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Grower Perceptions of Safety Hazards and Associated Injuries among Farmworkers Involved in Northwest Potato Production

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ABSTRACT

Background: Potatoes are a vital part of the Pacific Northwest's agricultural economy. As in many agricultural industries, workers involved in potato production may be at risk for illness and injuries.

Methods: A Hazard Perception Survey (HPS) was completed by 63 potato growers in Washington (n = 26) and Idaho (n = 37) during the fall and winter of 2017–2018. Participants were asked to indicate their level of concern regarding the frequency and severity of injuries associated with various potato production tasks. Descriptive statistical analyses were used to identify operations and tasks that potato growers perceived to be most hazardous.

Results: The majority of growers (70.9%) indicated that they were very concerned about injuries on their farm. Growers reported that tasks requiring bending, twisting, and lifting resulted in the most common and severe injuries, followed by potato sorting during harvest and falling during planting operations.

Conclusions: Potato growers were concerned with potential hazards related to a variety of potato production tasks. In response to these concerns, we developed educational materials to assist growers in identifying and mitigating safety hazards on their own establishments. Future research is needed to evaluate the utility of these tools on reducing potential hazards and injury rates among workers in the Northwest potato industry.

KEYWORDS
Agricultural worker; farm safety; occupational safety; potato production; workplace hazards

Introduction

Potatoes are a vital part of the Pacific Northwest's agricultural economy. They are the fourth most important food crop in the world and the leading vegetable crop consumed in the United States.[1] Together, Idaho and Washington produce more than half of the nation's potatoes. In 2017, the two states produced a value of nearly 4 USD billion worth of potatoes, totaling 442 million hundredweight ("cwt", where 1 cwt = 100 lbs.).[1,2] In Washington, potatoes rank fourth among agricultural commodities in production value,[3] and Idaho grows more potatoes than any other state.[1] This large-scale production is associated with a commensurately large workforce. The Washington State potato industry employs approximately 35,860 people,[4] and the Idaho potato industry also employs more than 30,000 workers,[5] with nearly 7,500 additional jobs in potato processing.[6]

Agriculture is one of the most hazardous industries in the United States, and every day, about 100 agricultural workers suffer lost-work-time injuries.[7] Transportation incidents – including tractor overturns and All-Terrain Vehicle (ATV) incidents – are the leading cause of death among farmers and farmworkers.[7] Machinery is also frequently implicated in agricultural injuries and fatalities.[8]

The potato industry utilizes a variety of farm vehicles and machinery that may present hazards, including tractors that may not be equipped with roll-over bars, harvesters with rotating power-take-off-shafts, and ATVs which may be operated without helmets. Workers also may be exposed to heat stress, electrical hazards, pesticides, and other agricultural chemicals. During harvest, multiple large conveyor belts are in use, which can snag loose hair or clothing.

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Hazards may also exist during industry-specific activities such as potato sorting and seed cutting. Potato sorting, at both the harvester and the sorting table, has been identified by potato producers as one of the highest priority safety hazards in a small survey conducted by the Washington State Potato commission (WSPC) (M. Blua, oral communication, July 2017). During the process of seed cutting, potatoes are chopped into smaller pieces by a mechanized cutter, and these smaller pieces are planted as seeds. Some pieces that emerge from the cutter are still too large, and workers push these pieces onto knives using their hands. This unique process also results in injuries (M. Blua, oral communication, July 2017).

In the past 5 years, Washington State's Department of Labor and Industries' Safety and Health Assessment and Research for Prevention (SHARP) program and the Occupational Safety and Health Administration (OSHA) in Idaho have identified numerous injuries and fatalities among farmworkers in Washington and Idaho.[9–11] In 2016, there were nine fatal occupational injuries in the agricultural, forestry, fishing and hunting industry in Idaho, and that number increases to 15 fatalities in 2017.[10] In Washington in 2017, there were four fatalities in crop production.[11]

In regard to fatalities and injuries occurring in the potato industry specifically, the Bureau of Labor Statistics reported six fatalities in 2018 that occurred in potato farming, [12] and a fatality on a potato farm was reported in Idaho in 2014.[9] Internationally, the Health and Safety Executive (HSE) recently launched an inspection initiative to potato farms following the release of HSE statistics showing 30 deaths on British farms in 2017, as well as many serious injuries resulting during potato harvest, including entanglement with machinery, vehicle accidents, and falls.[13] Despite the size and potentially hazardous nature of the potato industry in the Northwest, data is scarce surrounding injuries and fatalities in the Washington State and Idaho potato industries. Likewise, limited research – international, national, or regional – has focused on safety hazards in potato production.

