Chapter 5

Livestock-Handling Related Injuries and Deaths

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Additional information is available at the end of the chapter

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1. Introduction

Handling livestock is a dangerous activity. Few farm people look upon their livestock as a source of danger. However, a number of serious injuries and deaths occur every year as a result of animal-related accidents. Livestock handlers are involved in a variety of activities such as feeding, moving animals to different locations, loading animals on trucks/trailers, artificial insemination, shearing, grooming, basic animal care such as hoof care, dehorning, and cleaning animals, roping animals, applying topical insecticides, giving vaccinations, applying topical or administering oral medications, castrating, pulling teeth, ear tagging, milking, branding, shoeing, assisting with delivery of newborns, and assisting veterinarians with treatment or handling of injured animals. Other activities involving animals may include work tasks such as plowing fields; pulling equipment such as wagons to transport farm goods; riding animals, primarily horses, for farm or ranch activities such as corralling cattle; teaching others to ride; butchering animals for food; and, rarely, euthanizing or destroying sick or aggressive animals (Langley & Morrow, 2010).

The World Health Organization predicts that by the year 2020, injuries will be responsible for more death, morbidity, and disability than all communicable diseases combined (Murray & Lopez, 1998). Injuries account for 1 in 7 potential life-years lost worldwide, but by 2020 they will account for 1 in 5, with the developing countries bearing the brunt of this increase (Vilardo, 1988; Zwi et al., 1996; Murray & Lopez, 1998). Injury control has gained attention and enormous support with the infusion of funding for injury control in developed countries and particularly the creation of the National Center for Injury Control and Prevention within the Centers for Disease Control and Prevention in the United States (Myers, 1992; Myers, 1997). During the last decade of the 20th century, workers in the US agriculture industry received particular attention because of the high risk of fatal injuries and suspected risk for serious nonfatal injuries (Aherin et al., 1992; Myers, 1998).

Farming ranks among the highest of United States (US) industries for work-related fatal and non-fatal injuries. The lack of information regarding agricultural injuries has been recognized as an obstacle in the development of effective injury prevention measures (Zhou & Roseman, 1994). Within the past decades increased emphasis has been placed on quantifying and limiting farm-work injury hazards. Studies have consistently reported that farm machinery, livestock, and falls are major contributors to agricultural injuries (Brison & Pickett, 1992; Pratt et al., 1992; Zhou & Roseman, 1994; Nordstrom et al., 1995).

The weight of farm mammals varies from less than a few pounds in newborns to over 3000 pounds in adult bulls. Animals can cause serious injuries to animal handlers through various mechanisms. Farm animals can bite, kick, gore, trample, fall on, step on, knock down, crush or pin between other animals or farm structures, peck, scratch, throw or buck off, drag, and ram or butt (Langley & Morrow, 2010). Horses and cattle, rather than any single type of agricultural machinery, are reported the leading cause of injury (Cogbill & Busch, 1985; Shireley & Gilmore, 1995). Anyone who works with livestock knows each animal has its own personality. Animals sense their surroundings differently than humans. Their vision is in black and white, not in color. They also have difficulty judging distances. And differences exist between the vision of cattle, swine and horses. For example, cattle have close to 360-degree panoramic vision. A quick movement behind cattle may "spook" them. Animals have extremely sensitive hearing and can detect sounds that human ears cannot hear. Loud noises frighten animals, and research proves that high-frequency sounds actually hurt their ears. These factors explain why animals are often skittish and balky, particularly in unfamiliar surroundings (Baker & Lee, 1993).

2. Epidemiology

Agriculture ranks among the most hazardous occupations in the United States, with a fatality injury rate 8.5 times greater than for all other occupations combined (28.7 vs 3.4 per 100,000 workers) (National Safety Council, 2008). Shared working and living environments associated with agriculture place all residents at risk, including children (Bancej & Arbuckle, 2000; Gerberich et al., 2001).

There have been many local or regional surveys that have looked at risk to farm animal handlers (Stallones, 1990; Brison & Lawrence, 1992; Pratt et al., 1992; Waller, 1992; Zhou & Roseman, 1994; Layde et al., 1996; Boyle et al., 1997; Casey et al., 1997a; Casey et al., 1997b; Hwang et al., 2001; Sprince et al., 2003; Douphrate et al., 2009). Most of the studies show that livestock handling activities are the second or third leading cause of injuries on the farm, causing from 12% to 24% of farm injuries. It is estimated that about 30 farmers are killed each year from contact with farm animals, primarily horses and cattle (Austin, 1998). Dairy bulls may be more likely to injure humans than beef bulls. Dairy bulls generally have more frequent contact with humans than do beef cattle, and are known to be possessive of their herd and occasionally disrupt routine feeding, cleaning, and milking operations (Boyle et al., 1997).

Unfortunately, the number of animal handlers is not exactly known, but tens of thousands of people are exposed daily to farm animals. A recent survey estimated that there were at least 54,000 workers on swine and poultry establishments in the United States (Gray et al., 2007). Numerous hazards exist on poultry and livestock farms. However, most of the information in the recent medical literature has primarily focused on respiratory symptoms in pork production facilities, and injuries primarily involving cattle and horses, especially recreational activities with horses. There is very little published on injuries associated with handling swine or sheep/goats or other farm animals (Langley & Morrow, 2010).

Farming is one of the few industries in which families are at increased risk. In particular, farm surveys indicate that the injury rate is highest among children age 15 and under and adults more than 65 year of age. Unlike other occupations, farmers routinely work beyond the average retirement age. Data from the National Institute for Occupational Safety and Health (NIOSH) reveals that farmers aged 75 and older are more than twice as likely to die on the job than their younger counterparts. Age-related conditions, such as arthritis, vision or hearing problems make farming potentially more dangerous for senior farmers (Hernandez-Peck, 2001).

According to the Bureau of Labor Statistics, from 1992-1997, more than 75,000 workers received injuries and 375 workers were killed from animal-related injuries. Cattle are responsible for most injuries caused by farm animals. A 1997 study conducted by Oklahoma State University (OSU), Biosystems and Agricultural Engineering Department, found 150 cases of cattle handling-related injuries among 100 Oklahoma cow-calf operations. The study also showed that more than half of the injury cases resulted from human error (Hubert et al., 2003). In 2002 alone, 730 deaths and 150,000 disabling injuries occurred on U.S. farms. Each day, about 500 agricultural workers suffer lost-time injuries, 25 of which result in permanent impairment. Farm operators and their family members accounted for most of the injuries reported (Myers, 2003).

Previous studies of work-related injuries among farmers have described patterns of farmers' injuries and have evaluated a variety of potential risk factors (Aherin et al., 1992; Zhou & Roseman, 1994; Myers, 1997; Stallones et al., 1997; Browning et al., 1998; Crawford et al., 1998; Lewis et al., 1998; Myers, 1998; Norwood et al., 2000; Sheldon et al., 2009). In general, the risk factors have been categorized into 2 domains: physical characteristics of the farming environment and personal characteristics of the farmers. With respect to characteristics of the farming environment, the patterns of injury have been fairly consistently reported among these studies, with farm machinery, falls, and animal-related injuries being the 3 major external causes of injury (Zhou & Roseman, 1994; Myers, 1997; Stallones et al., 1997; Myers, 1998; Xiang et al., 1999). With respect to personal characteristics of the farmers, males were found to be at higher risk for injury than females, regardless of hours spent in farm activities (Stallones, 1990; Pratt et al., 1992; Myers, 1998). Although results of several studies indicated that younger farmers have the highest risk of nonfatal injuries (Stallones, 1990; Crawford et al., 1998; Lewis et al., 1998; Stallones, 1998; Xiang et al., 1999), older farmers tend to account for the greatest proportion of agricultural fatalities (May, 1990; Stallones, 1990).

