

## Safety Hazards on the Farm and Intervention Recommendations

Ravinder Thaper<sup>1</sup>, T'Any Carter<sup>2</sup>, Melanie Hayes<sup>2</sup>, Charles Boyd<sup>3</sup> and Priyanka Parab<sup>1</sup>

1. Samuel Ginn College of Engineering, Auburn University, Auburn, AL, USA

2. School of Nursing, University of Alabama, Birmingham, AL, USA

3. School of Public Health, University of Alabama, Birmingham, AL, USA

For any questions: Contact Ravinder Thaper: rkt0005@auburn.edu

**Abstract:** The multiple hazards exist on the farms and majority of them are ignored, which might cause the farmer to pay later in terms of his ill health, potential injuries, or death. The current article discusses some of the common issues such as dust, air quality, environmental (weather) stressors, psychological stressors, noise, hearing loss, and tractor safety on the farms. Finally, the recommendations to overcome these hazards are discussed.

**Keywords:** Noise; Noise-Induced Hearing Loss; Noise Apps; Weather Stressors; Psychological Stressors; Tractor Safety; Seat belt Use; Dust; Air Quality

**Introduction:** The OSHA regulations do not apply to family farms with fewer than eleven employees, safety remains a vital concern for every worker on the farm. Prince (2006) identified several hazards that are common on cattle farms. Traumatic injuries can occur from: being stepped on or pinned by animals; tractor rollover, run over or entanglement injuries, motor vehicle collisions, and all-terrain vehicle accidents; entrapment from shifting loads of feed or hay; slips, trips and falls on wet or muddy surfaces or from a tractor seat; or repetitive motion trauma from lifting or ergonomic stress. Additionally, hearing loss can occur as a result of exposure to farm equipment and machinery for prolonged periods of time. Burns can occur from electrical shock, fires, welding, and ultraviolet light from the sun. Temperature extremes are associated with heat and cold stress-related illnesses and injuries. Dust, chemicals, fumes, and mold can be respiratory hazards and contribute to allergies and lung disease. And finally, psychological and emotional stressors are prevalent given the long working hours and the stress and strain of everyday farm life. (Prince, 2006).

The following objectives were focused for the purpose of the article:

1. Dust and air quality concerns
2. Environmental (weather) stressors and psychological stressors
3. Noise and hearing protection
4. Tractor safety and seatbelt use
5. Safety training resources for new employees, seasonal workers, and students, including electronic and print sources that might be applicable to a policy and procedures manual

### **Air Quality**

At the cattle operation, the cattle are fed a mixture of hay and dried feed. The components of this feed source are stored separately in large bins, inside of a large commodity barn. These bulk components consist of soybean husk, cottonseed, and other various feed products. These products are mixed in an agricultural feed mixer on an as needed basis. This mixing process takes place outside and produces large amounts of dust. There can be aggravated “allergy like” symptoms from the dust present in this process. When breathing large amounts of dust it can sensitize the worker causing allergy formation. There has been some evidence that exposure to soybean dust can lead to an increase in an allergic response to soybean husk (Arduzzo et al., 2001). Along with the soybean dust, there is also a concern for general dust inhalation and endotoxin exposure in agricultural workers. A recent study of inhalable dust and endotoxins show exposures to these substances are very high throughout the agricultural industry (Spaan et al., 2006). Exposure to endotoxins has been associated with several negative respiratory health effects in agricultural workers (Environment, Health and Safety Online, 2019).

Depending upon which antihistamines are taken, there are some considerations that must be made, especially while working in an occupation that requires all the senses to be uninhibited.

Older antihistamines, or first-generation antihistamines such as diphenhydramine, have more of a sedative effect, as opposed to newer second-generation antihistamines such as loratadine, fexofenadine, or cetirizine (Church & Church, 2013; Randall & Hawkins, 2018). The first-generation antihistamines readily cross the blood-brain barrier and may cause drowsiness, fatigue, lack of concentration, poor effects on performance in children in school and impairment while working or driving (Church & Church, 2013). Studies have shown poorer performance is linked to older, first-generation antihistamines (Church & Church, 2013; Randall & Hawkins, 2018). Antihistamines have also been linked to car and aviation accidents (Randall & Hawkins, 2018).