Owners and operators of potato farms, commonly and herein referred to as potato "growers," have unique perceptions that can provide insight about the safety conditions they directly observe. To our knowledge, however, no research has focused on growers' perceptions of potential hazards on their own establishments. This pilot project aimed to fill that gap by surveying potato growers about their perceptions of potential hazards in potato production and further, to assist those growers in identifying and controlling hazards on their farm. This study lays the groundwork for a future project to measure the efficacy of a safety intervention to reduce illness and injury rates among workers in the Washington and Idaho potato industries.

Methods

Survey

We created a Hazard Perception Survey (HPS) to obtain information about growers' perceptions of the most hazardous tasks associated with potato production.[14] The HPS was an adaptation of a safety survey previously developed by the WSPC that asked potato growers to rate the frequency and severity of injuries associated with a variety of general farming operations.[15] Our HPS incorporated questions similar to those found in the WSPC survey, but specifically included questions regarding physical, chemical, mechanical and ergonomic factors that may be perceived to increase the number of injuries on a potato farm.

The HPS consisted of a collection of 25 structured and open-ended questions. Growers were asked about tasks related to general potato production, as well as tasks associated with five operations: planting, irrigation, pest management, harvest, and storage. Dr. Matthew Blua, a collaborator on this project and the director of industry outreach for the WSPC, identified and determined these five operations to be most relevant and useful to understanding grower perceptions of potential hazards in potato production, based on his professional expertise.

For example, the survey inquired about tasks commonly associated with planting operations, including seed potato cutting, truck driving, tractor driving, and ATV driving, and then asked

growers to indicate the frequency and severity of injuries associated with each of those planting tasks. Each question consisted of two associated Likert scales: the first was used for growers to indicate the *frequency* of injury associated with potato production tasks, and the second Likert scale was used for growers to indicate the *severity* of injury associated with those tasks. The multiple choice options for injury frequency included never, rarely (less than once per year), occasionally (1–5 per year), frequently (5–10 per year), and very frequently (more than 10 per year). The options for injury severity included mild (at home/first aid), moderate (physician visit), severe (ER visit/hospitalization), or not applicable (N/A). If a grower reported that a given injury "never" occurred, then it was not applicable (N/A) to rate the severity of that injury.

To encourage participation in the study, the survey did not inquire about demographic information. It did, however, ask each grower to indicate the number of acres planted with potatoes on their operation, which allowed us to understand the range of operation sizes captured within the survey results. Overall, the HPS was designed to identify how growers perceive the current safety level of various tasks commonly associated with those five operations, as well as general potato production, at their own potato production establishment.

Sample recruitment

We used two strategies to recruit survey participants from agricultural communities in Washington and Idaho. First, we recruited a convenience sample of growers in Idaho who attended the Big Idaho Potato Harvest meeting in Fort Hall, Idaho, a post-harvest event for growers and industry organizations hosted by the Idaho Potato commission (IPC). Second, we recruited a convenience sample of growers in Washington and Idaho via a survey invitation email sent by the WSPC and IPC. To be eligible for participation in the survey, participants had to be at least 18 years old, be a member of the WSPC or IPC, and identify themselves as potato growers. This study was reviewed by the Boise State University Institutional Review Board and determined to be exempt from further IRB review.

Analysis

Descriptive statistical analyses were used to identify operations, tasks, and other factors that potato growers perceived to be most hazardous. A frequency*severity index was calculated for each potato production task and potential hazard as the product of each respondent's injury frequency and severity score. The frequency*severity index has been used in other settings to measure the expected number of injuries and the average cost of each injury. For instance, it has been used to index exposure to traumatic incidents among police,[16] as well as injuries sustained by car occupants,[17] and by agricultural workers.[15]

For questions regarding the frequency of injuries, growers were presented with the following options: Never = 0, Rarely = 1, Occasionally = 2, Frequently = 3, Very Frequently = 4. For severity, mild = 1, moderate = 2, severe = 3, N/A = 0. Thus, if a grower indicated injuries associated with a certain task were occasional and moderate, that response would receive a score of 2*2 = 4. Each respondent's numerically coded answers were then summed to yield an overall score for each task/hazard. According to these frequency*severity scores, we ranked each task/hazard to indicate the highest priority hazards associated with potato production, as perceived by growers.

