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## Fatal Incidents in Australia's Older Farmers (2001–2015)

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### ABSTRACT

**Objectives:** This study assesses nonintentional injury deaths of older farmers and the causal agents associated with these fatalities in Australia (2001–2015). It also explores approaches based on the hierarchy of risk controls to reduce fatalities and injuries in this cohort. **Methods:** Data on farm-related incidents were sourced from the National Coroners Information System (NCIS) for the study period and coded. Rates were calculated and regression analyses completed to assess trends over time. **Results:** Those in the 50+ years category ( $n = 610$ ) accounted for 49.8% of all on-farm nonintentional injury deaths, with males ( $n = 566$ ) dominating the cases. The annual mean was 40.66 cases ( $SD = 8.08$ ) and the average rate 36/100,000. Trend analysis revealed a nonstatistically significant ( $P < 0.05$ ) increase in cases over the period. Farm vehicles and machinery were responsible for almost two thirds of the fatal cases. **Conclusion:** Nonintentional fatality rates for older farmers have remained relatively unchanged for a significant period in Australia. There is a need to examine additional approaches that not only maintain the benefits of work activity for older farmers but also balance this against a safety perspective.

### KEYWORDS

Aging; farm; injury; older; safety

## Introduction



Agriculture is a vital industry for Australia, with the gross value of total agricultural production exceeding AUD\$50 billion in 2013–2014, an increase of almost 6% from 2012 to 2013.<sup>1</sup> Although the value of agricultural production is rising, the number of Australian farmers is decreasing.<sup>2</sup>

Agriculture is identified as a high-risk industry in many Western countries.<sup>3–6</sup> In Australia, agriculture had the second highest rate of fatalities on an industry basis over the 2003–2014 period (14.4/100,000).<sup>7</sup> Within this context, the aging of the agricultural workforce is a significant industry characteristic that may impact safety.

In 2011, the average age of Australian farmers was 53 years compared with the all-industry mean of 39.5 years.<sup>8</sup> Furthermore, almost a quarter (23%) of Australian farmers were aged 65 years or over, compared with just 3% of people in other occupations.<sup>2</sup> Similar findings have been observed in Canada where 64% of farmers continue to work full or part time around retirement age, compared

with only 33% of nonfarming entrepreneurs and 6% of employed nonfarmers.<sup>9</sup> Overall farm work hours decrease with increasing age; however, older farmers remain active in the workplace.<sup>10</sup> As with other regions such as North America, this high participation rate of older farmers demonstrates how essential they are to the maintenance of agricultural output.<sup>6</sup>

Specific issues, which are potentially related to an increased injury risk in older farmers, revolve around the normal physiological and cognitive changes associated with aging. These include observed reductions in strength, flexibility, and balance, plus issues with sight, hearing, and memory.<sup>6,11</sup> Concurrently, issues such as health status, medication use, stress, and financial pressures all add to risks for older farmers.<sup>6,10,11</sup> Farmers also have long working hours and often work alone.<sup>2</sup> Risk factors do not operate independently but are associated with each other in a way that is difficult for individual farmers to control or even mitigate, e.g., age-related illnesses and medication use.<sup>6</sup> Canadian evidence suggests that older

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farmers suffer fewer injuries than younger farmers; however, when they are injured, older farmers are more likely to die.<sup>10</sup>

The age at which a worker is considered “older” can range from 28 to 75 years.<sup>12</sup> Although definitions of “older” people in the agricultural safety literature vary,<sup>6,10,13</sup> the mean age of Australian farmers is 53 years.<sup>8</sup> Additionally, the average age of US farm operators has been more than 50 years of age since the 1974 Census of Agriculture.<sup>14</sup> Consequently, for the purpose of this study, 50 years was selected as an appropriate and inclusive lower age threshold for this definition.

In assessing the impacts of aging in relation to farm safety, it is apparent that aging is not a dichotomy where everyone becomes old on turning a specific age. Consequently, many of the issues discussed in this article will affect farmers variably and incrementally, as they (like everyone else) get older.

