Utah Farm Owner/Operators' Safety Practices and Risk Awareness Regarding Confined Space Work in Agriculture

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ABSTRACT. *The purpose of this study was to describe current safety practices and risk awareness associated with confined spaces in agriculture among Utah farm owner/operators. There were 399 farm owner/operators in the sample. The final response rate was 82.2%. The typical farm owner/operator in this study was male, between the ages of 50 and 59, with some education beyond high school. Grain and dairy production comprised 48.7% of the operations responding to the survey. A majority (50.2%) of respondents reported having entered a confined space without an observer waiting from the outside. All but 9.5% of the respondents indicated that they had no written emergency response plan in the event of a confined space emergency involving an entrant. Only 49.1% of farm owner/operators perceived entering a grain bin while unloading as a high risk for fatal injury. More research is needed to determine the farmers' knowledge of the variety of hazards associated with confined space work. Few farm owner/operators reported using accessible safety equipment. A limited number of respondents indicated having access to gas monitors, lifeline and harness systems, or ventilation blowers with flexible ducting. This may be associated with the costs of the equipment, or lack of awareness of the need for specific safety equipment.*

Keywords. Confined spaces, Farm owner/operators, Fatal injury risks, Safety training.

Production agriculture is one of the most dangerous occupations in the U.S. (McCurdy et al., 2003; NIOSH, 2010). The National Safety Council's 2011 edition of *Injury Facts* ranks agriculture as the most dangerous industry in the U.S., with 25.4 deaths per 100,000 full-time equivalent workers (NSC, 2011). Miller et al. (2004) observed that Utah agriculturalists' injury rate was 387 injuries per 1,000 workers per year, and a rate of 199 injuries per 1,000 workers per year requiring professional medical treatment. Farm workers are typically aware of the risks associated with agricultural tasks but often feel incapable of avoiding risk-taking behaviors (Seiz and Downey, 2001). One of the top research and education priorities for agricultural safety and health professionals outlined by the Committee on Agricultural Safety and Health Research and Extension for the North Central Region (NCERA-197) is increasing safety in agricultural confined spaces. Two of the most commonly documented agricultural confined spaces are grain

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bins and manure storage facilities. Nearly 900 fatal and non-fatal grain entrapment cases in the U.S. have been documented between 1964 and 2010 by Purdue University's Confined Spaces Database (Riedel and Field, 2011), and 77 fatal incidents in livestock waste handling and storage operations have been documented between 1975 and 2004 (Beaver and Field, 2007). Of the 77 fatality cases related to manure storage, 17 (22%) were individuals who were attempting to rescue the original victim within the manure storage facility. Other forms of agricultural confined spaces, including silos, chemical storage tanks, transport vehicles, fermentation tanks, and bulk milk tanks, present hazards to agricultural workers. Riedel and Field (2011) documented that 72 fatality cases occurred on or inside forage storage structures between 1964 and 2010. Beaver and Field (2007) documented that operators and workers working around manure handling and storage facilities knew these facilities were unsafe yet failed to follow basic recommended work practices, such as those found in ASABE Standard EP-470. Concentrated animal feeding operations have numerous potential injury sources, such as manure storage systems, feed concentrate storage bins, and silage storage facilities (Sinnard, 1952; Johnston and Hawton, 2008; Radunz, 2010). Riedel and Field's (2011) summation of the diversity of fatal and non-fatal injury cases involving confined spaces associated with agricultural production documents the historical problem with these types of hazards.