Results

Study population

Potato growers (n = 63) were recruited from Idaho (n = 37) and Washington (n = 26) to participate in the Hazard Perception Survey (HPS) between November 2017, and March 2018. Participants reported that they operated on an average of 1,175 and 2,520 acres of farmland in Idaho and Washington, respectively. The average, standard deviation, and range of workers involved in the five operational categories at each farm in both states are shown in Table 1. Table 1 does not display the overall number of workers employed by each grower,

Table 1. Pacific northwest potato farm characteristics, as reported by growers, 2017–2018.

N (surveys completed)	Idaho			Washington		
	37			26		
	Average	Standard Deviation	Range	Average	Standard Deviation	Range
Farm size (acres)	1175	1331	35–10,000	2520	2638	106–7000
Workers involved in planting	14	17	4–30	16	12	3–100
Workers involved in irrigation	12	17	2–30	8	7	2–100
Workers involved in pest management	3	3	1–15	4	4	0–20
Workers involved in harvest	40	50	5–100	35	29	9–300
Workers involved in storage	12	49	0–75	14	20	0–300

but instead displays the average number involved in each operation since some workers were involved in multiple tasks. In both Idaho and Washington, the largest number of workers were involved with harvest operations, while growers reported that they employed only a few workers who were involved with pest management.

Survey results

Study participants responded to questions regarding the safety of six categories of operations on their farms. Study participants did not indicate that there were any operations during which injuries occurred "frequently" or "very frequently" (5 or more times per year). The highest ranking for injury frequency reported by growers was that injuries occurred "occasionally" for a given task within an operation (1–5 times per year). Grower responses are described by operation in the following sections.

Planting operations

Growers first answered questions about the frequency and severity of injuries associated with planting. In Washington and Idaho, growers reported an average of fourteen and sixteen workers involved with planting tasks, respectively. While most growers reported that injuries rarely or never occurred during planting activities, 29% reported that tasks requiring bending, twisting and lifting occasionally resulted in injuries. This was therefore the task reported by growers to most frequently be associated with injuries during planting. While growers did not report a high frequency of injuries associated with truck, tractor or ATV driving, a small percentage (2%–6%) perceived that when these injuries occurred, they could be severe.

For more detail regarding grower perceptions of injuries associated with planting tasks and potential hazards, see Figure 1. Growers were asked to indicate injury severity across four categories (not applicable (NA), mild, moderate, and severe), but for presentation purposes, mild/NA and moderate/severe are combined. No grower reported injuries occurred frequently or very frequently, so those categories are not included.

Irrigation operations

Growers in Idaho reported employing an average of twelve workers involved with irrigation operations, while growers in Washington reported an average of eight workers. Thirteen percent (13%) of growers reported that injuries were occasionally associated with bending/lifting/twisting during irrigation. Electrical shocks were of relatively low concern; however, 6% of growers indicated that, in the unlikely event of an injury resulting from an electrical shock, injuries could be severe. Fifty-six percent (56%) of growers reported that injuries resulting from vehicle driving were rare, but in the event that they did occur, 11% reported these injuries could be severe.

More details regarding grower perceptions of injuries associated with irrigation tasks are displayed in Figure 2. Growers were asked to indicate injury severity across four categories (not applicable (NA), mild, moderate, and severe), but for presentation purposes, mild/NA and moderate/severe are combined. No grower reported injuries occurred frequently or very frequently, so those categories are not included.