In Australia, legislation requires that measures to prevent work-related fatalities and injuries are based on implementation of the hierarchy of controls.<sup>15</sup> In summary, actions must first commence with consideration to eliminate the hazard or risk, then if that is not feasible, to progressively work down the hierarchy approaches. This would require investigation of actions to substitute the hazard/risk for one of lesser risk, incorporating engineering solutions to improve safety, putting in place administrative approaches such as policies/training, and ensuring suitable personal protective equipment is used. In many instances, a combination of these approaches will be most effective; however, the process must commence with considering if the hazard/risk can be eliminated.

Given the vital role that older farmers have in agriculture and the potential for injury, this study focuses on the pattern of nonintentional injury deaths of older farmers and the causal agents associated with these fatalities in Australia from 2001 to 2015. It also explores approaches based on the hierarchy of risk controls to reduce fatalities and injuries in this cohort.

## Methods

This study draws data from the National Coroners Information System (NCIS), which is the central

repository of information about every death reported to an Australian coroner and has close to a 100% capture rate. Data were available from the NCIS inception in 2001 through to the latest available data (2015).<sup>16</sup> For farm-related incidents, all cases regardless of age are included where (i) the person died unexpectedly and the cause of death is unknown; (ii) the person died in a violent or unnatural manner; and (iii) a doctor has been unable to sign a death certificate giving the cause of death. For each case, preliminary information is uploaded into the NCIS and these remain “open” until the coroner hands down a final determination and the case is then “closed.” In each of the NCIS cases, a Cause of Death is determined and recorded by a coroner, with specific cause of death details independently coded by the Australian Bureau of Statistics against the International Classification of Disease 10 (ICD-10).<sup>17</sup>

Data extraction from NCIS involve two inter-related processes. Firstly, a commercial media tracking organization (iSentia) is used to scan approximately 2,500 daily, weekly, and monthly publications Australia wide. Publications are scanned for various designated search terms (e.g., “farm\*”; “agric\*”; “growers”; “producers”; “horticulture”). Where a potential on-farm case is identified, the corresponding NCIS case file number is obtained for this “open” case. This process has been used since 2005 and has proven to be reliable in identifying potential case events for inclusion. However, as not all cases are reported in the media, there is potential for cases to be under-numerated. Consequently, the second approach to identifying cases of relevance relies on keyword searches of the NCIS documents (farm\* OR agric\*) for each year. All cases identified are then reviewed and validated using the NCIS information as the gold standard, with those that are not farm-related and those confirmed as intentional by the Coroner being withdrawn from the data set.

The available NCIS data for farm-related cases are coded using the Farm Injury Optimal Dataset, with farm fatalities including both work and non-work-related activities.<sup>18</sup> The data set provides specific codes on demographics, role in event (e.g., operator, bystander, passenger), work relatedness, relevant causal agents of injury (dams, electricity, firearm, grain augers, quads [all-terrain

vehicles; ATVs], tractors, etc.), mechanism of injury, and other context-specific information as applicable such as helmet usage, loads, rollover/runover, and toxicological results (alcohol/drugs). The data set has been widely used in other Australian farm injury studies.<sup>19–21</sup>

Closed and open NCIS cases for the period 2001–2015 involving people aged 50 or more were extracted from the database and are the focus of this article. Although “open” cases have less available detail, these were included so as to not underrepresent data from recent years where there is a much higher likelihood that not all cases are closed as yet by a Coroner.

Analyses were undertaken using SPSS version 22 (IBM, Armonk, NY, USA), with descriptive data on age, gender, causal agents, and mechanisms of injury being assessed. Denominator information for farmers over the age of 50 years in the period 2001–2015 was derived from the Australian Bureau of Statistics Census Data for 2006 and 2011.<sup>22,23</sup> Population projections for the pre-2006 and post-2011 periods were determined by applying the trend for 2006–2011 to the data in order to calculate annual death rates as numbers of deaths per 100,000 persons. Polynomial regression analyses (linear, cubic, and quadratic) were used to assess the temporal pattern over time, with years or time centered at 2007. The trend was considered to be statistically significant at ( $P < .05$ ). The study has ethics approval from the Department of

Justice Human Research Ethics Committee (approval number CF/14/1161).