In the United States, studies have consistently reported that the leading causes of agricultural injuries are machinery and other equipment, falls, and livestock (Myers, 1997; Myers, 1998; Lewis et al., 1998; Xiang et al., 1999). Because of the increasing mechanization of farming over the past half century, and the high fatality rate associated with injuries due to machinery and tractors (McFarland, 1968; Simpson, 1984; McKnight and Hetzel, 1985; Hopkins, 1989; Etherton et al., 1991; Lee et al., 1996; Bernhart and Langley, 1999; Carlson et al., 2005; Cole et al., 2006; Dogan et al., 2010), most studies of agricultural injuries have focused on issues related to interactions with machinery or tractors also. Animals may bite, kick, scratch, trample, crush, gore, buck or throw, or drag the livestock-handler (Langley, 1999). Studies demonstrated non-fatal injury rates are elevated on operations with livestock, especially beef and dairy cattle (Brison and Pickett, 1992; Pratt et al., 1992; Zhou & Roseman, 1994; Nordstrom et al., 1995). Researchers have reported between 12% and 33% of injuries on the farm are caused by animals (Cleary et al., 1961; Cogbill et al., 1985; Hoskin et al., 1988; Myers, 1990; Brison and Pickett, 1992; Pratt et al., 1992; Zhou & Roseman, 1994; Layde et al., 1995; Nordstrom et al., 1995; Pickett et al., 1995; Gerberich et al., 1998; Lewis et al., 1998; Sprince et al., 2003) and livestock-related injuries account for the highest rate of lost work days (Thu et al., 1997).

The 2007 United States Department of Agriculture (USDA) Census of Agriculture estimated the number of farms in the United States at approximately 2.2 million. The Census found that the number of cattle operations totaled 956,400, including 757,000 beef cow and 67,000 milk cow operations. The number of hog operations totaled 73,150, sheep operations 82,330, goat operations 149,800, and farms with any poultry 187,000. There are 575,900 farms with horses and 99,000 farms with mules/donkeys/burros. As of July 1, 2009, there were approximately 102 million head of cattle and calves, 67 million hogs and pigs, 7 million sheep and lambs, and 3.7 million goats on farms in the United States. In 2007, there were 266 million turkeys and 9 billion broilers produced. The USDA estimated in 2007 that there were 4,028,000 horses and ponies and 283,000 mules/burrows/donkeys on US farms. The American Horse Council estimated there were 9.2 million horses involved in farming, sports, entertainment, and recreational activities in the United States in 2005 (Langley & Morrow, 2010).

In a survey of US farm operations 1993-1995, the National Institute for Occupational Safety and Health (NIOSH) found that livestock was the number two cause of nonfatal injuries (99,310 injuries), almost the same as machinery, which was the number one cause of injuries (99,402 injuries). The rate of nonfatal occupational injuries from 1993 to 1995 was 7 per 100 workers on livestock farms, and cattle/hog/sheep operations had the highest number of injuries by type of farm operation. Of the injuries, 37% were due to horses and 31% due to cattle (Myers, 2001). The major source of injuries on US farming operations were machinery excluding tractor (21.3%), livestock (20%), and slips, trips, and falls on working surfaces (8.5%). Beef, hog, or sheep operations were found to have the highest number of lost work-time injuries (84,736) and restricted workdays (1,869,561). When looking at activities in which workers were injured, 45.7% involved livestock handling. When looking at restricted workdays by source of injury, livestock were responsible for the largest percent (34.9%),

followed by machinery. Austin (1998) studied nonvenomous animal related fatalities in the workplace 1992-1994. She found that about 40 deaths per year occur, and 27 of these occur in farmers. Of 144 deaths obtained using the US Department of Labor (US DOL) Census of Fatal Occupational Injuries (CFOI), there were 22 transportation fatalities involving animals. Of the 122 nontransportation deaths, 68 were due to cattle and 41 from horses, and 13 from other animals. Bulls caused 54% of the cattle related deaths. Of workers that were farmers, cattle caused 54 deaths and horses caused 27 deaths. Of the deaths from cattle, 40% were due to multiorgan trauma, 35% trauma to trunk and chest, and 18% from head trauma. Of the horse-related deaths, 46% were due to head trauma.

Among 20 reviewed studies of stress and occupational injuries, all found a statistically significant association between stress and injuries, and 12 of the 17 studies with quantitative measures had odds ratios greater than 1.0, indicating that stress increased the risk of injuries (Gadalla, 1962; Xiang et al., 2000). Other factors such as education (Johnston, 1995), preexisting diseases and use of medications (Browning et al., 1998; Crawford et al., 1998; Lewis et al., 1998; Xiang et al., 1999), alcohol consumption (Zhou & Roseman, 1994), family incomes (Aherin et al., 1992; Browning et al., 1998; Lewis et al., 1998; Xiang et al., 1999), and knowledge of safe practices and safety behaviors (Lewis et al., 1998) also have been evaluated, but the conclusions have been inconsistent. However, outside North America, western Europe, and Australia, information about injury problems and solutions is particularly sparse because the injury control efforts from communities and government in developing countries are well below the level of those directed at other health problems (Li & Baker, 1991; Gumber, 1994; Zwi et al., 1996; Li and Baker, 1997).

Drudi (2000) studied occupational injuries due to animals from 1992 to 1997 using the US DOL Census of Fatal Occupational Injuries and the Surveillance of Occupational Injuries and Illnesses (SOII) databases. He found there were 4600 bovine-related, 5100 equine-related, and 1900 porcine-related nonfatal occupational injuries reported over this time period. For these nonfatal injuries, it should be noted that self-employed and farms with less than 11 employees were excluded from the SOII. From CFOI information, of the 375 occupational deaths from animals, cattle caused 141 deaths and equine 104. Fewer than 5 deaths were reported from sheep and swine. On average about 30 deaths per year were from cattle and equine. Bulls, which account for only 2% of cattle, were responsible for 48% of the deaths from cattle. Five deaths were reported to farmers that were related to birthing or maternal defensiveness, such as cows attacking farmers trying to midwife them. Cattle attacks accounted for four fifths of the cattle-related deaths and about three fifths of cattle-related nonfatal injuries involved the worker being attacked by cattle. Likewise about half of the deaths from equine were due to attacks and more than half of the cases of nonfatal injuries from equine involved an attack.

In a follow-up study using CFOI data, Meyer (2005) evaluated fatal occupational injuries to farmers 55 years and older for the period 1995-2002. He found of 190 farm fatalities due to assaults from animals, 113 occurred in older workers (5% of the work-related deaths in older farmers). The median age of workers assaulted by an animal was 62 years, 4 to 6 years older than the average farmer age of 56 to 58 years. Fifty-nine percent of the deaths were from cattle.

A national study of youth on farms (younger than 20 years of age) was conducted in 1998. Approximately 1,260,000 youth under age 20 lived on farms. An estimated 32,808 injuries occurred with about 20% being due to animals. Of the animal-related injuries, 41% occurred in youth <10 years old, 29% in those 10-15 years old, and 30% in those 16-19 year olds (Hendricks & Adekoya, 2001). Seventy percent of the animal-related injuries occurred to farm residents and 69% were work related. In a survey of youth on racial minority farms and Hispanic farms, horses accounted for the second highest number and rate of nonfatal injuries, followed by all terrain vehicles (ATVs) and tractors (Myers et al., 2003).

NIOSH also conducted a national survey of injuries in farmers age 20 and older in 2001 and 2004. From the information collected, Myers et al. (2009) looked at injuries in a subgroup of farmers 55 years and older. Workers 20 to 54 years old had an injury rate of 5.8 per 100 compared to 5.3 per 100 in workers 55 and older, but the older farmers had more severe injuries and a fatality rate 2.6 times greater than farm workers <55 years old. They found that 10% of nonfatal injuries in older farmers were due to animals. Animals were the third leading mechanism of death in older farmers behind tractors (46%) and trucks (7%) with 5% of fatalities due to animals.