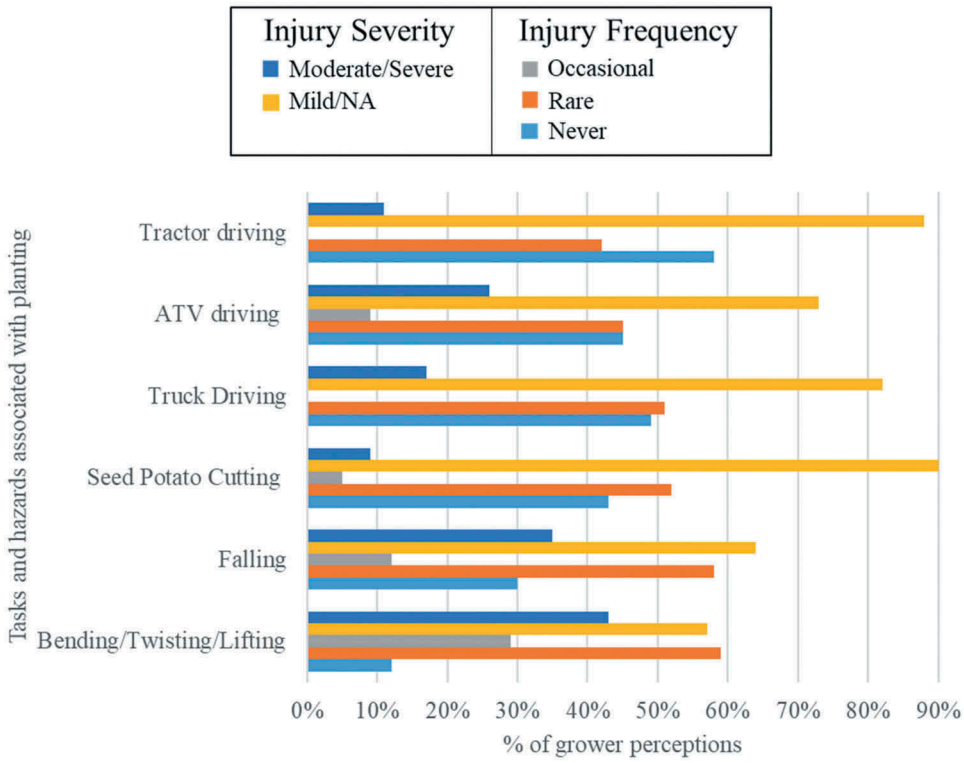

Figure 1. Grower perceptions (N = 63) of the severity and frequency of injuries associated with **planting** tasks and potential hazards.

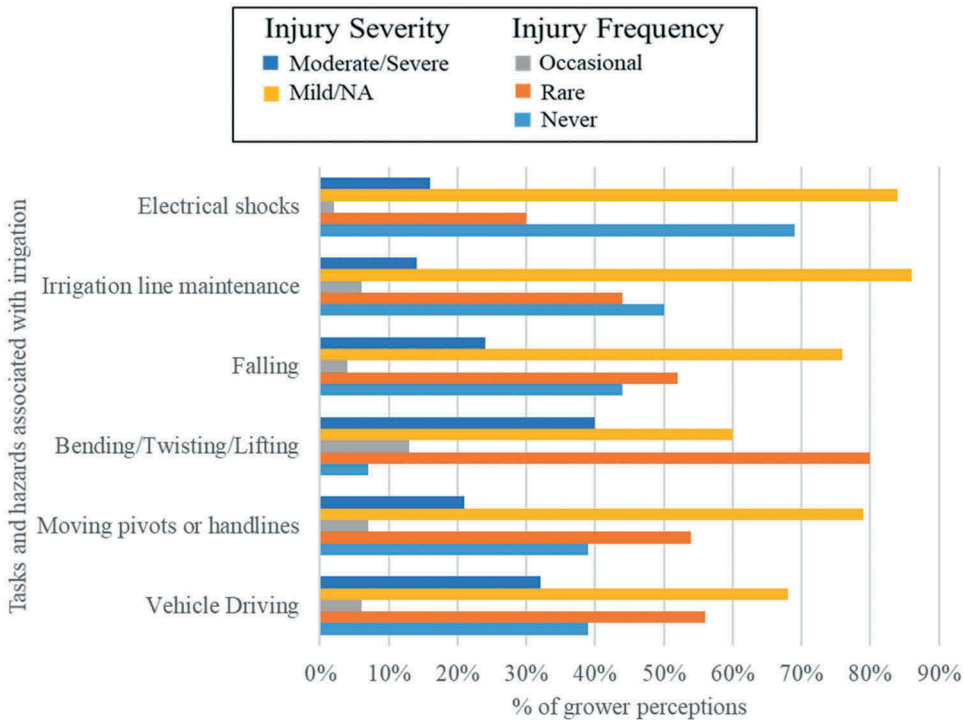

Figure 2. Grower perceptions (N = 63) of the severity and frequency of injuries associated with **irrigation** tasks and potential hazards.