Organizations often recognize that employees may be unaware of the hazards associated with their jobs. Managers often act accordingly by using safety training, especially to reduce workers compensation claims (Rubinsky and Smith, 1973; Morgenstern, 1992; Chadd, 1994; McLain, 1995). Many agricultural employees may not receive such training due to certain exemptions under OHSA regulations. However, the "general duty clause" of the Occupational Health and Safety Act, Public Law 91-596, indicates that a farm employer may be subject to OSHA citations and penalties for confined space hazards. A 2010 confined space incident involving a grain bin resulted in the deaths of two teenagers (USDOL, 2011). Additionally, a 2009 OSHA investigation of the death of a South Dakota Wheat Growers Association employee led to the discovery that five additional workers were placed in danger when they were sent into the bin to dig the victim out (Surbey, 2010). A similar case in May 2009 involved a 17-year-old employee of Tempel Grain LLP in Haswell, Colorado, who suffocated after being engulfed by grain. These events are tragic, especially because these deaths were preventable. It is unknown why individuals continue to enter agricultural confined spaces despite knowing the potential dangers. Through the use of on-site interviews and litigation review, Beaver and Field (2007) concluded that, while farm operators and workers knew that manure pits were unsafe, they did not perceive them to be so unsafe as to cause them to worry or follow recommended agricultural confined space work practices. Unsafe acts are often recognized as due to human factors, such as worker's attitude and/or lack of skill or knowledge (Daugherty, 1999).

Kingman et al. (2004) found that management decisions, along with an individual's perception of risk and willingness to avoid flowing grain hazards, had the most significant impact on reducing the potential for an engulfment. Kingman et al. (2004) recommended the use of training in hazard recognition and assessment to prevent fatal and non-fatal injures associated with grain storage facilities. Farm owner/operators' level of risk awareness about the dangers present in agricultural confined spaces is mainly unknown. Mitloehner and Calvo (2008) called for an increase in the safety training and preventive protection of all workers.

Attitudes toward agricultural safety programs are often negative, particularly if delivered by professionals with no farming experience (Murphy, 2003). Therefore, there is a need to develop agricultural safety programs that can be delivered by agricultural professionals within communities. Extension professionals can serve as change agents in their communities by communicating scientific knowledge in ways that are meaningful to the local population (Neufeld and Cinnamon, 2004). The development of a training program to address potential limitations of employees' safety knowledge and risk-taking may reduce the likelihood of injuries associated with agricultural confined spaces. When developing training to reduce deaths associated with agricultural confined spaces, human characteristics, including skill level, knowledge level, and level of risk acceptance, need to be assessed to determine effective programming (Beaver and Field, 2007).

Purpose and Objectives

The purpose of this study was to describe current safety practices and risk awareness associated with confined spaces in agriculture among Utah farm owner/operators. The main objectives for this study were:

- Describe the demographics of Utah farms with confined spaces.
- Describe Utah farm owner/operators' perceptions of the risks of working in agricultural confined spaces.
- Identify Utah farm owner/operators' use of safety and rescue equipment for agricultural confined space entry.
- Identify safe agricultural confined space work practices used on Utah farms.

Methodology

Instrumentation

A convenience sample of 28 students seeking a bachelor's degree in agriculture at Utah State University who had farm production experience associated with grain production, dairy, and poultry were asked to pilot the instrument to assess its reliability during the fall 2010 semester. Based on their experience, these individuals were considered to be similar to the target sample. These individuals indicated a desire to manage, operate, or own a farm after graduation. The decision to use these individuals to pilot the survey was based on the need to prevent a reduction in the number of farm owner/operators available to complete the survey and to reduce the likelihood of farmer survey fatigue. For survey reliability, Cronbach's alpha was calculated as 0.91 for hazard concerns items, 0.87 for safety practices items, 0.89 for training need items, and 0.65 for entry equipment usage items. The survey instrument was reviewed by four agricultural safety experts. These experts reviewed the survey for content validity in order to determine the degree to which the survey item constructs represented a proper sample of the theoretical content domain of agricultural confined space research. Experts also reviewed the survey face validity to determine whether the survey item constructs were appropriate for the objectives of the study. The survey was determined to have face and content validity.