The most comprehensive evaluation of bull-related injuries on persons or property was recently completed, finding 287 cases using different databases (Sheldon et al., 2009). The majority of reports were from 1980 to 2008. Of the 261 cases involving attacks on people, 57% resulted in a fatality. Of the fatal injuries, 94% were males. The average age of the victims was 56 years with a range from 3 to 91 years. The nature of the injury was classified as follows: unspecified attack (110 cases); charged (49 cases); gored (21 cases); trampled (15 cases); mauled (11 cases); and other (56 cases). The type of injuries reported appeared to be related to the nature of the attack. When a person was charged by a bull, the injury usually involved broken ribs, puncture wounds due to goring, or blunt force chest trauma. When the victim was trampled, the injuries usually involved broken bones, crushing-type injuries, internal injuries, or head injuries. The authors concluded that a bull that shows aggressive behavior should be culled from the herd and sent to slaughter and not sold at a general livestock auction in order to prevent it from posing a risk to a new owner.

Fatal and non-fatal traumatic injuries associated with agricultural production are a major public health problem that needs to be addressed through comprehensive approaches that include further delineation of the extent of the problem, particularly in children and older adults, and identification of the specific risk factors through analytic efforts (Hard et al., 2002). While these activities are in progress, additional endeavors will also be essential because of the numerous exposures involved that will require more intensive and specific investigations. Only through such efforts can appropriate prevention efforts be developed (Gerberich et al., 1992; Gerberich et al., 1994). Integral to this process is the incorporation of comprehensive surveillance systems that can be used to monitor the magnitude of the problem, over time, and evaluate the efficacy of any intervention efforts that are implemented (Gerberich, 1995). While surveillance is a key element for assessing the magnitude of the traumatic agricultural injury problem and identifying appropriate

intervention strategies, based on quality risk factor information, it will not reduce injuries on its own. It is apparent that effective interventions are imperative in the alleviation of this major public health problem. Continued development of relevant surveillance systems and implementation of appropriate interventions are the primary challenges for the current decade.

The major sources/vehicles of injury for the farming-related injuries were livestock (30%), machinery, other than tractors (20%), and tractors (9%), accounting for 59% of the events. Among all of the farming-related injury cases, only 6% resulted in hospitalization which has implications relevant to the limitations imposed if only hospital-based surveillance is used; however, 80% were treated by a health care professional. Furthermore, the fact that substantial proportions of cases were actually restricted for a week or more (37%, with 19% restricted for a month or more) and/or had some type of persistent problem, including some permanent disabilities (25%), is very important when looking at the overall impact (Gerberich et al., 1998). Farmers are exposed to a variety of hazards including tractors, machinery, enclosed structures such as grain bins and silos, overhead power lines, tools, ponds, and animals. In addition, they often work long hours under severe time constraints and many use older model farm equipment that lack safety features (Sterner, 1991). Farm machinery is involved in approximately 50% of farm work-related deaths (Murphy et al., 1990) and 18% of nonfatal injuries (Ehlers et al., 1993). When not fatal, these injuries can cause serious, permanent disability. For example, tractor roll-overs can cause crushing, evisceration, and amputation of limbs; and entanglement in rotating shafts or drivelines can result in limb amputation or scalping. Other types of farm injury include suffocation from silo-gas and engulfment in grain, physical trauma from working with livestock, drowning, and electrocution. The spouses and children of farmers are also at risk for injury because they come into contact with hazards on the farmstead, regardless of whether or not they are working (Cordes & Foster, 1988; Rivara, 1997; Dogan et al., 2010).

In a recent study, McCurdy et al. (2012) reported that injury risk was related in step-wise fashion to annual hours spent in farm work among rural California public high school students. After adjustment for farm work hours, ethnicity, and sex, we observed increased overall injury risk (i.e., not limited to injuries occurring in performance of the specified tasks) associated with each of eight selected farm tasks. Mixing chemicals, feeding large animals, and welding each showed a statistically significant approximate doubling of odds for injury. The number of these selected tasks performed showed a significant trend with injury risk.

3. Livestock behavior

An understanding of livestock behavior will facilitate handling, reduce stress for the animal and handler, and improve animal welfare and handler safety. Handlers who understand livestock behavior can reduce animal stress. Research has proven that reducing stress during handling will improve productivity. “Reducing stress also should help improve weight gain, reproductive performance and animal health.”

Cows, horses, sheep, goats, donkeys, and even chickens all have a herding instinct to protect survival of the group from predators. Many animals can tolerate sharing space with other species, but they are more at ease when sharing barn space with their own kind.

Understanding cattle behavior can help farm and ranch workers avoid dangerous situations. Temple Grandin, Colorado State University animal behavior specialist, states that "handling practices can be less stressful to the animals and safer for the handler if one understands the behavioral characteristics of livestock." An animal's physical structure, psychological makeup, environment, and individual personality can influence behavior.

An animal's senses function like those of a human; however, most animals detect and perceive their environments very differently as compared to the way humans detect and perceive the same surroundings. While cattle have poor color recognition and poor depth perception, their hearing is extremely sensitive relative to humans. Knowing these characteristics, one can better understand why cattle are often skitish or balky in unfamiliar surroundings (Hubert et al., 2012).

3.1. Cattle

Cattle handling skills are essential for managing cattle. Good cattle handlers learn these skills through observation and trial and error. Good cattle handling saves time and effort, and reduces stress for people and animals. Inefficient and rough handling causes financial losses because of bruising, poorer meat quality and lower milk production. Working with cattle may be dangerous, especially in yards, races and dairy sheds where people and cattle are close together. High risk activities include working with bulls and with cows and newborn calves.

Cattle live in social hierarchy with dominant and subordinate animals. People usually behave as the most dominant animal by forcing cattle to move, restricting movement and controlling access to feed. Handlers need to be confident and to establish authority from the start so that the cattle know who is boss.

The leader cattle are not always the dominant animals. Cows coming in for milking are led by middle-ranking cows, which are followed by the dominant animals and then the lowest-ranking animals. Forcing the hindmost animals along will not necessarily speed up the movement of cattle, as the dominant animals will not be forced by their subordinates.

Cattle behavior in yards is influenced by rank. Low-ranking animals may try to avoid dominant animals. Dominant cattle may turn and attack subordinate animals and as the defeated animal escapes it may run over the handler. The dominant cattle in a mob may stay as far away from people as possible.

Many farmers sustain minor injuries while working with cattle. Common injuries include cuts, bruises, fractures, sprains and strains. Serious injuries cost farmers in lost time, additional help and many other ways. Financial costs alone are large (Stafford, 1997).

Cattle have sensory functions similar to those in humans. However, cattle often detect and perceive their environments quite differently from humans. A better understanding of the sensory functions in animals is gained by observing cattle anatomical structure and comparing it to those in humans.

Vision - Livestock have their eyes located on the sides of their heads. As a result, they have wide-angle (panoramic) vision and can see all the way around them except for small blind spots at the nose and the rear. This is perhaps the most important factor involved in livestock handling. For example, cattle often "spook" at sudden movements behind them because they perceive such movements as threats. Handlers are often injured by being pinned or kicked by animals that are frightened in this manner. Approaching livestock from the side or front is less startling to these animals than approaching from behind. Proper approach angle will reduce the risk of injury.

The eye placement that gives livestock excellent wide-angle vision causes them to have relatively weak eye muscles. Therefore, livestock cannot focus quickly on nearby objects. This is another reason that causes livestock to "spook" or balk at sudden movements. One of the most common causes of balking in handling facilities are loose chain ends that makes a rapid movement. Fan blades or flapping cloth (a coat hung on a post) will also cause livestock to balk.

Livestock are either color-blind or have very limited color vision and often perceive shadows as holes. Therefore, cattle tend to balk if a shadow is across their path. A handler may be injured by being pinned between a balking animal and a fixed object or an animal moving from behind. Using diffuse, uniform lighting in areas where cattle are handled minimizes shadows and bright spots and can prevent balking. Cattle also have a tendency to move from dimly illuminated areas to brightly lit locations if the light is not glaring in their eyes. A spot light directed onto a ramp or other entry points will improve cattle movement provided the light does not shine directly into the eyes of approaching animals (Gay & Grisso, 2012).