## Results

### Age and gender

Of the 1,226 farm deaths in the NCIS across all age groups between 2001 and 2015 inclusive (range: 1–94 years), those in the 50+ years category ( $n = 610$ ) accounted for 49.8% of all on-farm nonintentional injury deaths. Of these 610 cases, 83.1% were closed ( $n = 507$ ). Males were involved in 566 of the older farmer cases (92.8%).

As indicated in Figure 1, the highest proportion of cases was in those aged 60–69 (32.6%;  $n = 199$ ), followed by those 50–59 years (28.5%;  $n = 174$ ) and 70–79 years (26.4%;  $n = 161$ ). Persons over the age of 80 years accounted for 11.3% ( $n = 76$ ).

### Fatality trends

There was a mean of 40.7 ( $SD = 8.1$ ) older farmer deaths each year, with considerable year-to-year variation (Figure 2). Over this period, the average rate of deaths was 36/100,000 ( $SD = 7.2$ ). During the 15-year period, there was a slight increase in the rate of fatal cases involving older persons (0.276 per 100,000 persons per year,  $SE = 0.439$ ); however, this was not statistically significant ( $F(1, 13) = 0.395$ ,  $P = .319$ ), with an  $R^2$  of 0.541. The

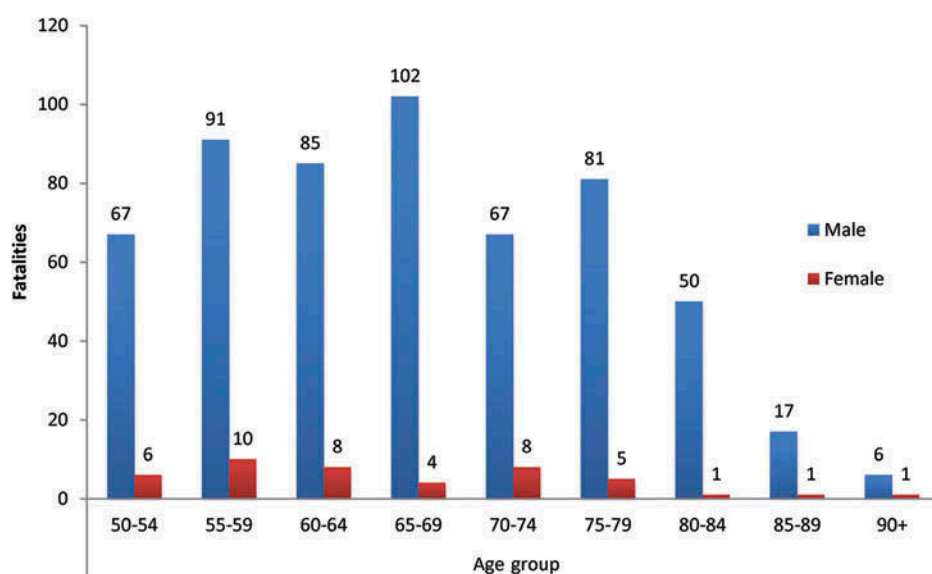


Figure 1. Older farmer deaths by age group and gender (2001–2015).