Sampling

In January 2011, a proportionate stratified random sample was taken of Utah farmers registered with the Utah Agricultural Statistics Field Office who had a grain storage capacity of 5,000 bushels or more, 200 or more head of dairy cattle, 500 or more head of

swine, or a poultry operation with 1,000 birds or more. Cash grain production operations were selected due to the confined spaces associated with grain storage, which has been documented as a significant source of deaths in agriculture (Roberts and Field, 2010). Livestock operations were selected based on the number of animals on site that would require the use of bulk feed bins, silage storage facility, and/or a manure handling system (Sinnard, 1952; Johnston and Hawton, 2008; Radunz, 2010). Manure handling systems have also been documented as a major source of fatalities related to confined spaces in agriculture (Beaver and Field, 2007). There were 482 operations that met the sample selection criteria. A total of 83 individuals were inaccessible due to death or incorrect contact information, reducing the sample size to 399 individuals.

Farm owner/operators were sent a detailed information letter explaining the study, accompanied by the questionnaire and a return envelope via U.S. mail. Farm owner/operators were offered an incentive to complete the questionnaire in the form of a $5 gift card to a farm supply store. A reminder postcard was sent to all nonrespondents two weeks after the initial package was mailed. Telephone follow-ups were conducted with any remaining individuals who had not responded two weeks after the reminder postcard was mailed. A total of 165 individuals completed survey via U.S. mail. A total of 163 individuals who were contacted by telephone completed the survey. The final accepting sample was 328 farm owner/operators, yielding a final response rate of 82.2%.

Analysis

Descriptive statistics including frequencies, percentages, statistical means, and standard deviations were used to report safety practices, risk perceptions of confined space work tasks, entry experiences, hazard concerns, and entry/rescue equipment access and usage for each category of production operation. To check for response error, an independent samples *t*-test was used to compare individuals responding by mail and individuals responding by telephone. No statistically significant differences were found between respondents who completed the survey by mail and those who completed the survey by telephone.

Findings

Respondents were asked to self-identify the type of production that provides the majority (≥51%) of the cash receipts for their farm operation. Figure 1 provides a graphical representation of the percentage of each operation type indicated by respondents. Grain production included operations producing wheat, barley, oats, or corn. The dairy category included dairy cattle and/or milk production. Cattle production included cow/calf operations, stocker operations, range production, and feedlots. The forage crop category included cash crop alfalfa and other hay production. The other livestock included swine, poultry, and sheep production. Other production included diversified operations in which no single commodity accounted for 51% or more of cash receipts.

Table 1 presents demographic characteristics of the respondents. The majority (63%) of respondents were between the ages of 50 and 69 years old. A little over three-fourths of the respondents (76.6%) indicated having attained some education beyond high school. Only 33.2% of respondents indicated earning a bachelor's or advanced degree. Most (94.8%) of the respondents were male.

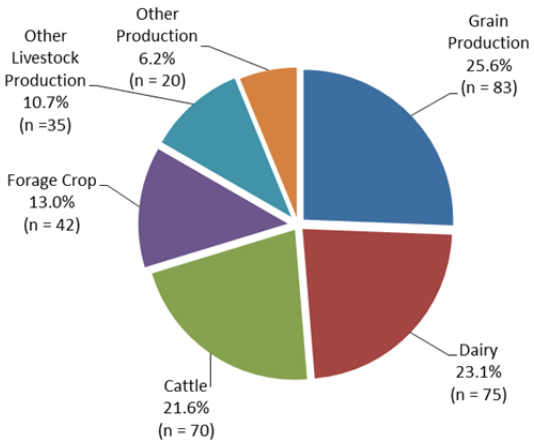

Figure 1. Graphical representation of agricultural production operations that responded to the survey.

Table 1. Survey respondents' demographic characteristics.

Variable		*n*	%
Age (*n* = 327)	<40 years old	22	6.7
	40-49 years old	54	16.5
	50-59 years old	113	34.6
	60-69 years old	93	28.4
	70+ years old	45	13.8
Education (*n* = 322)	High school or GED	75	23.3
	Vocational center certificate	13	4.0
	Some college	97	30.1
	Associate's degree	30	9.3
	Bachelor's degree	85	26.4
	Advanced degree (master's or PhD)	22	6.8
Gender (*n* = 324)	Male	307	94.8
	Female	17	5.2

Figure 2 provides a graphical representation of the distribution of respondents within the state. Box Elder County had the highest number of respondents (82), followed by Cache County (46), Sanpete County (31), Millard County (30), and Utah County (26). There were no respondents from Daggett, Garfield, Grand, or Kane counties, as these counties contain large tracts of national or state parks and monuments, with very little land available for agricultural production.