The farm workers suffer from allergic rhinitis, inflammation due to the release of histamine and other mediators (Randall & Hawkins, 2018). Allergic rhinitis may be seasonal due to grass or pollen, or year-around with such triggers such as pet hair, mold or dust (Randall & Hawkins, 2018). Though the newer antihistamines are less sedating, the opportunity for some sedating effects to occur remains such as reduced reaction time and impaired judgement (Church & Church, 2013; Randall & Hawkins, 2018). If antihistamines are needed, consider taking the smallest dose possible to achieve the desired effects and follow the recommended dosing instructions provided in the package insert.

With large amounts of grain dust present in the air, there is some concern for the combustion of these airborne particles. The likelihood of grain dust explosion is higher in confined spaces. A likely situation for grain dust explosion could present itself in the storage area, the mixing process, or during loading and delivery of feed product. Evaluating the amount of grain dust present would be key to recommending controls for these respiratory and combustion hazards. Determining the level of respiratory protection requires more characterization of the exposure during this process and the frequency with which this process is performed. Proper exposure

evaluation would allow us to determine the appropriate respirator and whether fit testing required. Personal sampling for endotoxins would allow to determine that risk as well. Making sure precautions are taken to reduce the likelihood of a combustible dust explosion throughout the process by reducing the amount of dust, removing ignition sources, and ensuring the process done outside would reduce grain dust explosion risk (Ardusso et al., 2001; Spaan et al., 2006).

## **Stress Management**

### Cold Weather Stressors

Beef cattle farming is one occupation where stress management is key. The health and welfare of the animals is a year-long process. The environmental elements not only create stress for the workers, but also for the cattle themselves. Though Alabama is located in the southern portion of the country, there are some winter seasons that can be unfavorably cool. During those cold winter months, extra care and precaution must be taken to minimize the effects of cold stressors on cattle. Cold stress for cattle leads to lethargy, increased respiration and heart rate, and decreased weight (Alberta SPCA, 2019). Decreases in weight for the cattle directly results in a decrease in value or revenue for the farm. While keeping the health of the cattle maintained, farm workers must also protect themselves from the effects of cold stress. The signs of hypothermia in humans are not all that dissimilar. Shivering, loss of coordination and fatigue can also be seen in humans (NIOSH, 2019; Ohio State University, 2019).

### Recommendations

It is recommended that body temperature be maintained by keeping as much of your body covered as possible. Appropriate clothing should be chosen protecting areas such as the head, face and hands (NIOSH, 2019; Ohio State University, 2019). Feet should be protected with waterproof boots at all times (NIOSH, 2019; Ohio State University, 2019). The time the worker is exposed

should be limited and exposure should be done in short time groupings. It is also key to check in with employees and assess the physical condition of each person as often as needed (NIOSH, 2019).

### Psychological Stress

A stress response in the body can manifest itself in many ways, potentially mounting a cumulative effect that initially goes unrecognized. Reed and colleagues (2012) surveyed aging farmers and found the farmer's definition of health was their "ability to work." If they were unable to work, then they did not consider themselves healthy. This demonstrates how firmly work is rooted is within their identities as farmers. For farmers in general, the variability and uncertainty with crops and livestock can be overwhelming at times. Alston & Kent (2008) discuss the link between poor health outcomes and men that live in rural areas. Financial stress, coupled with physical stress and stress of the animals, can manifest in mood swings, despair, unintentional injuries and distractedness, none of which should be present when dealing with large animals (Alston & Kent, 2008; Michigan State University, 2019).

Maciuba, Westneat, & Reed (2013) discuss the intertwined nature of the occupation of farming and the lives of the farmers, further highlighting the importance of good health both mentally and physically. Mental health in the farming community remains underdeveloped. Financial stressors have been linked with increased suicide rates and suicidal ideations among farmers (Maciuba, Westneat, & Reed, 2013). Suicide is one of many mental health conditions that are routinely seen in the farming community, along with depression, and overall poor health status (Maciuba, Westneat, & Reed, 2013).

## Recommendations

It is recommended that farmers and those in rural areas learn where there is support available for them in their communities. Online groups or local groups of people who can identify with your stressors is helpful to have established (Alston & Kent, 2008; Michigan State University, 2019). Support groups have been shown to demonstrate a positive effect in managing stress in this population (Alston & Kent, 2008). Other stress diminishing activities that can be performed in the moment or prior to starting the day involve simple stretching and breathing exercises (NIOSH, 2019). Something as simple as abdominal breathing or alternate nostril breathing has been shown to reduce cortisol, a stress hormone in humans and it can be done in very short increments with good results (Michigan State University, 2019). On longer workdays, it might be even more important to take a few extra breaks to practice breathing exercises, helping to eliminate the stressors of the day. Since work life and home life are inextricably linked together, maintaining good psychological health is imperative to total worker health.