Hearing - Cattle are more sensitive than humans to high frequency noises. Excessive yelling and hollering while handling and herding livestock causes stress and may make cattle more difficult to handle. Furthermore, unexpected loud or novel noises such as banging gates or load exhaust from air cylinders can startle cattle. Use of rubber bumpers on gates and squeeze chutes will prevent these loud noises. Cattle will readily adapt to reasonable levels of continuous noise such as a radio. Continuous playing of the radio may help reduce the reactions of some animals to sudden noises.

Flight zone - An animal's "personal space" is referred to as the flight zone. When a handler enters the flight zone the animal will move away. Understanding and respecting the flight zone can reduce animal stress and help prevent injuries to handlers. The flight zone is basically a circle and its size depends on the tameness of the animal. For example, wild cattle can have a flight zone with a 160 feet diameter. In contrast, a tame dairy cow has almost no flight zone and is difficult to drive. Understanding the flight zone is the key to easy, quiet handling of cattle. The size of an animal's flight zone depends on its fearful or

docile behavior, the angle of handler's approach, and its state of excitement. Work at the edge of the of flight zone at a 45 to 60 degree angle behind the animal's shoulder (Fig. 1). Cattle will circle away. The flight zone radius can range from five to over 25 feet for feedlot cattle and as far as 300 feet for range cattle. If one is within their flight zone, the animal moves away or retreats. When moving cattle, avoid approaching them directly. Try to work them close to the point of balance, moving back and forth on a line parallel to the direction the animal is travelling (Hubert et al., 2012).

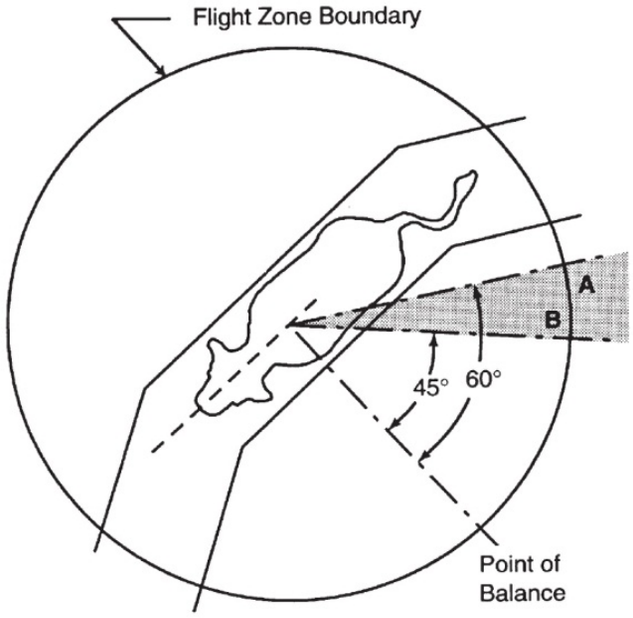

Figure 1. Cattle flight zone. Note: Animal movement stops if handler is in position "A". Handler moves to position "B" to start movement.

Isolation - Cattle are social animals used to living in herds. They are easier to move in groups. They do not like to be isolated. Cattle may become stressed and dangerous when they are separated from the herd. Cattle should always be able to see another member of the herd. They will follow a leader through yards, even in single file, without being stressed, as long as they can see the beast in front. Individuals that break away will usually rejoin the herd, given time and space.

Memory - Cattle remember painful or frightening experiences and react accordingly. Therefore, an unpleasant experience during a given routing can affect subsequent routines. Unpleasant experiences due to rough handling, electric shock, pokes, slipping on smooth floors and standing on shaky uncomfortable grates will impact future behavior (Stafford, 1997; Gay & Grisso, 2012).

Wild cattle were prey for wolves. They reacted to wolves by running away, kicking as they ran if the wolves were close, or by turning and fi ghting by butting and goring. Under some circumstances they responded by remaining immobile until the danger disappeared. Domesticated cattle retain these characteristics and are capable of defending themselves by using their head to bunt, their horns to gore and their legs to kick.

Cattle regard people either as predators, as cattle, or as irrelevant features of the environment. People chasing cattle imitate the behavior of wolves and engender fear. Young cattle should not be chased but should be moved slowly, using their working distance (the distance at which cattle start to move away from people).

Stationary cattle can kick forward to their shoulder and outward with their hind legs. Moving cattle usually kick directly backwards. The safest place when handling cattle is either close up against the beast or at a distance greater than the animal can kick. It is important to identify an escape route when closing in on cattle.

The size and speed of these animals mean that getting in close contact is always potentially dangerous.

However, when you are close to a cattle beast the power of a kick is reduced and becomes more of a push. A gentle touch and soothing words may calm an animal down. Good control requires that cattle regard people as dominant members of the herd.

- Cattle are social animals
- Cattle are easier to work in groups
- Aggressive cows should be culled
- Gentle handling of calves will improve their temperament as adults
- Breed is only one factor influencing temperament
- Cattle remember bad experiences
- Bulls, and cows with newborn calves, may be dangerous
- Make sure the cattle know you are the boss
- Cattle don’t see like we do
- Music may reduce the likelihood of sudden noises startling cattle
- Use your voice to let cattle know where you are
- Keep cattle calm. Overexcited cattle are difficult to handle
- Use your voice to soothe and calm cattle
- Keep your distance while moving cattle
- Beating cattle will overexcite them
- Give cattle time to settle when they come into yards
- Use the working distance like an accelerator pedal
- Keep your distance - getting too close to cattle may cause them to scatter
- Work at the edge of the working distance
- Learn to balance yourself on stock
- Use balance points by moving through them
- Keep an eye on what is going on around you
- Cattle learn from experience
- Gentle handling of calves should result in easy-to-handle cows
- Make yarding as pleasant as possible
- Cattle learn to avoid places where they have been hurt
- Never trust a bull - never turn your back on a bull

- Dairy bulls are particularly dangerous
- Bulls can kill people
- Keep the calf between you and the cow
- Keep the calf's mouth shut to stop it bawling
- Calving heifers are very sensitive to handling
- Remain calm and collected when milking heifers
- Cull nervous or aggressive heifers (Stafford, 1997).

Dairy producers recognize the ability of cows to communicate despite an inability to speak. Cattle display characteristic signs of fear and aggression. Good handlers are sensitive to these warnings, which include:

- Raised or pinned ears
- Raised tails
- Raised hair on back
- Bared teeth
- Pawing the ground
- Snorting

If an animal exhibits any of the above signs, practice extra caution around them (Gay & Grisso, 2012).

3.2. Horse

3.2.1. Basic horse behavior

- Horses detect danger through their vision, sense of smell and keen sense of hearing. They have wideangle vision, but they also have blind spots directly behind and in front of themselves. For example, when a horse lifts its head and pricks its ears, it is focusing on something far away. The horse lowers its head when focusing on low, close objects. Keep these blind spots in mind and know where your horse's attention is focused so you do not scare it.
- Your horse's ears will give you clues; they will point in the direction in which its attention is focused. Ears that are "laid back," or flattened backward, warn you that the horse is getting ready to kick or bite.
- Always work with calm but deliberate movements around horses. Nervous handlers can make horses nervous, creating unsafe situations.

3.2.2. Approaching the Horse

- When catching a horse, approach from its left shoulder. Move slowly but confidently, speaking to the horse as you approach. Read the horse's intention by watching its body language.
- Be careful when approaching a horse that is preoccupied, such as when its head is in a hay manger.

- When approaching a horse in a stall, speak to the horse to get its attention and wait until it turns and faces you before entering. Make sure the horse moves over before you walk in beside it.
- Speak to your horse and keep your hands on it when moving around. Even if a horse is aware of your presence, it can be startled by quick movements.
- When approaching from the rear, advance at an angle speaking to the horse, making sure you have its attention. Touch the horse gently as you pass by its hindquarters.