Farm owner/operators were asked to indicate the type of confined spaces found on their production operations (table 2). There were 247 respondents who indicated having a grain storage bin on site, while only 19 respondents indicated having a grain dryer. There were 205 respondents who indicated having a grain truck, and 37 respondents indicated having a gravity-flow grain wagon. For manure storage, 52 respondents indicated having a storage lagoon, and 57 respondents indicated having a storage pit. Only 13 respondents indicated having an aboveground manure storage tank. In addition, there were 28 respondents who indicated having a liquid manure spreader tank. A small percentage of respondents indicated having a conventional upright silo (3.7%, *n* = 12), oxygen-limiting upright silo (0.9%, *n* = 3), high-moisture corn storage bin (1.5%, *n* = 5), or a trench or bunker used for composting (1.8%, *n* = 6). A higher percentage of respondents indicated having a trench or bunker used for silage (23.9%, *n* = 78). None of the respondents indi-

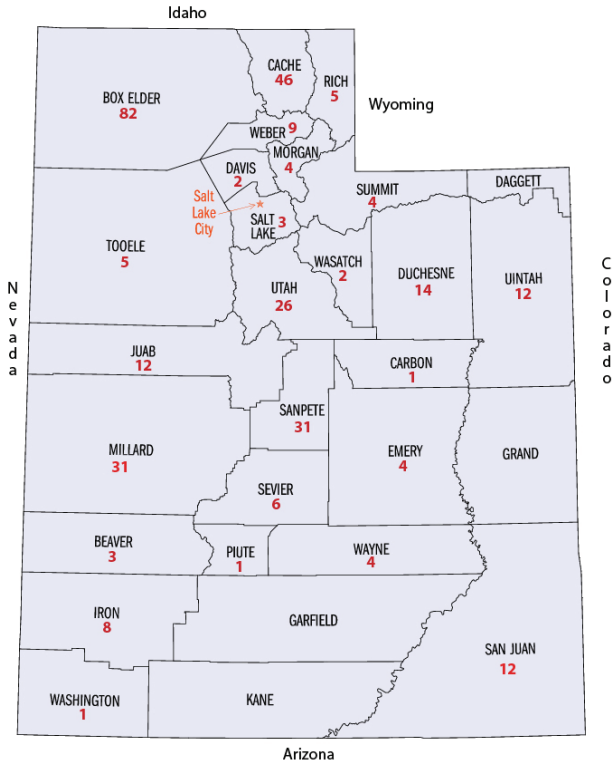

Figure 2. Frequency distribution of respondents by county.

Table 2. Percentage of operations with agricultural confined spaces.

Confined Space Type	Grain (*n* = 83) (%)	Dairy (*n* = 75) (%)	Forage (*n* = 42) (%)	Cattle (*n* = 70) (%)	Other Livestock (*n* = 35) (%)	Other Production (*n* = 20) (%)
Bulk feed bin	16.9	46.7	26.2	30.0	60.0	20.0
Grain storage bin	90.4	69.3	71.4	77.1	54.3	75.0
Grain dryer	10.8	1.3	7.1	4.3	0.0	15.0
Manure storage lagoon	3.6	54.7	0.0	1.4	14.3	10.0
Manure storage pit	4.8	48.0	7.1	7.1	17.1	5.0
Aboveground manure storage tank	2.4	8.0	2.4	1.4	5.7	5.0
Conventional upright silo	4.8	5.3	4.8	0.0	2.9	5.0
Trench or bunker used for silage	14.5	49.3	14.3	27.1	5.7	10.0
Trench or bunker used for compost	0.0	5.3	2.4	1.4	0.0	0.0
Oxygen-limiting upright silo	0.0	2.7	2.4	0.0	0.0	0.0
High-moisture corn storage bin	3.6	2.7	0.0	0.0	0.0	0.0
Milk storage tank	1.2	85.3	2.4	2.9	0.0	10.0
Sprayer tank	38.6	41.3	33.3	35.7	17.1	35.0
Methane digester	0.0	0.0	0.0	0.0	0.0	0.0
Liquid manure spreader tank	2.4	28.0	4.8	2.9	2.9	0.0
Gravity-flow grain wagon	14.5	10.7	14.3	4.3	8.6	25.0
Grain truck	80.7	62.7	50.0	47.1	65.7	65.0
Other[a]	1.2	16.0	9.5	2.9	8.6	10.0

