

Aging Farmers Are at High Risk for Injuries and Fatalities: How Human-Factors Research and Application Can Help

Anne Collins McLaughlin, John F. Sprufera

Agriculture is a dangerous profession with an aging population, combining age-related changes in physical and cognitive abilities with complex tasks performed under hazardous conditions. There are three general approaches to reducing injuries: designing for safety, providing positive reinforcement in prevention programs, and making safety a family affair.

Older Farmers Are at Risk

Farmers are an aging population nationwide, and North Carolina is no exception. The US Department of Agriculture reports an average age of more than 57 years for US farmers, and more than a quarter are older than 65. In addition to the lack of new, younger farmers, farmers tend to retire later than do individuals in most other occupations, adding to the disproportionate amount of older individuals. Unfortunately, the dangers of working on a farm are only aggravated when the effects of aging are considered. Older farmers have been found to be at high risk because they tend to suffer injuries more frequently than do younger farmers and the injuries they suffer are more likely to be fatal [1]. Thus, any focus on agricultural safety should include older farmers as a population of interest, with emphasis on the changes in the abilities and attitudes that can come with age. In the following commentary, we review the connection between human behavior, aging, and agricultural accidents.

General Hazards in Agricultural Work

Although there are numerous specific hazards associated with agricultural work, we focused on 4 risk constructs that could contribute to agricultural accidents. These include hidden hazards, risk attitudes, workload, and equipment age.

A hazard is considered hidden when it runs contrary to the expected dangers of a product or process. An example from agriculture is the pressure associated with hydraulic lines. Although normal leaks can be temporarily stopped by covering with a fingertip, the pressure of the hydraulic leak will cut through skin and flesh. As another example, grain bins, one of the most common locations for a fatal accident, have 2 hidden hazards associated with asphyxiation. The first occurs when humidity causes grain to be perceived to

be solid when it is not. The second occurs when undetectable fumes build up inside the bin, causing unconsciousness and eventually suffocation to an individual [2]. Such hidden hazards can occur in all professions, but the tendency of farmers to use equipment for multiple purposes (often purposes not envisioned by the designers) makes hidden hazards likely to affect farming operators.

Other important risk contributors are the attitudes of farmers and operators. One attitude found on farms that is not typical of most workplaces is that accidents are inevitable. Although farmers wish to avoid accidents, most farmers report a general sense that accidents are part of their occupation [2]. This outlook could have many consequences, from encouraging risky behaviors to the underreporting of accidents. Older farmers likely experienced situations similar to those that eventually resulted in an accident but escaped previously without negative consequences. Thus, they have been rewarded over a lifetime with nonaccident experiences that contribute to an attitude of "just this one time," to get the job done.

"Getting the job done" is the third farming-specific risk contributor. There is high pressure in agricultural work to complete a task despite adverse conditions, such as weather, darkness, time pressure, broken equipment, or an inadequate workforce. This differs from many work environments, where emotional distance exists between the worker and the outcome of the task. For example, in a factory, there may be pressure to meet a goal or quota, but the outcome each day likely does not drive the overall finances of that worker. Farmers are highly invested in harvest outcomes because of both the effect on their long-term finances and their personal investment as owner-operators or family members. Such contingencies often explain why farmers do not always employ safe behaviors when completing a task. Unfortunately, getting the job done often requires

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Address correspondence to Dr. Anne Collins McLaughlin, Department of Psychology, North Carolina State University, Box 7650, Raleigh, NC 27695 (Anne_McLaughlin@ncsu.edu).

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performing strenuous and complex tasks under suboptimal conditions.

Changes Related to Older Age

Physical, cognitive, and motor abilities all show age-related declines. Visual acuity and auditory capabilities are among the physical abilities that tend to decline with age. Such declines can have a direct impact on agricultural safety, demonstrated by the correlation between older-adult hearing loss and agricultural accidents [3]. Other abilities that tend to decline with age include performing multiple tasks concurrently, remembering to take future action (prospective memory), and the inhibition of task-irrelevant information [4]. Last, reaction time tends to increase with age, particularly when a decision is required. Such changes may partially explain why older farmers have been found to be more likely to be injured by machinery (often complex and fast-moving) than are younger farmers [5]. These age-related declines in cognitive abilities increase the importance of safe equipment design—agricultural work frequently requires coordination of multiple streams of information and action. In the example of ditch mowing, the operator must monitor inputs from the environment, such as slope, obstacles, and ground condition, while operating the machinery.