3.2.3. Leading the horse

- Hold the lead line with your right hand, 8 to 10 inches away from the horse's head, while holding the end, or bight, of the line with your left hand. Always use a lead line so you have this "safety zone" and to prevent getting a hand caught in the halter.
- Teach your horse to walk beside you so that you are walking at its left shoulder, with your right elbow near the horse's shoulder so you can anticipate its actions. Do not let the horse "walk" you. Do not allow it to get behind you either, as it could jump into you if spooked.
- To lead a horse through a doorway, you should step through first and then quickly step to the side out of the horse's way. Keep an eye on it, as some horses try to rush through narrow spaces.
- Never wrap any piece of equipment attached to a horse around your hand, even with small loops, as it could wrap around the hand and cause serious injury.
- After you remove the halter, make the horse stand quietly for several seconds before letting it go completely. This will help prevent the horse from developing a habit of bolting away and kicking at you in the process.
- Some horses can become sour and begin nipping at you if they anticipate discomfort during grooming. Do not hurry the grooming procedure, especially with a young or spooky horse. Stay near the horse and keep a hand on it at all times so you can anticipate its movements.
- Do not climb over or under the lead line of a tied horse. The horse may pull back and cause you to trip over the line, and you will have no quick escape should the horse lunge forward, paw or try to bite. Never walk under the belly of any horse (Gay & Grisso, 2012).

3.3. Swine

- Your best safety aid for the jobs is a lightweight hurdle or solid panel with a handle attached. The panel should be slightly narrower than the alleys through which the animals are being driven.
- As with most animals, make yourself known quietly and gently to avoid startling your hogs. A knock on the door or rattling the door handle will usually suffice.

- Don't let small children reach through pens or fences to pet or feed hogs. Keep unauthorized people out of pens or away from the facility. Bio security can be an important issue.
- Keep boars separate at all times.
- Use a drafting board when moving boars.
- Use nose ropes and crushes to restrain pigs when necessary.
- Lifting a pig should be avoidable, but if you must lift a pig, sit it down facing away from you, draw it close to your body and pick it up by the back legs, making sure to lift with your thigh muscles (NCFM, 2012).

3.4. Sheep

- A common accident involving sheep is being butted by a ram. Ewes will also protect their young and should be handled carefully. A sheep can be immobilized for safe handling by sitting it up on its rump on the ground.
- Plan musters in advance.
- Assume that rams will act unpredictably.
- Use suitably trained sheep dogs to control the mob.
- Lifting a sheep should be avoidable, but if you must lift a sheep, sit it down facing away from you, draw it close to your body and pick it up by the back legs, making sure to lift with your thigh muscles.
- When shearing, use a harness to support your back (NCFM, 2012).

Watching animals for signs of aggressiveness or fear alerts you to possible danger. Warning signs may include raised or pinned ears, raised tail or hair on the back, bared teeth, pawing the ground or snorting. Although handling methods may vary greatly for different types of livestock, there are some generally accepted rules for working with any animal:

- Most animals will respond to routine; be calm and deliberate.
- Avoid quick movements or loud noises.
- Be patient; never prod an animal when it has nowhere to go.
- Respect livestock - don't fear it!
- Move slowly and deliberately around livestock; gently touch animals rather than shoving or bumping them.
- Always have an escape route when working with an animal in close quarters (Baker & Lee, 1993).

4. Types of livestock-handling related injuries and deaths

The injuries caused by animals are related to the ecological structure of the environment as well as the sociocultural and socioeconomic properties of the society. People who work with animals including farmers, veterinarians, butchers, and workers in zoos and circuses are all at risk (Wiggins et al., 1989). A high-energy trauma is applied to the body as a result of attack generally by bull, horse, pig, or large dogs, possibly resulting in serious injury or

death. People at greatest risk for these injuries are those whose occupation or livelihood involves large animals (Nogalski et al., 2007). It has been reported that animals are one of the main causes of injury in the farming industry in the United States of America (Purschwitz, 1997). Although the animals are implicated in such injuries, in most cases the incidents occur due to inappropriate behaviors of people or a lack of control of the animals (Nogalski et al., 2007). Langley et al. (2001) reported that large animals (cows and horses) caused the majority of deaths (67%) among workers in farms. Farmers and farm workers can easily be injured by livestock. Cattle, pigs, horses, sheep, dogs and other farm animals can be unpredictable and should be treated with caution at all times. Attempting to lift or push animals can cause injury and animals are capable of transmitting certain diseases (NCFM, 2012). The majority of studies find that activities involved in livestock handling are a leading cause of injury on the farm and that contact with animals causes 12% to 25% of injuries. Various researchers have found factors that may increase the risk of incurring an injury in livestock handlers. Among the risk factors found are presence of hearing loss or joint problems (Stallones, 1990; Sprince et al., 2003), working more hours per day or week (Layde et al., 1996; Stallones, 1990), younger age (Stallones, 1990; Zhou & Roseman, 1994; Sprince et al., 2003), older age (Brison & Lawrence, 1992; Pratt et al., 1992), alcohol consumption (Zhou & Roseman, 1994), male sex (Brison & Lawrence, 1992; Pratt et al., 1992), and prescription drug use (Brison & Lawrence, 1992).

In animal attacks, health and life can be threatened by the direct effect of trauma (hitting, kicking, biting, etc.) or by subsequent wound infections or contagious illnesses transmitted by the animal. It has been reported that most serious animal-related injuries are caused by large animals such as bulls, horses, or pigs (Busch et al., 1986; Conrad, 1994).

The size and speed of these animals create forces similar to those which occur in motor vehicle accidents (Norwood et al., 2000). Nogalski et al. (2007) reported that most of the injuries that occurred as a result of bull and horse attacks necessitated hospitalization of the victim.

Interactions with animals of all kinds may result in human fatalities from a wide variety of causes ranging from blunt force trauma to envenomation. In the United States between 1991 and 2001, a total of 1943 people died after encounters with venomous and nonvenomous animals, representing an average of 177 deaths per year. Of these fatalities, 61% were caused by nonvenomous animals, with dog attacks resulting in 17.6% of these deaths and "other specified animals" responsible for 71.5% (Langley, 2005).

Occupation may have an effect on the occurrence of injury and death, with the highest rates occurring in situations of greatest exposure, such as farm workers, veterinarians, cowboys and rodeo riders, animal caretakers, and hunters (Langley, 2001). Animal-related deaths were cited as the fourth most common cause of death in those aged over 55 years in the agricultural industry in Australia from 2001 to 2004, causing 7.1% of deaths. In those aged 15 years and older, horses were the main culprit causing 3.5% of deaths, followed by cattle at 1.9% (Bury et al., 2012). Those most at risk in the United States are men over the age of 65 years (Langley, 2001).

4.1. Blunt force injuries

Animals may be responsible for an array of potentially lethal injuries. Blunt force injuries characteristically involve larger animals such as cattle or horses that may kick, crush, or trample a victim causing head and facial injuries. Farm workers in particular are at high risk of lethal injuries involving the head and torso (Bury et al., 2012). There are many reported cases of large farm animals butting or kicking individuals, resulting in death, with horses, bulls and cows being the most common offenders (Karkola et al., 1973; Rabl & Auer, 1992; Langley, 1994; Holland et al., 2001; Dogan et al., 2008). Occupation and sex bias are demonstrated in the report of nine cattle-related deaths in which eight of the victims were men with the deaths occurring on farms. Predictably, kicks to the head and chest result in more immediately fatal outcomes, most likely due to the effects of direct trauma to the brain, heart, or lungs (Langley, 1994). Because of their small size and physical vulnerability, children are at high risk of being kicked by farm animals such as horses. In addition, riding accidents are not uncommon, when children either fall from or are thrown off a horse. Deaths in such cases are usually caused by severe head trauma and may be related to failure to wear protective helmets (Bury et al., 2012).