[a] Respondents provided open responses for the "Other" category. Responses included well casing, irrigation screening structure, and feed wagon.

cated having a methane digester on their production operation. Confined spaces reported by respondents falling into the "Other" category included well casing, irrigation screening structure, and feed wagon.

Respondents were asked to report their level of concern regarding the risk of working alone in a confined space on their operation as *not concerned*, *slightly concerned*, *concerned*, or *very concerned*. Few (19.6%, n = 64) respondents indicated they were very concerned that working alone in a confined space could result in an injury. Respondents were asked to report their level of concern regarding the risk of death while working alone in a confined space on their operation. Similarly, only 19.3% (n = 63) of respondents indicated they were very concerned that working alone in a confined space could result in death.

Farm owner/operators were asked to rate agricultural confined space work tasks as *not a risk*, *low risk*, *moderate risk*, or *high risk* for a potential fatal injury to occur while performing that work task. Table 3 provides a detailed account of respondents' risk perceptions regarding agricultural confined space work tasks by operation type. A majority of cattle (55.7%), dairy (52.2%), forage (64.3%), and other production (55.0%) owner/operators perceived riding on top of a gravity-flow wagon loaded with grain to be a high risk for a fatal injury. A majority of cattle production owner/operators (53.7%) and forage crop production owner/operators (63.4%) perceived entering a manure storage facility to be a high risk for a fatal injury. Few Utah farm owner/operators (17.4%, n = 57) responding to this survey perceived packing silage in a trench or bunker as having a high risk for fatal injury. Only 36 of the 328 Utah farm owner/operators (11.0%) perceived unloading silage from a trench or bunker as having a high risk for fatal injury. Relatively few farm owner/operators perceived cleaning a milk storage tank, unloading a grain wagon or truck, and loading a grain wagon or truck as high risks for a fatal injury.

Farm owner/operators were asked to indicate access to agricultural confined work space safety equipment. Access was defined as having personal ownership, renting, or borrowing. Table 4 provides details regarding the number of operations indicating access to safety equipment on their operation. Five dairy production operations and five "other

Table 3. Percentage of operations who perceived agricultural confined space work tasks as a high risk for a fatal injury.

Task	Grain (n = 83) (%)	Dairy (n = 75) (%)	Cattle (n = 70) (%)	Forage (n = 42) (%)	Other Livestock (n = 35) (%)	Other Production (n = 20) (%)
Riding on a loaded gravity-flow grain wagon	43.9	52.2	55.7	64.3	37.1	55.0
Working in a grain bin while unloading	51.8	42.5	48.6	50.0	57.1	50.0
Entering a manure storage facility	48.1	37.5	53.7	63.4	42.9	45.0
Entering a liquid manure transport vehicle	45.1	37.7	46.4	56.4	45.7	47.4
Loading an upright oxygen-limiting silo	30.0	39.3	39.1	45.0	23.5	38.9
Unloading an upright oxygen-limiting silo	31.3	37.7	37.5	47.5	20.6	44.4
Entering a loaded grain bin	27.7	31.1	42.9	45.2	28.6	30.0
Entering a bulk feed bin	26.5	13.7	23.2	22.0	17.1	10.0
Packing silage in a trench or bunker	22.0	17.6	21.4	22.5	0.0	5.3
Loading an upright conventional silo	13.4	19.4	18.5	25.0	2.9	5.3
Unloading an upright conventional silo	16.9	13.1	15.2	25.0	5.9	10.5
Removing manure from a storage facility	14.6	8.1	19.4	17.9	8.8	5.3
Unloading silage from a trench or bunker	15.0	1.4	16.2	17.5	5.7	15.8
Cleaning a milk storage tank	13.9	5.6	12.1	5.0	6.3	5.3
Unloading a grain wagon or truck	4.9	1.4	5.7	7.1	2.9	10.0
Loading a grain wagon or truck	2.4	0.0	5.8	0.0	2.9	5.0