## **Heat Stress**

Ten percent of agriculture related fatalities are related to heat-induced illnesses (Jackson & Rosenberg, 2010). Heat related injury or death is most likely to occur within the first few days for new employees, if not accustomed to working in the heat, or during a heat wave for all employees (Jackson & Rosenberg, 2010). The physical labor of agricultural work during warm weather may contribute to heat stress even in lower temperatures, especially when humidity is high and wind speeds are low (Jackson & Rosenberg, 2010). When exposed to heat, the body attempts to cool down by increasing the heart rate, dilating the blood vessels, increasing circulation to the skin, and sweating. Profuse sweating can lead to dehydration and electrolyte imbalance and inability to regulate body temperature if adequate fluid intake is not maintained. With prolonged

blood circulation toward the skin for cooling, the internal organs can become deprived of proper blood flow leading to organ damage. Additionally, dehydration impairs the body's ability to regulate body temperature. If the body reaches 104 degrees (F) without immediate cooling measures and medical treatment, seizures, organ failure, and death can occur (Jacklitsch, et al., 2016).

### Heat related illnesses

Jackson & Rosenberg (2010) noted that heat related illnesses can be mild to severe. Heat rash is a mild, prickly, rash due to skin irritation as a result of clogged sweat glands. This rash may be more prevalent in areas of friction, but it can occur anywhere sweat glands are present on the body. Heat syncope is characterized by dizziness and temporary loss of consciousness due to decreased blood flow to the brain. This type of illness usually occurs in new employees who are not acclimatized to the heat; however, it may occur in seasoned employees at the start of summer season or during a heat wave. Heat cramps usually occur following profuse sweating and are painful muscle spasms that occur as a result of the loss of electrolytes from intense sweating. Heat exhaustion happens when the body temperature exceeds 100 degrees (F) and is accompanied by intense thirst, dehydration, fatigue and weakness. The person may also experience nausea and vomiting, headaches, confusion, irritability, difficulty with coordination, rapid heart rate, and low blood pressure. Heat stroke occurs when the body can no longer regulate core temperature and the body temperature reaches 104 degrees (F) or more. This heat illness is characterized by severe symptoms of profuse sweating, altered mental state (delirium or confusion), rapid breathing or hyperventilation, muscle soreness, irregular heart rate, difficulty breathing, coma, seizures, and, shock. This condition is a medical emergency. Immediate cooling and medical care should be provided to prevent permanent organ damage or death (Jackson & Rosenberg, 2010).

## Recommendations

General recommendations to prevent heat stress include wearing light-colored, breathable clothing, acclimatization, maintaining adequate hydration, and modifying the works schedule on hot days (NIOSH, 2018). According to Jacklitsch et al. (2016), workers who are over 65 years old and/or who have certain medical conditions (e.g. hypertension, diabetes), or who take certain medications (e.g. beta blockers, diuretics, antihistamines) may be more susceptible to heat illness. All workers should be educated regarding symptoms of heat strain and first aid measures for heat related illness. A buddy system should be implemented to watch for signs and symptoms of heat strain, e.g. weakness, dizziness, stumbling or unsteady gait, irritability, foggy thinking, skin color changes, or general fatigue or malaise (Jacklitsch, et al., 2016). Signs of heat stress require immediate cooling and medical attention to prevent permanent health effects or even death. The OSHA Quick Card: Protecting Workers from Heat Stress (OSHA, n.d.) is a quick reference for employers and workers.

Acclimatization is an important strategy to reduce the risk of heat illness and should be implemented over a seven to fourteen-day period. No more than twenty percent of the workday working in heat is recommended on the first day for new workers. The time spent in the heat can be increased by a maximum twenty percent per day until acclimatized. For seasoned workers, the schedule should be limited to no more than fifty percent of the usual workday and increased to sixty percent the second day, eighty percent on the third day, and one hundred percent the fourth day (NIOSH, 2018). Workers who are not physically fit may require more time for acclimatization. Re-acclimatization should once again be achieved after a seven-day absence from working in the heat. If previously acclimated prior to the break, re-acclimatization can usually be achieved in two-three days. Breaks taken in the air conditioning will not increase the length of time needed for

acclimatization (NIOSH, 2018). Hydration is a critical aspect of preventing heat illness and should be implemented before, during and after working in the heat. Workers should drink eight ounces of water every fifteen minutes (maximum six cups per hour) for the first two hours in the heat. For periods of prolonged sweating (over 2 hours), sports drinks should be used for rehydration. Workers should be advised to avoid alcohol and drinks with caffeine and high sugar content as these may contribute to dehydration (NIOSH 2018).