4.2. Penetrating injuries

Bulls and buffalos, along with other horned animals, gore their victims as may sometimes be seen with matadors in Spanish bull fighting (Langley, 1994; Bakkannavar et al., 2010). In Pamplona, Spain, there is a yearly tradition of running with the bulls with 15 people having died since 1922 (BBC, 2009). Both domestic and wild pigs may fatally attack humans. Wild boars incapacitate prey by repeatedly charging with their tusks causing multiple penetrating injuries, sometimes resulting in intestinal evisceration (Manipady et al., 2006). Two deaths caused by domestic pigs were reported by Langley (1994) where both victims sustained significant tearing and shredding injuries of the skin because of biting, with limb amputation in one case. There were also multiple fractures and extensive crush injuries. Exsanguination can result from vascular injury inflicted by the tusk of wild boar (Prahlow et al., 2001). Although the agricultural environment poses a number of dangers to people in all age groups, there are also notable hazards for children that are important sources of childhood mortality and morbidity (Marlenga et al., 2001). Because of the increasing mechanization of agricultural operations over the past half-century, and the high fatality rate associated with injuries due to machinery and tractors, much of the literature has focused on injuries due to these sources. However, animal-related injuries are also an important source of operation-related injuries (Layde et al., 1996) and have frequently been reported as a major source of nonfatal agricultural injury (Cogbill et al., 1985; Boyle et al., 1997; Gerberich et al., 2001; Gerberich et al., 2003; Gerberich et al., 2004). Several studies have identified animals as a leading source of injury to children on agricultural operations (Gerberich et al., 2001; Gerberich et al., 2003; Cogbill et al., 1985; Pickett et al., 2001). Jones & Field (2002) found that 33% of all fatalities to Amish adults and children were directly or indirectly related to animals. A major barrier to progress in

the prevention of agricultural injuries has been a lack of knowledge about the magnitude of the problem and of specific risk factors associated with these injuries (Gerberich et al., 2001). Despite the large number of documented animal/livestock injuries, little is known about the consequences of this problem or factors that increase or decrease the risk of injury (Boyle et al., 1997).

4.3. Needle stick injuries

Needle stick injuries are not uncommon in animal handlers (Berkelman, 2003; O'Neill et al., 2005; Weese & Jack, 2008). Very little research has been done on needle sticks in farmers, but there are several studies that have looked at needle sticks in veterinarians. Some vaccines contain live bacteria and infection has occurred in the person who was accidentally injected. Some cases of sterile abscess formation and even tissue necrosis have developed after unintentional vaccine injections, especially ones with oil-based adjuvants. Injuries from needles sticks can be prevented by following the recommendations of the NASPHV and others (Weese & Jack, 2008; Centers for Disease Control and Prevention, 2009).

- Read the package insert, label, and material safety data sheet (MSDS) for any medications administered, and use the product only as directed on the package or as directed by your veterinarian
- Never remove needle caps by using your mouth
- Do not recap needles except in rare instances when required as part of a medical procedure or protocol
- Dispose of all sharps in designated puncture-proof sharps containers
- Dispose of the used syringe with attached needle in the sharps container when injecting live vaccines or aspirating body fluids
- For most other veterinary procedures, use the needle removal device on the sharps container and dispose of the syringe in the regular trash
- Sharps containers should be located in every area of the workplace where sharps are used
- Do not transfer sharps from one container to another
- Devices that cut needles prior to disposal should not be used because they increase the potential for aerosolization of the contents
- Never dispose of sharps in the regular trash
- Work with your veterinarian to determine how often you should change needles
- Don't place your hands between the animal and the side of the stall when injecting drugs
- Don't carry a syringe and needle in your pocket
- Don't use damaged or bent needles
- Develop, communicate, and enforce standard operating procedures for safe sharps handling
- Make sure employees are trained on hazards of handling drugs, hormones, and vaccines

4.4. Other health and safety hazards

There are numerous hazards besides animal contact that present a risk to livestock handlers on the farm or ranch. As previously noted, most fatal injuries are due to machinery and equipment. Tractors, augers, and other feeding equipment are frequent sources of injuries. Trucks and trailers used to move livestock may be involved in traffic accidents. Injuries from corral gates, either from the animal kicking the gate that strikes the worker or from other contact with gates, caused 4% of compensation claims in livestock handlers in Colorado. Injuries were also associated with contact with milking units, milking rail, walls, squeeze chute, and even a hose. Falls and slips on farms and ranches from slippery surfaces or stepping in holes or uneven surfaces are often recorded as being in the top three leading causes of farm injuries. Strains from heavy lifting caused 13% to 21% of the claims among dairy farm workers, cattle raisers and dealers in Colorado (Douphrate et al., 2009).

Waller (1992) evaluated dairy farmers and the various sources/activities that led to their injuries. Of 147 injuries, 29% were due to cattle but other causes included equipment repair/use 7.5%, chemicals/biologics 7%, hay/haying 6%, tractors 6%, slip/trip/fall same level 5%, foreign body in eye 5%, bumped fixed object 4%, pitchfork 3%, fall from height 3%, and miscellaneous 5%.

Asphyxiation from oxygen deficient environments may occur when farmers enter manure pits or silos. Meyer (2005) found 73 fatalities among farm workers due to oxygen-deficient exposures from 1995 to 2002. He also detected 157 electrocutions among farm workers.

Although injuries from chemical use on farms are not uncommonly reported, thousands of tons of various chemicals and fertilizers are used on farms, creating risk not only to the handler but also to farm family members, farm animals, and the environment. There are thousands of pounds of herbicides also used on farms that may potentially cause adverse effects if not handled properly (Langley & Morrow, 2010).

4.5. Risk factors associated with farm injuries

Risk factors associated with farm injuries can be categorized into two levels: (1) characteristics of the farm environment, and (2) characteristics of the farmer. Studies examining farm environment factors have reported that larger farms, farms with more workers, and farms with higher annual production were associated with higher injury risks for the farmer (Zhou & Roseman, 1994; Pickett et al., 1995). Studies have demonstrated that injury risk is elevated on farms with animals, especially on beef and dairy farms (Brison & Pickett, 1992; Pratt et al., 1992; Zhou & Roseman, 1994; Nordstrom et al., 1995). The patterns of injury have been fairly consistently reported across these studies, with farm machinery, accidental falls, and animal related injuries being the three major external causes of injury (Brison & Pickett, 1992; Zhou & Roseman, 1994; Nordstrom et al., 1995).

With respect to individual risk factors for the farmer, greater number of hours spent farming, full-time farm work, greater cumulative years of farm work experience, and male

gender have shown positive associations with higher injury rates (Stallones, 1990; Brison & Pickett, 1992; Zhou & Roseman, 1994; Layde et al., 1996). Whereas several studies have suggested that farmers holding off-the-farm employment may be at greater risk for injury (Zhou & Roseman, 1994; Nordstrom et al., 1995; Zhou & Roseman, 1995), other studies have not confirmed the finding (Brison & Pickett, 1992). Although other personal risk factors for injuries, including alcohol consumption, prior traumatic injury, lower levels of education and training, and the use of prescription medications have been investigated, the evidence associating these risk factors with farm injuries remains inconclusive (Elkington, 1990; Zwerling et al., 1995; Zhou & Roseman, 1995).

A substantial portion of the risk for injury associated with working on the farm can be attributable to the farm environment itself (Browning et al., 1998). There may be several reasons for the elevated risk of injury on farms with beef cattle. Research by Elkington (1990) suggests that farms with livestock tended to be the most time-consuming enterprises and that injury risk increased with increasing number of hours worked on the farm. Brison & Pickett (1992) reported a harvest-related peak for injuries on beef farms. They argued that the excessive fatigue, missed meals, and stress associated with harvest time is particularly felt by beef farmers. They indicated that beef farmers worked larger amounts of land with fewer manpower resources and used older equipment. Proper animal handling and transportation practices and the exercise of caution around bulls, steers, and pregnant cows could reduce some of these injuries (Layde et al., 1996; Browning et al., 1998).