Harvest operations

Growers in both states reported employing the most workers during harvest operations (35–40 workers on average). Twenty-two percent (22%) of growers reported that injuries associated with potato sorting during harvest

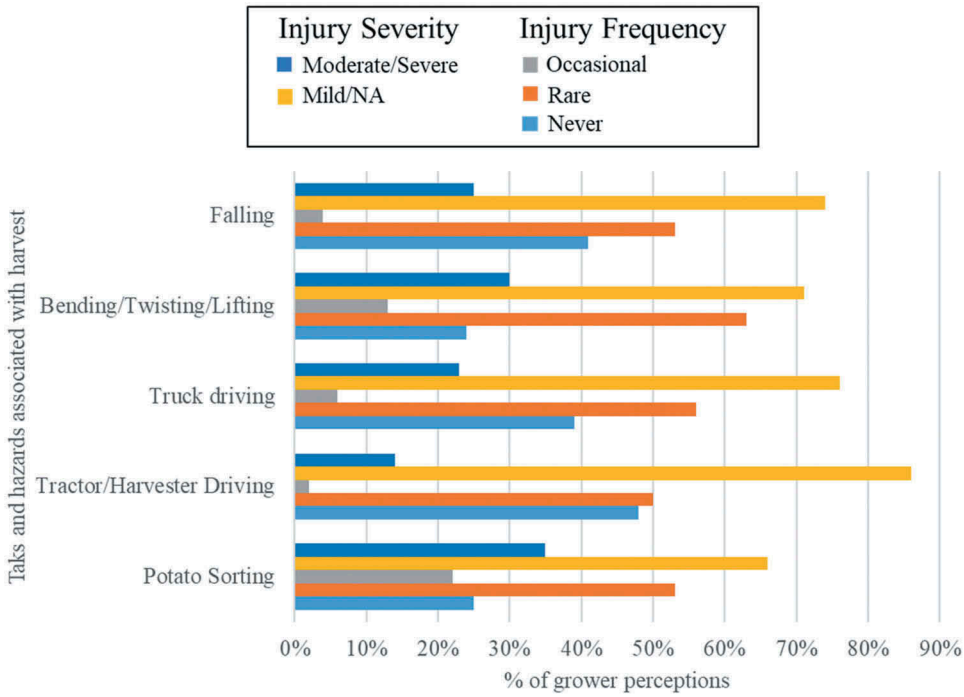

Figure 3. Grower perceptions (N = 63) of the severity and frequency of injuries associated with **harvest** tasks and potential hazards.

resulted in occasional injuries. Ten percent (10%) of growers reported that injuries associated with harvest were severe. Again, injuries related to bending, twisting and lifting were reported to occur more often than other injuries, but they were also reported to be less severe.

For more detail regarding grower perceptions of injuries associated with harvest operations, see Figure 3. Growers were asked to indicate injury severity across four categories (not applicable (NA), mild, moderate, and severe), but for presentation purposes, mild/NA and moderate/severe are combined. No grower reported injuries occurred frequently or very frequently, so those categories are not included.

Pest management operations

Growers in Idaho and Washington reported employing an average of three and four farmworkers who performed tasks related to pest management, respectively. Growers were asked to report the frequency and severity of injuries associated with the following pest management tasks: preplant fumigation, treatment of seed potatoes, other pesticide mixing, other pesticide application, accidental exposure (spills, drift, storage problems), and vehicle driving (truck, tractor, ATV). The majority of growers reported that injuries associated with all of these tasks never or rarely occurred. Four and two percent of growers reported that injuries associated with accidental exposure and vehicle driving occasionally occurred, respectively.

In terms of injury severity, approximately 45% of growers reported that mild injuries were associated with each of the pest management tasks. Notably, 11% of growers reported injuries associated with pesticide mixing were moderate, while three percent of growers reported severe injuries associated with pre-plant fumigation, pesticide application, and vehicle driving.

Storage operations

Growers in Idaho and Washington reported employing an average of twelve and fourteen workers who were involved in storage operations, respectively. In this category, growers were asked about injuries associated with potato sorting, tractor/harvester driving, truck driving, bending/twisting/lifting, and falling; no growers reported that these tasks were associated with frequent or very frequent injuries. More than 90% of growers reported these injuries were either rare or never occurred.

On the rare occasion that these injuries did occur, 8% of growers perceived potato sorting to be associated with severe injuries, followed by 3% for severe injuries associated with truck driving, and 2% for injuries associated with bending, twisting, and lifting tasks. Moderate injuries associated with bending, twisting, and lifting, as well as falling, were perceived by 21% and 18% of growers, respectively. The remaining growers perceived all injuries associated with storage operations to be rare or not applicable.