Modifying work schedules to do more intensive work during the cooler part of the day and increasing rest periods in the hottest portion of the day are other ways to prevent heat stress. Allowing workers to rest in the shade or air conditioning to cool down can decrease the likelihood of heat illness. Increasing manpower or utilizing tools or machinery to decrease the need for physical exertion in heat can also help prevent heat injury (NIOSH, 2018). NIOSH offers a free smartphone app that can be downloaded to monitor weather conditions and the risk for a high heat index or heat wave (OSHA-NIOSH, 2018). The app also lists warning signs and symptoms for heat stress and first aid measures.

## **Noise**

Noise is typically defined as an unpleasant, unwanted or hazardous sound. Hearing loss is not as dramatic nor as sudden as traumatic injuries such as those from an overturned tractor or machine entanglement, but the damage is permanent (Depczynski et al., 2005). Hearing loss from noise is irreversible and significantly impacts the sufferer's quality of life (Depczynski et al., 2005). Research has shown that the prevalence of hearing loss is higher among those who work on the farms as compared to the general population (Beckett et al., 2000). The hearing loss is insidious in nature; with the gradual onset not recognized until significant losses have occurred (Beckett et al., 2000).

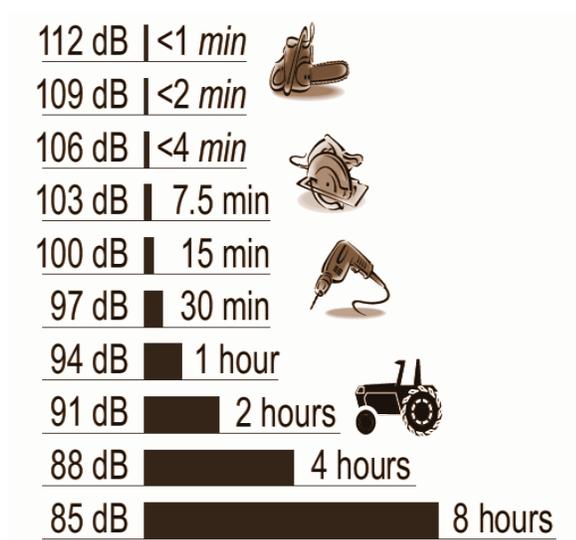
Agriculture is a hazardous occupation involving a relatively high rate of injuries and illnesses. After mining and quarrying, the National Safety Council has reported that agriculture has the second highest mortality rate in the United States (2006). Farmers are frequently exposed to noise from the heavy farming machinery being in addition to other equipment that may contribute to hearing loss (Depczynski et al., 2005). There are some other contributing factors such as aging, use of ototoxic (toxic to the ear) chemicals, diseases, etc. associated with hearing loss among farmers.

Hearing loss commonly affects those farmers working in high levels of noise (above 85 dBA). The hearing loss may lead to accidents and injuries on the farm, as this perceptual loss may prevent farmers from recognizing warning signals or imminent dangers associated with the use of farming equipment (Hager, 2002). There are various negative impacts of hearing loss which include irritability, negativism, anger, fatigue, tension, stress, depression, avoidance or withdrawal from social situations, social rejection, loneliness, reduced alertness, increased risk to personal safety, impaired memory and ability to learn new tasks, reduced job performance, reduced earning power, as well as diminished psychological and overall health (Hagar, 2002). Also, it may negatively impact the social as well as personal life of the exposed people (Hass et al., 2005).

### Recommendations

Although hearing loss can be minimized by using proper hearing protection, many farmers remain unaware of the potential hazards of this noise and the permanent nature of hearing loss. In fact, in a research study in California, it was found that only 33% of farmers used hearing protection in high noise while 93% used personal protective equipment (PPE) to protect against chemicals. The hearing loss problem is aggravated by the fact that farmers generally do not wear hearing protection.

