9. The most common type of incidents was “entrapped and suffocated by grain, feed, or other loose material,” with 13 cases (65.0%). The second most common type was “drowning in pond, lagoon, or stream,” with five cases (25.0%). In some cases, it appears that the drownings were associated with being trapped beneath an overturned tractor or mowing equipment.

Table 9. Breakdown of fatal smothering and asphyxiation incidents.

Category	Frequency	Percent	Percentage of All Cases
Entrapped and suffocated by grain, feed, or other loose material	13	65.0	3.4
Drowning in pond, lagoon, or stream	5	25	1.3
Asphyxiation or poisoning from gases	2	10	0.5
Total	20	100	5.2

The breakdown of the category of falls is shown in Table 10. The most common cases were “falls from farm structures,” with nine cases (50.0%), and the second were “fall from ladder,” with five cases (27.8%). Data on falls that occurred in the home, though identified in some reports, were not considered work-related and therefore not included in the data set. Considering the age of the population being studied, the number of non-work fatal falls could have been significant [45,46].

Table 10. Breakdown of fatal fall incidents.

Category	Frequency	Percent	Percentage of All Cases
Fall from farm structure	9	50	2.3
Fall from ladder	5	27.8	1.3
Fall incident, unspecified	4	22.2	1.0
Total	18	100	4.6

The breakdown of the livestock fatality type is shown in Table 11. The most common type of incident involved bulls, with six cases (35.3%), and the second involved cows, with five cases (29.4%). The exotic livestock cases involved a wildebeest and a buffalo.

Table 11. Breakdown of fatal livestock incidents.

Category	Frequency	Percent	Percentage of All Cases
Bull	6	35.3	1.5
Cow	5	29.4	1.3
Horse	4	23.5	1.0
Exotic livestock	2	11.8	0.5
Total	17	100	4.4

The breakdown of the “fires, burns, and explosions” fatality categories is shown in Table 12. The most common type of incident involved explosions, with five cases (29.4%). The second most common type of incident was tied between “caught on fire with accelerant”, “electrocutions”, and “other fire-related incidents” with three cases each.

Table 12. Breakdown of fatal fire, burn, and explosion Incidents.

Category	Frequency	Percent	Percentage of All Cases
Explosion	5	29.4	1.3
Caught on fire with accelerant	3	17.6	0.8
Electrocution	3	17.6	0.8
Other fire-related incident	3	17.6	0.8
Farm structure fire	2	11.8	0.5
Smoke inhalation	1	5.9	0.3
Total	17	100	4.1

4. Discussion

The data showed that the number of fatalities involving older farmers has been on the rise from 2012 to 2017, with 2015–2017 having the highest reported number. This increase does not reflect the general decrease in the frequency of older fatal farm incidents over the same time period [15]. The increase could be the result of several factors, including the increasing age of current farmers, farmers putting off retirement, older non-farmers becoming beginning farmers as part of their retirement, or due to improvements in reporting. The average age of all farm operators increased from 50.5 in 1982, to 58.3 in 2012, and to 59.4 in 2017 [1–3]. A survey by Amshoff and Reed (2005) of 725 male farmers 50 years or older found that 42% stated they were not retired from farm work, even though the average age of the sample was 67 years [47]. In addition, the number of principal operators of farms increased for the age groups of 55 to 64 years old, 65 to 74 years old, and 75 years and older from 2012 to 2017 by 28.8%, 45.0%, and 35.1%, respectively [3]. The frequency of fatalities involving older farmers is clearly increasing, while the distribution of fatal incidents for all ages appears to be on a slight but continuous, decline. The increase in the number of small farms owned and operated by retired people cannot be ignored as a contributing factor. There was a 10.8% increase in the number of farms owned by operators 65 years and older from 2007 to 2012 [2,4]. In some of these cases involving new and beginning farmers, the lack of experience and safety training in the use of agricultural tractors and equipment may have played a significant role in the fatality. It is also important to mention that new methods in reporting, such as the internet, may have caused the increase in the number of recent cases.

The distribution of the victims' age showed a decrease around age 75 up into the 90s. This may be explained by the fact that there is a smaller population of farmers still active at that age. The large number of fatalities in this age range, however, follows the literature that farmers work longer than the general workforce, with 178 fatalities reported over 70, and the oldest case being 93 years of age [3,47]. It appears that this trend parallels the 6% increase in the total number of farmers who were 70 years or older from 2007 to 2012 in Indiana [2]. This is a concern because farm-related injuries occurring to older farmers are more likely to be fatal or result in long term or permanent disability. As noted, it is well documented that certain age changes, such as arthritis or hearing and vision impairments, contribute to increased risk of sustaining both non-fatal and fatal injuries.

Regarding type of contributing injury agents, tractors were identified as an area of concern, representing 40.5% of the reported fatality cases. This finding aligns with other reports for the most common type of contributing agent for all ages [15,19,48–50]. The second highest type of fatality was farm machinery-related, with 87 fatalities that accounted for 22.4% of the deaths. The third and fourth highest fatality types were roadway and the cutting and trimming of trees, with 31 and 27 fatalities, respectively.

Tractor rollover incidents were clearly the most significant event, accounting for 22.1% of cases, with most frequently reported fatal injuries of broken or crushed pelvis, broken bones, loss of blood, collapsed lungs, and chemical or other burns. Other similar studies have reported that tractor rollovers, or overturns, have also been historically the most common type of fatal incident [15,48,49,51–54]. It has also been reported that farm operators 65 years and older are more likely to be operating a tractor without a ROPS [55].

Occupational farm-related injuries and fatalities have a huge cost, estimated to be \$8.3 billion in 2015 due to medical costs and reduced productivity [56]. Tractor overturns alone were projected to have a social cost of \$1.5 billion over 25 years [57]. The problem gets even more complex when coupled with a large percentage of farmers and household members, 10.7%, not having any health insurance in 2015 [58]. With respect to older farmers, the length of recovery and rehabilitation costs associated with serious injuries can become unmanageable.

5. Conclusions

This study identified the most prevalent types of contributing injury agents and reported types of fatal injuries, as well as other demographic factors of Indiana farmers 55 years and older. The data are important to help guide the development and delivery methods of agricultural safety material to create a safer worker environment by illustrating what risks are most prevalent for older farm workers. The summary suggests that agricultural safety material and practices should be focused towards farm worker incidents relating to tractors, farm machinery, roadways, cutting and trimming trees, and smothering and asphyxiation risks.

Educational materials should clearly address how the aging process contributes to the increased risk of injury and measures needed to reduce the impact of age-related functional limitations. The most significant risk that should be addressed with this population is the potential for tractor overturn and the well-recognized hazard of operating older tractors without ROPS.

The findings from this study should be an important tool to be given to stakeholders, including farm families and extension educators, so they can be better informed about the health and safety of the older farmers in their families and communities. Findings should assist in initiating a discussion on ways to enhance the safety of these workers while still allowing them to continue contributing to the farm operation.

Future research is needed to better understand how this population perceives risks and to better understand the values and behaviors of older farmers, compared to other age groups, that motivate them to remain involved in performing hazardous farm-related tasks. Work is also needed to develop and field test injury prevention strategies that are effective at modifying behaviors and attitudes that contribute to a higher risk of farm work injuries among this population.

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