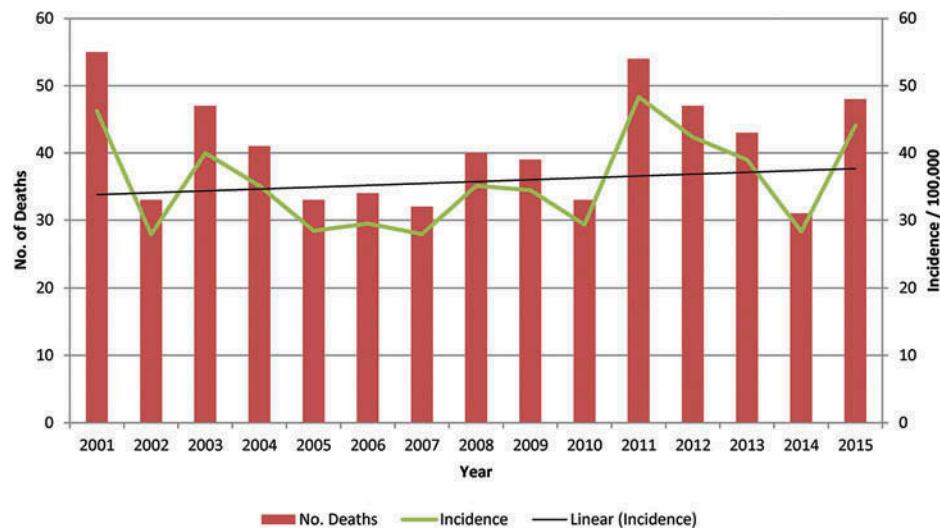


Figure 2. Older farmer deaths by year and fatality rate/100,000 (2001–2015).

addition of higher level quadratic ( $F(1, 12) = 2.015$ ,  $P = .181$ ) or cubic ( $F(1, 11) = 2.094$ ,  $P = .176$ ) components did not significantly improve the relationship.

### Causal agents

Mobile farm machinery ( $n = 209$ ; e.g., forklifts, grain augers, headers, tractors, etc.) and farm vehicles ( $n = 201$ ; e.g., cars, farm pickups [utes], quads [ATVs], trucks, two-wheel motorbikes, etc.) were responsible for almost two thirds of the cases. The disproportionate impact of these two broad categories is

reflected by the fact that the total number of fatal injuries for all the other categories was 199 (Figure 3).

For mobile farm machinery, tractors were the causal agent category involved in 151 of the 209 (72%) fatal incidents and 25% of all farm deaths for those in this age cohort. Similarly for the Farm Vehicle category, 85 of the 201 deaths (42%) involved quads as the causal agent. Farm utilities and cars accounted for a further 47 of the 201 recorded deaths (24%) and a small number of motorcycle incidents ( $n = 7$ ). Of the 48 animal-related cases, most involved horses (52%;  $n = 25$ ) and cattle (35%;  $n = 17$ ). Deaths categorized under the Working Environment category

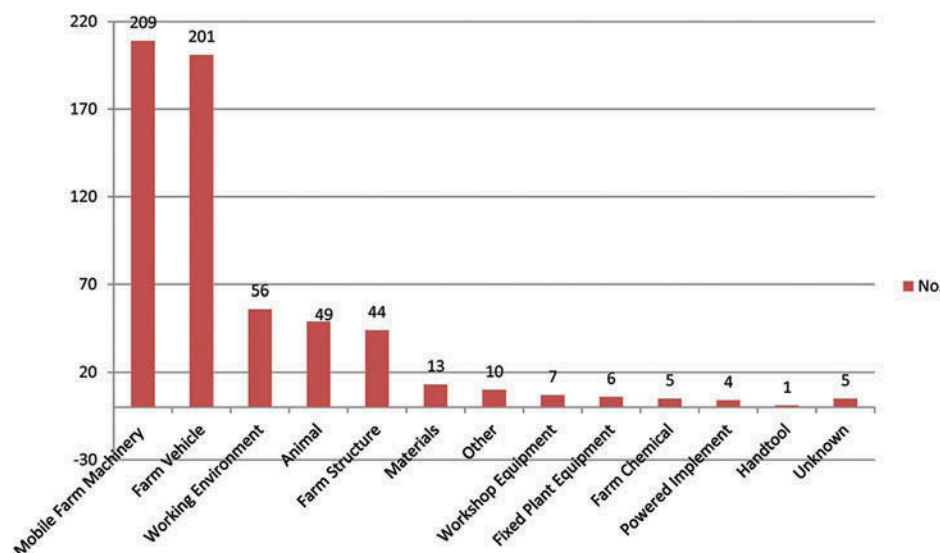


Figure 3. Agent categories associated with older farmer deaths, 2001 to 2015.

overwhelmingly involved felling trees or being hit by falling branches (75%;  $n = 42$ ). The Other category ( $n = 10$ ) predominantly involved unintentional incidents with firearms ( $n = 8$ ).