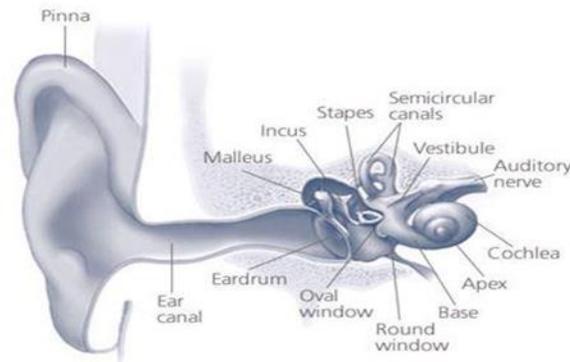
While hearing protection devices can help prevent noise-induced hearing loss, the best remedy to prevent hearing loss is using engineering controls. Hwang et al. (2001) found in their study in New York State that 'self-reported hearing loss' was a significant factor for injuries on the farm (Odds Ratio = 1.86) after adjustments for other covariates. Similarly, Browning et al. (1998) found that hearing loss increased the risk of injuries by 60%. Figure 1 is an example illustration for describing how long one should be exposed to various levels of sound.



**Fig. 1** Example illustration describing the permissible duration to different levels of noise.

### Why Noise-Induced Hearing Loss Occurs

The hearing depends on the events which provide electrical signals by changing the sound waves. Fig. 2 represents the parts of the inner ear.



**Fig. 2 Inner ear (Source: NIH Medical Arts)**

The following are the steps for the process of hearing by the human ear: 1) The outer ear receives the sound waves through the ear canal leading to the eardrum, 2) The vibrations are generated by the sound waves and the vibrations are transferred to the tiny bones (malleus, incus and stapes) in the middle ear, 3) Then the sound vibrations are coupled with the fluid vibrations present in the cochlea in the inner ear, 4) The fluid in the cochlea ripples due to the vibrations, the hair cells (present on the top of the basilar membrane) ride the wave, 5) The hair moves up and down open up pore channels (at the tip of the stereocilia). Due to this action electrical signal is created due to rushing of cells in the chemicals and 6), Then the electrical signals are carried up the auditory nerves to the brain and translate into sound. The death of the hair cells due to frequent exposure of noises for prolonged periods causes the noise-induced hearing loss.

### Recommendations to mitigate Noise-Induced Hearing Loss

Although hearing loss can be minimized by using proper hearing protection, many farmers remain unaware of the potential hazards of this noise and the permanent nature of hearing loss. In fact, in a research study in California, it was found that only 33% of farmers used hearing

protection in high noise while 93% used personal protective equipment (PPE) to protect against chemicals. The hearing loss problem is aggravated by the fact that farmers generally do not wear hearing protection. While hearing protection devices can help prevent noise-induced hearing loss, the best remedy to prevent hearing loss is using engineering controls. Hwang et al. (2001) found in their study in New York State that 'self-reported hearing loss' was a significant factor for injuries on the farm (Odds Ratio = 1.86) after adjustments for other covariates. Similarly, Browning et al. (1998) found that hearing loss increased the risk of injuries by 60%.

As hearing loss is preventable, provided are some of the precautions which can be followed to avoid hearing loss ([nidcd.nih.gov](http://nidcd.nih.gov)):

1. The noises  $\geq 85$  decibels may damage the ear if one is frequently exposed to it.
2. When involved in loud noises always wear the earplugs.
3. If it is not possible to prevent the noise, one is advised to move away from it.
4. One should be alert to hazardous noises.
5. Protect the ears of children who are too young to protect their own.
6. Spread awareness among friends, family, and colleagues about the noise hazard.
7. Get hearing tested if exposed to loud noise for prolonged periods of time.

Noise-induced hearing loss continues to be one of the most widespread occupational conditions and hazardous noise exposure affects almost 22 million workers in the United States. Occupational hearing loss is preventable through the hierarchy of controls, which should prioritize the use of engineering controls over administrative controls and then personal protective equipment. Companies do not periodically audit the sound levels or test their workers for Threshold shifts due to the associated high costs with the testing equipment. In 2016, there were 2.1 billion smartphone users worldwide, with this number projected to exceed 2.8 billion by 2020.

Due to this widespread use of smartphones, a lot of apps are being developed for human safety, especially occupational safety. They can be a highly effective and low-cost alternative to the traditional noise monitoring systems.

Whenever a smartphone app is used in place of a sound level meter or dosimeter, there are some questions that need to be answered (Thaper, et al. 2019).

- 1.) How accurate is the device/application compared to that of the sound level meter or dosimeter?
- 2.) If there is a difference in accuracy, is the difference of any practical significance?
- 3.) Does the device/application accurately measure sound levels at different frequencies?