Potential risks can be assessed in many ways:

- Walk through all animal-handling areas and look for hazards, such as broken gate latches, broken posts, restraining equipment not working.
- Consult with farm safety advisers from the Victorian WorkCover Authority - they may provide free consultations.
- Reflect on injury records to pinpoint recurring dangers, including less obvious ones like lacerations and sprains.
- Talk over safety issues with family members, workers and other animal handlers.
- Make sure at least one person on the farm is trained in first aid.
- Remember that inexperienced workers and bystanders are more likely to be injured (NCFM, 2012).

5. Preventive measures for livestock-handling related injuries and deaths

Efforts to reduce or eliminate on-farm animal-related injuries should be directed principally to farm residents. Efforts should be made to educate farm residents about the many dangers presented by farm animals. In addition to educational efforts, structural modification of barns to limit animal interaction, isolation of dangerous animals, and wearing protective gear in recreational and work activities are a few of the prevention strategies which can be employed to reduce animal-related farm injuries.

Animals may not purposely hurt a worker, but their size and bulk make them potentially dangerous, especially when in close contact. Farmers, veterinarians and other animal handling businesses should implement the following measures to prevent injuries (Hendricks & Adekoya, 2001).

5.1. Facilities

Many livestock handling injuries are directly related to equipment or building structures. Poor facilities and equipment can also cause injuries to animals. This can mean considerable economic loss at market time. Tripping hazards such as high door sills, cluttered alleyways and uneven walking surfaces can cause serious injury and a considerable amount of lost work time. Concrete floors are best for livestock. The finish on concrete floors should be roughened to prevent slips under wet conditions. High traffic areas, such as alleyways, should be grooved. Floors should allow water to drain easily. Slatted floors often are used to keep animals dry in a confinement system. Fencing and gates should be strong enough to contain crowded livestock. A variety of materials are available, but the key is strength and durability. A protruding piece of lumber, a nail or a bolt can cause painful and infectious injuries. If backed or pushed into, one of these objects can cause a serious back injury. Alleys and chutes should be wide enough to allow animals to pass, but not wide enough to allow them to turn around. A width of 30 inches is recommended for a cow-calf operation. For cattle in the range of 800 to 1,200 pounds, a 26-inch width is recommended. Solid wall chutes, instead of fencing, will lower the number of animals that balk in the chute. Lighting should be even and diffused. Bright spots and shadows tend to make animals more skittish, especially near crowding or loading areas. Animals move more readily from dark areas into light, but avoid layouts that make them look directly into the sun. Handling equipment can speed up livestock confinement work operations, reduce time and labor requirements, cut costs, and decrease the risk of injury (Baker & Lee, 1993).

5.1.1. Corral systems design & pens

In crowding pens, consider handling cattle in small groups up to ten head. The cattle need room to turn. Use their instinctive following behavior to fill the chute. Wait until the single file chute is almost empty before refilling. A crowding gate is used to follow the cattle, not to shove against them. If a lone animal refuses to move, release it and bring it back with another group. An animal left alone in a crowding pen may become agitated and attempt to jump the fence to rejoin the herd.

Corral and working facilities are constructed to confine cattle safely and efficiently for close observation and to perform routine health and management procedures. Good cattle handling systems make working livestock easier with limited manpower. The operation of any cattle facility depends on cattle behavior, corral design, and the skill and technique of the handler.

Pens serve several purposes, including catching and holding cattle being worked, sorting cattle into groups, and holding cattle being quarantined. When designing and constructing pens for working facilities, consider the following:

- Provide at least 20 square feet per head for mature cattle.
- Size pens for a maximum of about 50 head of mature cattle.
- Larger, wider pens can make effective sorting difficult for a single worker.
- Pens too small or narrow can result in workers entering the animal's flight zone. The smallest pen dimensions should be no less than 16 feet.
- Too few pens can make separating animals difficult. This can also put workers at risk, as they must physically enter pens with large numbers of agitated animals. Consider adding in a 14-inch wide pass-through for worker escape in pen corners.
- Use proper gate placement to facilitate animal movement from pen to pen and to other areas. Poor animal movement puts workers at risk by having to force the movement. If there are too few gates, some animals can become separated. Thus, when animals enter the alley, separated herdmates will follow along the inside of the pen. This is often referred to as "backwash." There may be problems guiding these pen-bound animals back to the exit gate as their herdmates move away from them down the alley. Separated animals can become confused or agitated, putting workers at further risk.

The proper design, construction and operation of a cattle handling facility is important to ensure safe working conditions for animals and humans. Understanding the inherent behavior of cattle, plus working them slowly and quietly, will reduce injuries and help make an operation run more smoothly and efficiently (Hubert et al., 2012).

5.2. The human element

Human error is the primary cause of many types of accidents. These errors in judgement and action are due to a variety of reasons, but occur most when when people are tired, hurried, upset, preoccupied, or careless. Remember that human physical, psychological, and physiological factors greatly affect the occurrence of life threatening accidents. Using this information in combination with proper cattle handling techniques can reduce the risk of injury.

Stress - When the handlers are under physical or psychological stress, avoid major animal handling activities. Fatigue and stress can predispose handlers to serious farm accidents.

Training - Teach new and young workers how to work safely with farm animals. During training sessions, emphasize all known animal behavior problems. Also demonstrate the use and effectiveness of all animal restraining equipment and facilities available.

Sure Footing - Reduce the hazards of falls, provide slip-resistant footing for both handlers and livestock with a roughened surface on concrete ramps and floors in animal facilities.

Lifting - Use a hip lifter to lift or assist a downed cow, and have additional handlers help with the handling to prevent any strain or back injuries (Gay & Grisso, 2012; Hubert et al., 2012).

5.3. Additional handling tips

In addition to the flight zone, an understanding of the "herd instinct" is important. Cattle follow the leader and are motivated to follow each other. Each animal should be able to see others ahead of it. Make single file chutes at least 20 feet long, or 30 to 50 feet for larger facilities. Don't force an animal in a single file chute unless it has a place to go. If the cow balks, it will continue balking (Hubert et al., 2012).

5.3.1. Specific handling methods

Specific handling methods vary with species. However, some general handling rules for all animals include the following:

- Most animals respond favorably to routines having calm, deliberate responses.
- Avoid loud noises and quick movements.
- Be patient; never prod an animal when it has no place to go.
- Move slowly and deliberately.
- Touching animals gently can be more effective than shoving and/or bumping them.
- Respect rather than fear livestock. Breeding stock are highly protective and often irritable. Disposition deteriorates with age and parturition. Old breeding stock can be cantankerous, deceptive, unpredictable, and large enough to be dangerous.
- Special facilities should be provided for breeding stock, especially for large males. Most animals are highly protective of their young. Be especially careful around newborn animals.
- Male animals should be considered potentially dangerous at all times. Proper equipment and facilities are necessary to assure safety. Extreme caution should be practiced when handling male animals.
- The size, mass, strength, and speed of an individual and herd's of animals should never be taken lightly. Animals will defend their territory and should be worked around keeping in mind that there is always the potential for harm (Gay & Grisso, 2012).

5.3.2. Reducing animal risks

Management of a dairy farm involves animal handling activities such as milking, feeding, and providing health care. This constant close contact with animals increases your chance of having an animal-related accident. How can the accident risk be reduced?

Gates - The gate is the simplest and often most versatile item for handling animals. When improperly placed or hinged in the wrong direction, it can also be the most obtrusive, resulting in blocked freestalls, inability to move cows in the desired direction, unnecessary injury to cattle and people and damage to the gate.

Properly located gates can block off a travel lane and direct the cow into a desire area. Gates may also be used within pens to form a funnel to direct a reluctant cow into a stanchion or other lockup. They can also be part of a smaller confinement area for breeding or rectal examination.