### Tractors and quads

In combination, quads and tractors were involved in over one third (39%) of all older farmer deaths in the period (Figure 4). Quads were variable in their impact with just 1 case in 2010, but 12 in 2011 (mean 5.7 cases;  $SD = 3.1$ ). Deaths from tractors appear to have stabilized at around 10 per year ( $SD = 2.5$ ).

Almost half of the tractor fatalities (48%;  $n = 73$ ) resulted from being run over. The context surrounding these cases most typically involved run over by the rear wheels while getting on/off a tractor or jump-starting older tractors without a neutral safety switch, resulting in the tractor jumping forward. A further 28% involved rollover incidents ( $n = 42$ ), with the remainder resulting from other causes ( $n = 22$ ) or the direct mechanism being unknown ( $n = 14$ ). Meanwhile for quads, rollovers accounted for 70% ( $n = 60$ ) of cases, nonrollovers involving the rider being ejected from the vehicle 28% ( $n = 24$ ) of cases, with the mechanism being unknown for 1 case. Typically, rollover incidents involve crush injury and asphyxiation, whereas nonrollovers are more likely to result in head injuries.<sup>24</sup>

### Discussion

This article aimed to identify the major causes of nonintentional farm injury fatalities for older Australian farmers. Throughout the study period, although the rate of rate of fatalities to older farmers did increase, this was not statistically significant, suggesting that reductions have stabilized. Importantly, the overall rate for older farmer fatalities identified (36.0/100,000) is some 2.5 times higher than the official agricultural rate (14.4/100,000) for all-age workers.<sup>7</sup> These findings reinforce previous North American studies illustrating that older farmers are at increased risk.<sup>6,11,25–27</sup> The findings suggest that there is a wide range of agents that contribute to the risks faced by farmers; however, farm machinery and vehicles dominate as the fatal causal agents. This is in keeping with existing knowledge in relation to western agricultural systems.

As aging occurs, there is only a certain extent to which one can effectively impact on this process. Approaches that maintain good physical health and cognitive stimulation are clearly important; nonetheless, there will be a reduction in capacity as a result of aging. Consequently, while farmers continue to work well beyond what would be considered “normal” retirement age in other sectors, there is a need to identify improved ways to balance the extensive benefits of older farmers continuing to be actively involved in work with their personal safety.<sup>28</sup>