General farming operations

Growers were also asked to report the frequency and severity of injuries associated with general farm operations and potential hazards: tractor driving, truck driving, ATV driving, bending/twisting/lifting, falling, and equipment maintenance/shop work. While most growers reported that injuries never or rarely occurred during general farming operations, 23% reported that equipment maintenance and working in a shop occasionally resulted in injuries. In addition, 10% of growers perceived injuries associated with truck driving to be severe, followed by 9% who perceived severe injuries associated with falling.

Hazard frequency and severity index results

Frequency*severity scores were used to create a quantitative metric with which we could compare growers' perceptions of the relative danger of each task/potential hazard. The maximum frequency*severity score that could be assigned to a single task was 756: to receive this score, each of the 63 participants would have had to indicate that the task was associated with the most frequent and severe injuries. Regardless of the operations of which they were a part, growers perceived bending, twisting, and lifting tasks to result in the most common and severe injuries. Bending, twisting and lifting tasks associated with planting received the highest frequency*severity index score of 94, followed by potato sorting during harvest (80); bending, twisting and lifting during irrigation (79) and during harvest (63); and falling during planting (62). Utilizing the frequency*severity index, the remaining tasks and potential hazards and their associated score are outlined in Figure 4.

It is important to note that, while growers did not report a high frequency of injuries on their farms, this did not mean that they were not concerned about worker safety. Most respondents (71%) reported that they were very concerned about injuries on their own farm, while 23% reported being somewhat concerned and 6% reported being "a little bit" concerned. Despite these high levels of concern, all growers reported that the frequency of injuries associated with any potato production task was either occasional, rare, or never occurred; no growers indicated that any of the tasks were associated with frequent injuries.

Discussion

Our study provides new information on potato growers' perceptions of potential hazards on their farms. We describe growers' perceptions of the severity and frequency of injuries associated with common tasks performed, both those that are specific to the potato industry, such as potato cutting and sorting, and those that are common across other agricultural commodities, such as driving a tractor or ATV. To our knowledge, this is the first study to focus exclusively on perceptions of growers in the potato industry.

Based on our survey results, growers were most concerned with tasks involving bending, twisting, and lifting, regardless of the operations of which they were a part. While it may be valuable to educate farmworkers about the tasks that might be most hazardous, it is almost certainly more effective to eliminate ergonomic hazards by redesigning the workplace to meet farmworker needs and abilities, rather than modifying behavior. This is consistent with the hierarchy of controls, which always indicates engineering and process changes over individual behavior changes.[18] In addition, perceptions from farmworkers themselves, who likely have different perceptions than growers, would provide complimentary evidence into the highest priority potential hazards in potato production.

The majority of our study participants also expressed concerns about injuries associated with falling, which is consistent with an earlier study among potato and vegetable farmers in Finland.[19] This study utilized injury claim records, finding