In tasks of daily living, older adults tend to cope well with the reduction in available mental resources, typically by selecting tasks they can do well, optimizing their work to fit their abilities, and compensating for lost abilities with strategies, such as planning more thoroughly [6]. However, the aforementioned pressures of farmwork do not always permit older farmers to employ these strategies and likely contribute to the high accident rates for older farmers.

A last age-related risk contributor is that farmers tend to use old equipment, and older farmers typically use even older equipment [2]. Whereas a car may be considered old after 10 years, tractors tend to be several decades old before being replaced. Indeed, the largest number of fatal accidents involved tractors of more than 20 years of age [7]. Aged equipment comes with its own problems, including the need for repair and not having the latest safety devices or measures (including rollover protection systems and guards on moving parts, such as power takeoff shafts, which are used to couple tractors, to power other equipment).

Potential Solutions and Areas for Future Research

We have enumerated the safety issues related to aging farmers in terms of their workloads, abilities, equipment, and attitudes. We next provide potential solutions and our assessment of remaining research questions.

Designing safety for aging as well as non-aging farmers. While newer products are often safer, the economy of agriculture does not permit replacement of all older equipment. The culture of agriculture is also such that new equipment often does not replace older equipment—it only adds to the total available [2]. Retrofitting equipment—such as install-

ing a rollover protection system and seat belts on older tractor models—promises to be more beneficial for farmers. However, more research is needed to choose and design these retrofits. A last comment on equipment safety is that newness does not guarantee safety. For example, having an ostensibly safe cutoff switch triggered by lack of weight on a seat can encourage hurried behaviors, as the farmer tries to perform a task outside the cab and return before the motor turns off.

Interfaces for farm equipment could also be improved for an older workforce. Modifying equipment to include multimodal warnings and feedback may reduce the attentional load placed on the operator. For example, giving the tractor driver an auditory cue may be more effective than a visual cue, as the operator's visual attention is already taxed by driving. However, such designs should be tested, since the salience of an auditory cue in a potentially noisy environment must be considered. Though there are numerous resources to inform design for older users [8], a search of the literature found few resources specific to agricultural equipment and tasks.

Positive reinforcement, not punishment. Attitudes toward risks are internal to the operators and are part of farming culture; thus, the motivations for the behavior must be addressed. Rewards are an effective way to promote desired behaviors. For instance, government agencies or insurance companies might offer incentives for keeping an updated farm safety plan. These attempts at changing behavior could be most useful for the large number of family farms that are not required to follow safety regulations [9]. Although regulation can be an effective tactic to increase safety (as has occurred in European farming), using a positive reward system might be more popular with US family farms than would increased regulation.

Care must be taken to prevent safer designs from punishing older farmers. Rules for safety are often broken, but preventing that behavior in the future requires understanding why the rules were broken. Adding an extra step, confirmation, procedure, or guard to enforce a rule may increase the time it takes for a farmer to complete a task, which may frustrate the operator into bypassing the safety measure. Testing new and retrofitted designs with farmers, including older farmers, is the most important step in creating acceptable designs.

In many fields, such as health care and aviation, behavioral models have been useful in understanding and changing unsafe behaviors. Examples of these models include Ajzen's Theory of Planned Behavior and the Theory of Reasoned Action [10]. These models have been applied only infrequently in the agricultural context [11], and it is our opinion that including such theoretical background will move the field of agricultural safety forward in ways that additional training and regulation have not.

Making safety a family affair. The operator of the machines on the farm is not the only person who can encourage safety: the farmer's spouse can also play a role in helping the farm

adhere to safety regulations and plan for emergencies. Such involvement may increase the engagement of all family members and increase feelings of accountability in maintaining and adhering to a current plan. This could be particularly helpful for farmers working alone. Older farmers have been found to be more likely to have been working alone when they were fatally injured [2]. Part of a safety plan can include communication between family members and workers, with technology specific to this purpose.

Research has shown that farms with a current safety plan report fewer accidents than do those without one, but more research is needed to understand whether safety plans cause a safer environment or whether farms that choose to have plans already promote a culture of safety. More research is also needed on the roles other family members can play in forming and adhering to these plans.

Conclusions

Farming is an occupation in which danger and consequences can increase with the age of the farmer. By utilizing the information concerning design for aging and behavioral change, researchers can determine both technological and social solutions to help prevent accidents. Such physical, cognitive, and social ergonomic applications on the farm can improve the livelihood of the industry and can serve as an example of how human factors can reduce the risks of a dangerous work environment. **NCMJ**

Anne Collins McLaughlin, PhD assistant professor, North Carolina State University, Raleigh, North Carolina.

John F. Sprufera PhD candidate, North Carolina State University, Raleigh, North Carolina.

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