Table 4. Percentage of operations indicating access to safety equipment.

Safety Equipment	Grain (*n* = 83) (%)	Dairy (*n* = 75) (%)	Cattle (*n* = 70) (%)	Forage Crop (*n* = 42) (%)	Other Livestock (*n* = 35) (%)	Other Production (*n* = 20) (%)	Total Operations (*n* = 328) (%)
Gas monitor for toxic/flammable gases and lack of oxygen	7.2	6.6	1.4	7.1	14.3	15.0	7.6
Ventilation blower with flexible ducting	13.3	12.0	8.6	9.5	17.1	25.0	13.4
Lifeline/harness system to lift an individual out in an emergency	15.6	8.0	4.3	7.1	11.4	15.0	10.4
Respirator	41.0	29.3	34.3	38.1	51.4	30.0	37.5
Fully self-contained breathing apparatus	4.8	2.7	4.3	2.4	5.7	5.0	4.3
Bulk grain rescue tube	1.2	0.0	0.0	0.0	0.0	0.0	0.3
Security fence around manure storage lagoon	4.8	44.0	1.4	0.0	8.6	5.0	12.8
Tripod lifting device to lift an individual out in an emergency	2.4	4.0	5.7	0.0	2.9	10.0	4.0

livestock" production operations indicated access to a gas monitor to test for the presence of toxic/flammable gases and lack of oxygen. Eleven grain production operations and six "other livestock" production operations indicated access to a ventilation blower with flexible ducting. Grain operations accounted for 38.2% of the 34 operations indicating access to a lifeline and harness system to lift an individual out in the event of an emergency. Cattle, dairy, and "other livestock" production accounted for 60.1% of the 123 operations indicating access to a respirator. A total of 14 operations indicated access to a fully self-contained breathing apparatus. Only one grain operation indicated access to a bulk grain rescue tube. Thirty-three dairy operations indicated having a security fence in place around their manure storage lagoon. A total of 13 operations indicated access to a tripod lifting device to lift an individual out in the event of an emergency.

Farm owner/operators were asked to indicate usage of accessible agricultural confined work space safety equipment. Details regarding farm owner/operators' use of safety equipment are provided in table 5. Seventeen out of 25 operations indicated they used their gas monitor to test for the presence of toxic/flammable gases and lack of oxygen. Thirty-two operations indicated using a ventilation blower with flexible ducting. A total of 17 operations out of 34 indicated using a lifeline and harness system to lift an individual out in the event of an emergency. Respirators were the most common piece of safety equipment that farm owner/operators (*n* = 128, 37.5%) had access to, yet only 86 of those individuals indicated using them. Four operations indicated using a fully self-contained breathing apparatus. The grain operation that indicated access to a bulk grain rescue tube also indicated using the tube. Of the dairies having a manure storage lagoon surrounded by a security fence, only 24 indicating using the security fence to prevent access to the lagoon. Thirteen operations indicated having ready access to a tripod lifting device to lift an individual out in the event of an emergency.