The answers to these three questions will enable us to better assess the effectiveness of measuring noise levels using a smartphone app.

Noise exposure can be diagnosed and combated with the help of smartphone applications. The advantages of a cheaper, more user friendly, and more accessible way to measure sound levels in the workplace. To detect the decibels exposed at the farm, the workers on site can use the NIOSH Sound Level Meter app for iPhone. It is preferred to use the app with a microphone to get the accurate results. The recommended app for Android smartphones is Decibel X when used with a microphone.



**Fig. 3 Smart Phone Noise Apps**

The NIOSH Sound Level Meter provides a readout of sound level using a built-in microphone or the app can be used with an external microphone for better results. The app also reports some important sound metrics such as run time, A-weighted Equivalent Sound level (LAeq), the maximum level measured during the current time, Time-weighted average (TWA) and dose. The app also assists the user in attaining some basic information on noise and hearing loss prevention.

There are no reliable apps developed on the Android platform yet. So, the Decibel X app is one of the apps that can be recommended for the Android users. The app though provides some great features such as real time scale level chart and wave graph on the display. So, it is recommended to use the Decibel X app with a microphone.

## **Other recommendations**

### Body Mechanics

Farm work involves tasks requiring strength, reaching, bending, and high repetition. These tasks commonly cause strains, sprains, and back injuries. Solutions for these issues should be low-cost and not hinder productivity. Some general solutions for hand work include avoid placing equipment above shoulder height; use seats or standing mats where possible; and provide tools with comfortable grips (NIOSH, 2001).

For lifting and carrying tasks: avoid lifting from the floor or above shoulder height; use dollies or carts where possible; and use lighter, more frequent lifts when possible (avoid objects over 50lbs) (NIOSH, 2001). For working with animals: stand with a wide, balanced stance in case of sudden movements; use chutes and halter ropes when possible. Finally, have open discussions among all workers on ergonomics. Brainstorm solutions for challenging tasks, remind each other of best practices and promote honest reporting of discomfort.

### Tractor Safety

Agriculture is among the top three most hazardous industries for workers (Keskin, Keskin, and Soysal, 2012). The agriculture, forestry and fishing industry have many inherent dangers and one of the highest occupational death rates over the past several years. Two hundred and thirty-two people died in farming accidents in 2013 (Hard, et al., 2016). Tractor related deaths account for most deaths occurring on farms and in the agriculture industry (Hard, et al., 2016). Keskin et al. (2012) reported 100 fatalities per year related to tractor rollovers, but runovers and entanglements add additional tractor-related injuries and deaths.

One should retrofit their farm equipment with rollover protective structures (ROPS), however, a comment was made that seatbelts are worn only when on the main roads. This is

consistent with the findings of Sanderson et al. (2006) showing only 4% of farmers who had seat belts on tractors used them. Keskin, et al. (2012) noted that only minor injuries and no fatalities occurred in tractor rollover accidents when the seatbelts were fastened, and the tractor was fitted with ROPS. According to Hard, et al. (2016), the best prevention includes ROPS and wearing a seatbelt any time one is operating the tractor. Tractors are least likely to roll over when traveling on main roads, and much more likely to roll over when the equipment is being operated on uneven terrain or when operating under heavy load. As such, a strict seatbelt use policy is recommended for all members operating tractors, as long as the tractor has ROPS installed (Keskin, et al., 2012).

### Recommendations

A checklist for operators to utilize prior to daily tractor use will help ensure the tractor is in proper working order and slow-moving vehicle signs are visible and in good repair. Additionally, for students and new employees working on the farm, the “Employer’s Instructional Guide: Training Employees Who Operate Agricultural Tractors” (Iowa State University, 2013) is provided in Appendix A for training purposes.

### Additional Recommendations

#### **First Aid and Emergency Plan**

During the farm visit, it was noted that the closest hospital was in Opelika, Alabama. Preparing ahead and sharing an emergency plan is an important safety measure for those working on the farm. The plan should include the address and closest cross streets to be given to emergency medical services, if one needed to call 911. Numbers of persons to call in an emergency, location of first aid kits, and a severe weather plan should also be included. Laminated cards with the emergency plan and a first aid kit should be in each farm vehicle, whether the vehicle is utilized

on-road or off-road, and in the main buildings on the farm. Finally, a current tetanus booster every ten years should be a requirement for employment.