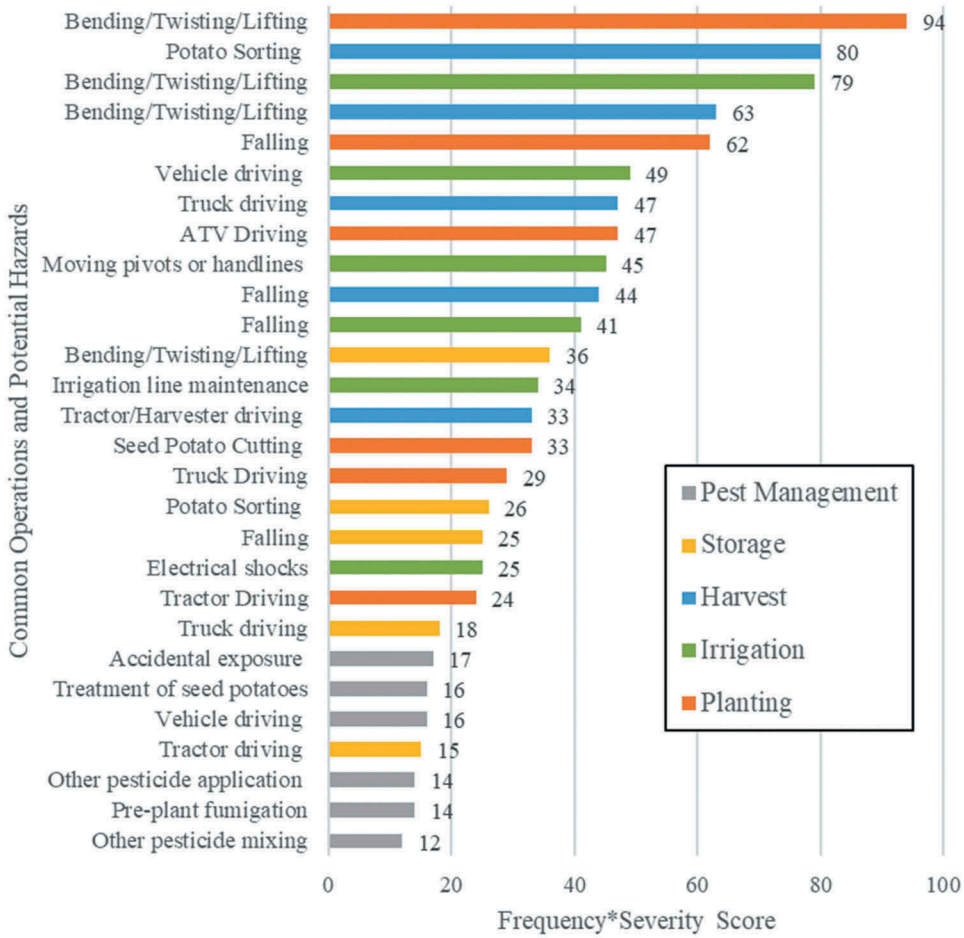

Figure 4. Frequency*severity scores, used to quantitatively rank growers' perceptions of the hazards associated with each task during each operation.

that 45% (n = 740) of injuries among workers in potato, sugar beet, and vegetable production resulted from a slip, trip, jump, or fall. While potato growers in the present study were most concerned with falls during planting, Mattila et al.-[19] found that farmers were aware of hazards related to deficient access paths, use of ladders, climbing on equipment, and insufficient work-space, most frequently during post-harvest activities or transporting products to storage. In 2014, more than 10,000 falls, slips, and trips in agricultural work-related injuries on US farms were reported, which is equivalent to about 18% of all injuries.[20]

Other researchers in Maine[21] and Canada[22,23] have suggested that many occupational injuries in potato production are attributable to machinery. In Maine, most injuries resulted from a body part being caught in equipment, most often, the harvester.[21] Two farm injury data reports out of Canada stated that many injuries can result from a body part being caught in equipment including the harvester,[19,21,22] conveyor belt when sorting out rocks and debris,[21] and the potato scooper and grader.[22] These findings are consistent with the more than 16,000 injuries that resulted from contact with objects and equipment in the US in 2014, the most common injury event.[20]

In addition, the Canadian Agricultural Injury Surveillance Program reported that among the 89 hospitalizations related to potato production work between 1990–1997, 84% were attributed to farm machinery, specifically a potato harvester, picker, or combine.[23] Exposure to a harmful substance, being struck by an object, or falling were involved with the remaining 16% of injuries.[23]

In the present study, the majority of growers were somewhat concerned with injuries related to potato sorting and vehicle driving as well as falling from machinery and equipment, but were more

concerned with the frequency of injuries resulting from tasks requiring bending, twisting, and lifting. Nearly a quarter of all agricultural work-related injuries to adults in 2014 were classified as sprains, strains, or torn ligaments,[20] which are associated with the bending, twisting, and lifting motions about which our study population was most concerned.

The National Institute for Occupational Safety and Health (NIOSH) has a variety of free and publicly available resources available for controlling ergonomic hazards in the workplace, including a tool to calculate the overall risk index for lifting tasks,[24] and a guide to preventing work-related musculoskeletal disorders.[25] Numerous participatory ergonomic interventions, defined as practical ergonomics with participation of the necessary actors in problem solving,[26] have effectively improved worker health.[27] A participatory ergonomic intervention could also be a useful intervention strategy in the potato industry.

Results of this study have potentially important implications for efforts to reduce farmworker injuries associated with potato production tasks. This study does not rely on injury records (which can be subject to under-reporting), but instead we report potato growers' perceptions about injuries and potential hazards, which we believe provides complementary insight into occupational conditions of potato production workers and industry needs.

However, there are several study limitations to acknowledge. First, these results should be interpreted with caution due to the small sample size (n = 63), and the possibility that our participants may not have accurately represented our targeted demographic of all potato growers in Idaho and Washington. In addition, these results might not generalize to other populations, including other crops and other states.