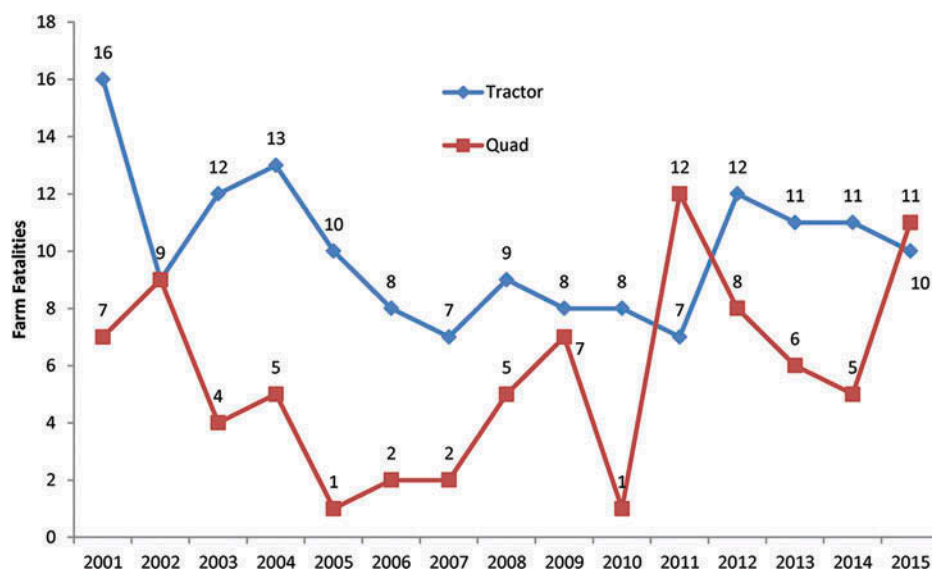


Figure 4. Tractor and quad (ATV) fatalities in older farmers (2001–2015).



As for all farmers regardless of age, multiple prevention strategies based on the hierarchy of controls have been developed that aimed at reducing older farmers' fatalities, yet economic, political, and cultural barriers often impede their implementation.<sup>29</sup> Educational campaigns are often raised as a focal approach to reduce injury; however, in isolation they are generally ineffective and must be coupled with other approaches, including reengineering of machines and safety devices to reduce fatalities.<sup>30</sup> With the significant involvement of machinery-related incidents in these Australian data, efforts that draw on higher-order approaches centering on elimination, substitution, and engineering controls are required.<sup>31</sup>

The significant burden of tractors and quads as agents of fatal injury accounting for over one third of all deaths is noteworthy. Tractors and specifically rollover events are recognized internationally as a major cause of death and injury within agriculture.<sup>30</sup> With rollovers resulting in entrapment, the key control measures advocated are the fitting of rollover protection structures (ROPS) in conjunction with the use of a seat belt. There is robust evidence of the effectiveness of ROPS internationally and also within Australia.<sup>30,32</sup> ROPS became mandatory in Australia for new tractors 32 years ago, with extensive retrofitting programs also being undertaken.<sup>32,33</sup> Although ROPS fitment compliance rates have not reached 100%, it is estimated that around 80% of all tractors are fitted with a ROPS.<sup>34</sup> Operator age has been identified as a strong risk factor for low ROPS prevalence rates, with older farmers identified as the group most likely to operate tractors without ROPS.<sup>35–37</sup> As such, additional fitment of ROPS to older tractors will continue to further reduce deaths from these incidents.

Run-overs accounted for almost half the tractor cases. This is in contrast with other countries/states where ROPS may not be required by legislation and rollovers dominate the fatality pattern.<sup>25,38</sup> From an injury prevention perspective, more recently designed tractors have entry/exit steps that finish outside the track line of the rear wheels, thereby reducing the potential of run-overs. Based on this, the retrofitting of safety access steps/platforms has also been advocated as a control

measure to reduce tractor run-over risks and access onto/off tractors.<sup>39,40</sup>

It is hypothesized that reductions in the mobility and balance of older farmers due to the aging process, along with possible influences of some medications, may increase these risks.<sup>6,11,27,41</sup> Exposure to potentially dangerous farm equipment does not decrease as much as would be expected based on a linear reduction in all work tasks, as overall work quantity decreases with age.<sup>6</sup> However, Canadian data suggest that older farmers disproportionately retained tasks involving tractors and harvesters as they aged, so that the proportion of time spent operating farm equipment such as tractors increased by about 40% in the older age groups.<sup>27</sup> Although tangible evidence is not available for Australia on this issue, it is likely that a similar transition may occur as farmers age. In conjunction, these findings suggest that there should be a focus on safe machinery operation taking account of age-related changes.