Respondents were asked to report their work practices associated with entering agricultural confined spaces located on their farm operation. Farm owner/operators were asked to indicate how many times they entered an agricultural confined space within the last 12 months. Table 6 provides details regarding the percentage of respondents reporting confined space entries in the last 12 months. Most farm owner/operators (54.8%, *n* = 180)

Table 5. Percentage and frequency of operations indicating usage of safety equipment.[a]

Safety Equipment	Grain % (*f*)	Dairy % (*f*)	Cattle % (*f*)	Forage Crop % (*f*)	Other Livestock % (*f*)	Other Production % (*f*)	Total Operations % (*f*)
Gas monitor for toxic/flammable gases and lack of oxygen	4.8 (4)	5.3 (4)	0.0 (0)	0.0 (0)	11.8 (4)	15.0 (3)	5.1 (17)
Ventilation blower with flexible ducting	10.8 (9)	10.7 (9)	4.3 (3)	9.5 (4)	11.8 (4)	20.0 (4)	10.3 (34)
Lifeline/harness system to lift an individual out in an emergency	4.8 (4)	6.7 (6)	0.0 (0)	4.8 (2)	8.8 (3)	10.0 (2)	5.1 (17)
Respirator	31.3 (26)	21.3 (16)	20.0 (14)	26.2 (11)	34.3 (12)	20.0 (4)	26.2 (86)
Fully self-contained breathing apparatus	3.6 (3)	0.0 (0)	0.0 (0)	0.0 (0)	2.9 (1)	0.0 (0)	1.2 (4)
Bulk grain rescue tube	1.2 (1)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.3 (1)
Security fence around manure storage lagoon	2.4 (2)	32.0 (24)	0.0 (0)	0.0 (0)	8.6 (3)	5.0 (1)	9.1 (30)
Tripod lifting device to lift an individual out in an emergency	1.2 (1)	0.0 (0)	0.0 (0)	0.0 (0)	2.9 (1)	5.0 (1)	1.2 (4)

[a] Total number of individuals responding was 328. Respondents included 83 grain operations, 75 dairy operations, 70 cattle operations, 42 forage crop operations, 35 "other livestock" operations, and 20 "other production" operations. Three individuals did not indicate production type.

Table 6. Frequency and percentage of agricultural confined space entries made by farm owner/operators.

Number of Confined Spaces Entries in the last 12 Months[a]	*f*	%	Cumulative %
0	111	33.8	33.8
1 to 2	69	21.0	54.8
3 to 5	66	20.1	74.9
6 to 8	30	9.1	84.0
>9	52	16.0	100.0

[a] Total number of individuals responding was 328.

reported two or fewer entries in the last 12 months. There was 25.1% of respondents (n = 82) reported six or more agricultural confined space entries in the last 12 months.

Farm owner/operators were asked if they performed specific safe entry or injury prevention practices involving agricultural confined space work on their farms by indicating *yes*, *no*, or *not applicable*. Kingman et al. (2004) found these practices to significantly predict the likelihood of a confined space entrapment. Table 7 presents information only for those respondents who indicated the tasks were applicable. A majority (50.2%) of the respondents reported they do not enter a confined space without an observer watching from the outside. There were 256 respondents (90.5%) who indicated that they had no written emergency response plan in the event of a confined space emergency involving an entrant. Only 47.3% of the respondents indicated having family members and employees trained on the hazards of confined spaces. Few respondents indicated having local emergency first responders visit to train for a rescue (4.0%), labeling confined spaces with safety alert decals (25.7%), or having a site assessment to identify potentially hazardous confined spaces (41.9%).

Grain and feed storage bin maintenance was performed by most respondents who perceived the task to be applicable to their operation. These maintenance activities included grain moisture monitoring to maintain 14.5% or less (62.7%), grain bin and roofs checked for leaks (82.0%), repairs made to grain bin roofs (95.3%), bulk feed bin roofs checked for leaks (77.4%), repairs made to bulk feed bin roofs (95.7%), storage grain bin

Table 7. Frequency and percentage of respondents reporting confined space safety behaviors/practices.