Inoculation of the cattle is another source of potential danger. Not only can the cattle cause crush injuries if a worker is caught between a frightened animal and a pinch point, ingestion of the medication or hormones can occur during this high-risk operation. To prevent such injuries, proper personal protective gear should be provided and worn. Goggles, gloves, and protective clothing can help prevent skin or mucus membrane contact or needle-stick injuries. Employees should be taught to never re-cap needles as this increases the likelihood of injury to the worker.

## References

1. Alberta SPCA (2019, Mar 4). *Need to know: Stress factors for beef cattle*. Retrieved from [http://www.ctsanimals.ca/va2020/com/assets/data/pdf/farm/needToKnow7bc\\_20.pdf](http://www.ctsanimals.ca/va2020/com/assets/data/pdf/farm/needToKnow7bc_20.pdf)
2. Alston, M. & Kent, J. (2008). The big dry: The link between rural masculinities and poor health outcomes for farming men. *Journal of Sociology*, 44, 133-47. DOI:10.1177/1440783308089166
3. Angus TV (2015, Nov 25). *I am angus: Jim Collins*. [Video File]. Retrieved from <https://www.youtube.com/watch?reload=9&v=PNs9ymrR-Hw>
4. Arduso, L.R., Crisci, C.D., Codina, R., Lockey, R.F., Galimany, J., Marcipar, A., Monje, S. (2001). Association between soybean dust exposure, allergic sensitivity and profile of respiratory symptoms. *Medicina (B Aires)*, 61, 1-7.
5. Beckett, W. S., Chamberlain, D., Hallman, E., May, J., Hwang, S. A., & Gomez, M. (2000). Hearing conservation for farmers: Source apportionment of occupational and environmental factors contributing to hearing loss. *Journal of Occupational and Environmental Medicine*, 42, 806–813.
6. Browning, S.R, Truszczynska H., Reed D., McKnight, R.H. (1998). Agricultural injuries among older Kentucky farmers: The farm family health and hazard surveillance study. *American Journal of Industrial Medicine*, 33, 341–353.
7. Collins Family Farm (2019, March 4). *Farm history*. Retrieved from <http://collinscattle.com/about-2/>
8. Church, M.K. & Church, D.S. (2013). Pharmacology of Antihistamines. *Indian Journal of Dermatology*, 58, 219-224. DOI: 10.4103/0019-5154.110832
9. Depczynski, J., Franklin, R. C., Challinor, K., Williams, W., & Fragar, L. J. (2005). Farm noise emissions during common agricultural activities. *Journal of Agricultural Safety and Health*, 11, 325–334.
10. Environment, Health and Safety Online. (2019, March). Endotoxins and your health. Retrieved from <http://www.ehso.com/ehshome/endotoxins.htm>
11. Hager, L.D. (2002). Didn't hear it coming ... noise and hearing in industrial accidents. *Occupational Health Safety*, 71, 196–200
12. Hard, D. L., McKenzie, Jr., E. A., Cantis, D., May, J., Sorensen, J., Bayes, B., Madden, E., Stone, B., and Maass, J. (2016). The NIOSH CROPS Demonstration Project: A study in New York and Virginia with an emphasis on youth. *Journal of Agricultural Safety and Health*, 22(3), 173-186. doi:10.13031/jash.22.11624
13. Hass-Slavin, L., McCall, M. A., & Pickett, W. (2005). Challenges and strategies related to hearing loss among dairy farmers. *Journal of Rural Health*, 21, 329–336.
14. Hwang, S., Gomez, M.I., Stark, A.D., St. John, T.L., May, J.J., Hallman, E.M. (2001). Severe farm injuries among New York farmers. *American Journal of Industrial Medicine*, 40, 32–41.
15. Iowa State University (2000). Employers' instructional guide: Training employees who operate agricultural tractors. Retrieved from: [https://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=1004&context=extension\\_ag\\_pubs](https://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=1004&context=extension_ag_pubs)
16. Jacklitsch, B., Williams, W. J., Musolin, K. Coca, A., Kim, J., & Turner, N. (2016). Occupational exposure to heat and hot environments: Revised criteria 2016. *Department of Health and Human Services, Centers for Disease Control, National Institute of*