In Australia, anecdotal reports of older farmers utilizing quads in lieu of two-wheel motorbikes or horses because they are perceived as more stable and user-friendly are common. Similar issues have also been identified for older farmers in the United States.<sup>28,42</sup> Notwithstanding this, quads have become the major causal agent of nonintentional farm injury fatalities across all age groups in Australia, with older farmers accounting for almost half of these incidents.<sup>43</sup>

Despite their perceived stability, quads have no lateral stability standard and have been labeled by an Australian coroner as “prone to rollover.”<sup>44,45</sup> As identified in this study, the vast majority of older farmer quad cases (70%;  $n = 60$ ) involve rollover and accompanying crush injury or asphyxiation. Although quad manufacturers point to active riding (shifting of body weight) as the central means to attempt to maintain stability and prevent rollover, the validity of “active riding” as an effective and reliable risk control measure has not been accepted in Australia and continues to be contentious.<sup>46</sup> Regardless of this, work health and safety requirements in Australia necessitate that all risks are managed in accordance with the hierarchy of controls.<sup>15</sup> A key approach is to encourage farmers of all ages to move to more stable and suitable vehicles such as side-by-side vehicles as

the first option. Given the increased risks with aging, this appears to be an even higher priority for older farmers. Alternatively, if choosing to continue to use a quad, the appropriate safety guidelines are to fit a crush protection device (similar to a small ROPS on a tractor) to reduce risks from crush injury and asphyxiation, ensure the quad is in good mechanical condition, not exceed carrying capacity, get training, and wear a helmet.<sup>47</sup> Such an approach is also in alignment with recent regulatory approaches in Australia.<sup>48</sup> However, quad manufacturers continue to question these steps.<sup>49</sup>

To be effective, the approach taken to assist older farmers in enhancing safety must be undertaken in a context that older farmers themselves support. Recent US work suggests that older farmers place a higher value on the safety of others than that of themselves. This emphasizes how crucial the involvement of older farmers is to define context-specific approaches that can be taken to improve safety.<sup>28</sup> In Australia, a program (the Great Idea Bank) was developed based on consultation with older farmers.<sup>50</sup> Some of the key concepts incorporated into this program were that older farmers (a) did not want to hear about or have the term safety used in resources (i.e., it was to be a “health and safety free-zone”); (b) wanted to know what the physical and cognitive changes were that impact on their capacity to work; and (c) wanted practical ideas to assist them with an emphasis on “making farm work easier as we get older”—lifting, awkward positions, vision, hearing, preventing falls, memory, etc. In essence, the program was designed by farmers for farmers and respected the importance of their ongoing involvement in farm work. It drew on practical solutions identified by farmers that could be introduced to make the work load easier and surreptitiously safer (without explicitly stating this as an outcome).

The data used in this study are drawn from the NCIS, which has virtually universal coverage of all fatal injury-related incidents in Australia. An additional strength of the study is that it is nationwide in scope, in contrast with focusing on injuries and/or fatalities in individual states or agricultural industries. However, a corresponding weakness is that this study’s broad-ranging approach may result in important differences between agricultural industries or

between Australian states being unrecognized. Further studies are planned to consider trends in older farmer fatalities in different Australian states and in different agricultural industries.

Although rates of death per 100,000 older farmers have been included in the study, we were not able to account for exposure in relation to hours of use/operation for specific causal agents. This may be highly significant, particularly in regards to comparing rates for tractors, farm pickups (utes), and quads, which for the two former agents are ubiquitous within Australian agriculture. Further, although the study focused solely on fatal incidents, it is undeniable that there will be a much larger burden from nonfatal injuries; however, the causal agents associated with those cases may not necessarily reflect those of the fatal cases. Additionally, it has been documented in other settings that the actual injury risk is lower for older farmers, but the severity of incidents that do occur is greater.<sup>25</sup> Finally, as individual age-related changes cannot be ascertained, only general inferences relating to the impact of the aging process can be proposed. However, the consistent nature of the findings with other studies supports the validity of the findings.

This study indicates that older farmers are at significantly elevated risk of unintentional farm death and that this risk has remained largely unchanged for the past 15 years in Australia. Although a direct causal pathway for each individual case is beyond the scope of this study, the findings do support the contention that normal age-related changes influence farm injury risk. With an increasingly “aged” farmer cohort in many western agricultural settings, a greater emphasis on approaches that account for and consider these changes is required. In Australia, there is a clear need for increased investment in practically orientated intervention programs, as without a reduction in injury-related fatalities in this age cohort, agriculture will continue to be among the highest-risk industries.

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