Another limitation is the possibility that growers may have had different perceptions of the term "injury". While some may have considered only traumatic injuries to be relevant, others may have included chronic musculoskeletal disorders. Further, the severity categories used in the Hazard Perception Survey – at home/first aid, physician visit, and ER visit/hospitalization – were crude markers of injury severity, but were selected in order to decrease the subjectivity of grower responses. We had greater confidence that growers would have objective knowledge of the level of care needed for a given injury, but less confidence that growers would have knowledge of the duration of the injury or how it was otherwise handled. This pilot project also did not have the capacity to evaluate any educational material on reducing farmworker injury.

It is also important to note that our study population did not indicate frequent occurrence of injuries. The highest ranking for injury frequency in this study was occasional, meaning growers perceived them to occur 1–5 times per year. This may be because injuries are, in fact, quite rare, and/or it could suggest that growers may be unwilling to admit that injuries are sustained more frequently or that they exhibited recall bias when completing the survey. It is also possible that workers may not report injuries/illnesses due to a variety of social, cultural, and economic disadvantages inherent in the race and immigration status of many farmworkers. For instance, barriers to reporting occupational injuries may include the fact that many farmworkers have limited English proficiency, lack health insurance, and are less educated and less likely to be US citizens compared to most other US workforces.[28] Studies investigating grower perceptions of potato production hazards should consider these possibilities when interpreting future survey results.

Outreach & communication

In response to the areas of highest concern indicated by growers in the HPS, our research team developed two resources that were distributed to growers that are intended to help growers better identify potential hazards on their own farms, and to take corrective measures to prevent or mitigate associated injuries. We first developed a Hazard Self- Assessment Tool (HSAT) to help reduce the risk of injury. It includes a Job Hazard Analysis instrument that encourages growers to stop what they are doing, watch the steps that are being taken by employees to complete a task, and identify the potential actions or hazards that could lead to an injury. The HSAT includes detailed instructions, an example, and a blank form for growers to

conduct the hazard self-assessment at their own workplace.

One of the key components of the HSAT asks growers to record recommended actions for minimizing risk of injury associated with each potential hazard identified. In order to identify actions to minimize injury risk, growers are encouraged to refer to a set of recommended practices contained in ten Potential Hazard Sheets. Our team created these sheets to provide simple solutions to decrease injury rates associated with the ten most common hazards that growers identified within the HPS.

These Potential Hazard Sheets were created in collaboration with the IPC and WSPC and are based on a review of relevant literature, professional experiences, and field observations collected during the 2018 potato harvest in Eastern Washington. Each of the ten Potential Hazard Sheets includes 2–3 recommendations on how to minimize the likelihood of work-related injuries, as well as simple instructions for accomplishing that recommendation. The Potential Hazard Sheets can be found in the Supplemental Materials.

The HSAT and the Potential Hazard Sheets were distributed to approximately 900 potato growers in Idaho and Washington by the IPC and WSPC. The two grower organizations electronically emailed growers a link to our website containing the HSAT and Potential Hazard Sheets, which will remain accessible electronically or can be downloaded and printed. In addition, we believe the use of the resources has the potential to increase communication between growers and employees, increase worker productivity and morale, and reduce workers' compensation costs.

Conclusion

Understanding potato growers' perceptions about potential hazards and injuries is an important step in accurately understanding health and safety conditions on potato farms. Findings demonstrate that most growers (71%) in this study were highly concerned about injuries on their farms, indicating a willingness to prioritize health and safety improvements. While no growers reported that injuries occurred frequently on their farms, overall, the highest level of concern was expressed about those tasks that require bending, twisting, and lifting and about injuries occurring during potato sorting at harvest, and falls during planting operations.

In response to these concerns, our research team created a tool that encourages growers to "Stop, Watch and Identify" hazards on their own farms, and ten Potential Hazard Sheets that provide recommendations for minimizing or eliminating the ten most common/severe hazards identified by growers in the HPS. We anticipate that the HSAT and Potential Hazard Sheets produced during this pilot project may encourage potato growers to improve safety practices on their farms. This project lays the groundwork for future work in improving health and safety within the Northwest potato industry, but future research is needed to evaluate the influence of the HSAT and Potential Hazard Sheets on reducing potential hazards and injury rates.

Disclosure statement

No potential conflict of interest was reported by the authors.

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