- Occupational Safety and Health*. Retrieved from: <https://www.cdc.gov/niosh/docs/2016-106/pdfs/2016-106.pdf>
17. Jackson, L., & Rosenberg, H. R. (2010). Preventing heat-related illness among agricultural workers. *Journal of Agromedicine*, 15,200-215. doi: 10.1080/1059924x.2010.487021
  18. Keskin, S. G., Keskin, M., & Soysal, Y. (2012). Assessing farm tractor incidents and awareness levels of operators for tractor safety issues in the Hatay Province of Turkey. *Journal of Agricultural Safety and Health*, 18(2), 113-128.
  19. Maciuba, S.A., Westneat, S.C., & Reed, D.B. (2013). Active coping, personal satisfaction, and attachment to land in older African-American farmers. *Issues in Mental Health Nursing*, 34, 335-343.
  20. McCurdy, S. A., Hong, X., and Kwan, J. A. (2011). Agricultural injury among rural California public high school students. *American Journal of Industrial Medicine*, 55, 63-75.
  21. Michigan State University (Mar 4, 2019). Managing farm stress. Retrieved from [https://www.canr.msu.edu/managing\\_farm\\_stress/](https://www.canr.msu.edu/managing_farm_stress/)
  22. National Institute of Occupational Safety and Health (2019, Mar 4). *Stress at work*. Retrieved from <https://www.cdc.gov/niosh/topics/stress/default.html>
  23. National Safety Council. (2006). Injury facts, 2005–2006 edition. Itasca: Author.
  24. Niland, J., Zenz, C., Dickerson, O. & Horvath, E. (1994). Occupational hearing loss, noise, and hearing conservation. *Occupational Medicine*. St Louis: Mosby.
  25. NIOSH. (2018, June 6). Heat Stress. *National Institute of Occupational Safety and Health*. Retrieved from: <https://www.cdc.gov/niosh/topics/heatstress/>
  26. NIOSH. (n.d.). OSHA-NIOSH heat safety tool app. *National Institute of Occupational Safety and Health*. Retrieved from: <https://www.cdc.gov/niosh/topics/heatstress/heatapp.html>
  27. Ohio State University (2019, March 4). *Injury prevention: Types of cold stress*. Retrieved from <https://ohioline.osu.edu/factsheet/AEX-981.13>
  28. OSHA, (n.d.). OSHA Quick Card: *Protecting workers from heat stress*. Publication 3154 [pdf file]. Retrieved from: <https://www.osha.gov/Publications/osha3154.pdf>
  29. OSHA-NIOSH (2018). OSHA-NIOSH heat safety tool app. Retrieved from: <https://www.cdc.gov/niosh/topics/heatstress/heatapp.html>
  30. Prince, S. (2006). Overview of Hazards for Those Working in Agriculture. In J. E. Lessenger (Ed.), *Agricultural Medicine: A Practical Guide*, (pp 29-34). Portersville, CA: Springer.
  31. Randall, K.L. & Hawkins, C.A. (2018). Antihistamines and allergy. *Australian Prescriber*, 41, 41-45. DOI: 10.18773/austprescr.2018.013
  32. Reed, D. B., Rayens, M. K., Conley, C. K., Westneat, S., & Adkins, S. M. (2012). Farm elders define health as the ability to work. *Workplace Health & Safety*, 60, 345–351.
  33. Sanderson, W. T., Madsen, M. D., Rautiainen, R., Kelly, K. M., Zwerling, C., Taylor, C. D., Reynolds, S. J., Stromquist, A. M., Nurmeister, L. F., & Merchant, J. A. (2006). Tractor overturn concerns in Iowa: Perspectives from the Keokuk County rural health study. *Journal of Agricultural Safety and Health*, 12(1), 71-81.
  34. Schwab, C. V. (2013). Employers' instructional guide: Training employees who operate agricultural tractors. *Iowa State University Extension and Outreach*. Retrieved from: <https://store.extension.iastate.edu/product/3989>

35. Spaan, S., Wouters, I.M., Oosting, I., Doekes, G., & Heederik, D. (2006). Exposure to inhalable dust and endotoxins in agricultural industries. *Journal of Environmental Monitoring*, 8, 63-72. DOI: 10.1039/B509838F
36. Thaper, R.; Gibson, M.; Reed, M.; Morris, W.; Putta, A.R. *How Well Mobile Phone App DecibelX Measures Noise and the Usability Study*. Preprints 2019, 2019120397 (doi: 10.20944/preprints201912.0397.v1).
37. United States Department of Health and Human Services. NIOSH (nd). *NIOSH Fast Facts: Protecting Yourself from Cold Stress*. Print. 2010-115.
38. United States Department of Health and Human Services. NIOSH (2001). *NIOSH Fast Facts: Simple solutions: Ergonomics for farm workers*. Publication 2001-111.