Task	Yes *f* (%)	No *f* (%)	Total *n*
Entry without an observer waiting from the outside	140 (49.8)	141 (50.2)	281
Written emergency response plan	27 (9.5)	256 (90.5)	283
Family and employee training on the hazards of confined spaces	133 (47.3)	148 (52.7)	281
Grain moisture less than 14.5%	141 (62.7)	84 (37.3)	225
Grain bin and roofs checked for leaks	201 (82.0)	44 (18.0)	245
Repairs made to grain bin roofs	200 (95.2)	10 (4.8)	210
Bulk feed bin roofs checked for leaks	130 (77.4)	38 (22.6)	168
Repairs made to bulk feed bin roofs	134 (95.7)	6 (4.3)	140
Storage grain bin hatches latched after loading prior to storage	221 (91.3)	21 (8.7)	242
Bulk feed bin hatches latched after loading prior to storage	129 (87.8)	18 (12.2)	147
Local emergency first responders visited to train for a rescue	11 (4.0)	266 (96.0)	277
Confined spaces labeled with safety alert decals	69 (25.7)	199 (74.3)	268
Site assessment to identify potential confined spaces and develop an emergency response plan	137 (41.9)	190 (58.1)	327

hatches latched after loading prior to storage (91.3%), and bulk feed bin hatches latched after loading prior to storage (87.8%).

Conclusions and Recommendations

Caution should be exercised when considering generalizations of these finding to populations outside of this study. The climate faced by the respondents in this study differs from the climates faced in most Midwestern states that have wetter conditions, resulting in the storage of out-of-condition grain. Production details regarding the number of employees, the number of animals in confinement, manure storage capacity, and the amount of grain/feed stored on site were not assessed in this study. Further research is needed to determine if the results of this study are consistent with other populations of farm owner/operators.

Most farm owner/operators responding to the survey indicated having some form of agricultural confined space located on their production operation. Some of these farm owner/operators continue to enter confined spaces without taking proper safety precautions, such as observers watching from the outside or having rescue procedures in place in case of an emergency involving an entrant. We concluded that most of these farm owner/operators do not understand, or ignore, the risks associated with working in agricultural confined spaces. The evidence of the hazardous environments associated with agricultural confined spaces has been well documented (Harshman et al., 2004; Riedel and Field, 2011). Yet only 19.6% of the respondents in this survey indicated they were very concerned that working alone in a confined space could result in an injury, and only 19.3% indicated that they were very concerned that working alone in a confined space could result in death. Utah farm owner/operators' work behaviors indicate that they could be unaware of the dangers associated with agricultural confined spaces environments, as indicated by the relatively few Utah farm owner/operators who had conducted site assessments for identifying confined space hazards, and only 9.5% (n = 27) indicating they had a written emergency response plan in the event of a confined space emergency involving an entrant. More work needs to be done to help farm owner/operators understand the dangers associated with working in agricultural confined spaces. Educational programming on agricultural confined space safety should be developed for these producers with the goal of modifying their behavior to model safe agricultural confined space entry.

There are several possibilities as to why respondents are not using the safety equipment or practice safe work behaviors. This may be a result of Utah farm owner/operators' belief that the agricultural confined space work area does not warrant using protection or safeguarding in case of an emergency. We recommend more research to determine the farmers' knowledge of the variety of hazards associated with not using safety equipment while working in agricultural confined spaces. The implementation of a training program regarding the hazards of agricultural confined space work may help reduce agricultural confined space entries by farm owner/operators. An example of an approach is given by Cole et al.'s (1997) conceptual model of narrative representation, which integrates behaviorist, constructivist, and socio-cultural views of learning. From this model, human behavior becomes much more dynamic. Culture shaped by social interactions influences the construction of mental models by which people perceive, believe, know, evaluate, and act (Bandura, 1986). Desired behaviors may be more likely to occur if intrinsic motivation has been developed in the participants. Agricultural professionals, such as extension agents, can serve as change agents in their communities by communicating scientific knowledge in ways that are meaningful to the local populations they serve (Neufeld and Cinnamon, 2004). This would help to reduce the dissonance between safety knowledge and behavior by making training meaningful through integrated social and personal experiences. Additional research will be needed to determine the effectiveness of the educational programming to change producers' beliefs and work behaviors.

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Safety Emphasis

Data gathered through this survey can be used to guide training programs to reduce the frequency of agricultural confined spaces incidents.

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