Gates should be high enough to discourage jumping (6-7 feet). The bottom rail should be low enough to discourage animals from turning around or crawling under it, and high enough to allow a trapped person to roll underneath (16-20 inches). Cross bars or rails should be spaced no farther than 10 inches apart to prevent animals from getting their heads trapped between them.

For young animals, cross bars or rails should be 4-6 inches apart. In open buildings, gates may be covered with plywood to minimize drafts on animals during cold weather conditions.

Stanchions - A stanchion or yoke is a fixed or swiveled device that consists of two vertical bars or slates that can be closed against the animal's neck. A swivel stanchion pivots around its vertical axis, making it easier for the animal to turn its head. Self-closing stanchions are used for post calving examinations, pregnancy checks, vaccinations, tail head chalking, heat detection, and artificial insemination. They may be used in large groups along a feed line in a freestall barn, in small groups in a treatment holding area, or individually in a maternity pen. Satisfactory fenceline stanchions self-lock upon cow entry, provide individual or group release, have a method to lock out animals when the system is not in use, and allow for easy removal of "downed" animals.

When evaluating a self-locking stanchion be sure the top opening is wide enough for the cow to easily insert and extract her head without twisting, turning or banging. The height of the pivot point is also critical to assure the unit will lock closed as the cow reaches down to eat, but also will swing open as her head reaches a normal position. Stanchions that require the cow to raise her head too far upward will result in more banging and possible injury to the animals. If the pivot point is too low the cow may not trip the stanchion. Recommended mounting heights will vary among manufacturers. The bottom rail is also critical for unobstructed access by the animal to feed. Very young calves often have trouble using self locking stanchions if the pivot point is too high. In general, a fixed vertical or slant bar divider works better until calves learn to reach through a hole for eating.

Headgates - Self-locking headgates have many features not found in a typical stanchion. The force of the cow trying to walk through opens, closes, and latches the headgate. Headgates should be adjustable for size and be on hinges to allow them to open completely from top to bottom, to avoid injury to the hips and legs of the animals. The restricted opening should extend to the ground to prevent choking a "downed" animal and to permit easy removal. Some operators feel that self-locking headgates result in excessive bruising to an animal's shoulders. Manually controlled mechanical, hydraulic or air operated closing mechanisms are also used.

Chutes - Chutes, usually used in conjunction with headgates, help direct the animal into a headgate and prevent side to side cow movement during examination and treatment. It is necessary that the sides of the chute be open, and removable, to permit access to the sides of the cow for examining the udder, body cavity and feet. For rectal examinations, a gate or pass through is required behind the animal. A head grate and working chute can usually be incorporated in lanes where cows walk single file (Gay & Grisso, 2012).

5.3.3. Restraining equipment and facilities

Over 75% of the animal-related human injuries are due to *insufficient restraining equipment and facilities on most dairy farms.* Proper application and the right choice of restraining equipment and facilities are very important consideration for reducing potential injuries to the dairy farmer.

Before selecting the animal restraining equipment and/or the facility, ask: Will it be safe for the animal handler? Will it be safe for the animal? Will it accomplish the intended purpose?

Equipment for various activities - When milking in the barn or cleaning or examining the udder use anti-kicking devices on cows that are chronic kickers. Use a rope halter, squeeze chute, and headgate when you engage in major animal handling activities such as hoof trimming, breeding, and applying medication. Use a squeeze chute with a headgate to protect yourself from the animal's violent movements. Use a tail holder to prevent eye injuries when milking or examining the animal.

Mangates - Many veterinarians recommend mangates in cattleyard pens. Mangates are small passages between two posts about 14 inches apart in the fence around a yard pen, through which a person can easily escape from unexpected, dangerous situations without having to open the animal gate or climb the fence.

Dairy bulls - If you keep a dairy bull on your farm for breeding purposes, have all the necessary restraining equipment and facilities. An ideal confinement unit for a dairy bull should be designed so you never come in direct contact with the bull for feeding or breeding. Dairy bulls are much more aggressive by nature than cows. Although some dairy bulls appear gentle and calm, they may react to unexpected movements, inflicting serious injuries or death onto the bull handler. Never consider a bull safe, and do not let your children play with a bull even if you have raised him.

Treatment stall - Maintain a treatment stall on your farm to reduce the risk of injuries to yourself as well as the veterinarian during activities such as pregnancy examination, vaccination, medication, deworming, and artificial insemination.

Cows with new calves - A cow with her new calf is usually more defensive and more difficult to handle. Let her calf stay as close to her as possible.

Horned animals - Horned cows or bulls are more prone to attacking handlers. Make sure all cattle on the farm are dehorned.

Kicking - Cows commonly kick forward and out to the side. They also have a tendency to kick toward the side where they have pain from inflammation or injuries. Therefore, if a cow is suffering from mastitis of only one quarter, you may want to consider approaching her from the side of the non-affected udder when examining or milking.

Dry cows - Dry cows usually exhibit more aggressive behavior after coming back from the pasture. It may take them a week or so before they get used to barn life again (Gay & Grisso, 2012).

5.3.4. Handling of escaped animals

If horses, cattle, or other large animals escape from an auction ring, show ring, or slaughter plant, they must never be chased. Chasing escaped cattle often cause them to run wildly through crowds of people, injuring people and damaging property. If an escaped cow or horse is located and they are not an immediate threat to people, allow them to be alone for 30 minutes so they will calm down. Twenty minutes is required for the animal's heart rate to return to normal. When the escaped animal has calmed down, it can be quietly moved. Interestingly, a lone animal often returns of its own volition to other horses and cattle. A panicked cow or horse may crash through a chain link fence, because they can not see the thin mesh. Escaped cattle have knocked over a chain link fence when being chased. Chain link fences hold a calm cow, but a frightened bovine may either knock it over or go under the bottom edge of the mesh. Fences that present a visual barrier, such as a board fence, are less likely to be broken down by excited animals.

Allow only experienced livestock handlers to approach an escaped animal. A panicked horse, steer, or bull can be calmed when it hears its owner's familiar voice. Some of the most dangerous incidents with escaped animals have occurred when security guards or the police became involved (Gay & Grisso, 2012).

5.3.5. Personal protective equipment

Farm safety experts estimate more than half of farm injuries can be prevented by using some type of personal protective equipment, depending on the work activity. Use safety glasses, gloves, long trousers, steel-toed work shoes, and a bump hat for activities such as handling bulls, hoof trimming, and shipping the animals. This type of equipment will reduce the injury potential to the head, feet, hands, and other parts of the body.

Use a chemical respirator, eye goggles, hard shell hat, rubber gloves, trousers, and a longsleeved shirt when preparing and applying pesticides. Exposure to pesticide chemicals through breathing, swallowing, or skin contact is a significant health hazard and may lead to poisoning or serious skin problems.

Use a dust respirator when working in areas that generate dust. Avoid breathing any dust generated by moldy forage or grain because it may cause farmer's lung disease (Gay & Grisso, 2012).

5.3.6. Controlling diseases

Handlers should also be concerned with zoonotic diseases, which are illnesses that can be transmitted between humans and animals. Leptospirosis, rabies, brucellosis, salmonellosis and ringworm are especially important.

To reduce exposure to disease, use basic hygiene and sanitation practices, which include prompt treating or disposal of infected animals, adequate disposal of infected tissues, proper cleaning of contaminated sites, and proper use of personal protective equipment.

6. Conclusion & recommendations

Education is a key component to prevent injuries and illnesses in the livestock industry. Frequent staff turnover means that training new employees may be needed several times a year. Employees in livestock operations need to be trained on such issues as proper animal handling, including animal welfare concerns, correct methods to employ during animal loading and transportation, proper use of personal protective equipment, and proper use of antibiotics, pesticides, and other chemicals. Employees also need to be trained on hazards of confined spaces, weather extremes, and proper cleaning and first-aid of any injury that occurs. Workers should be instructed to report to their supervisor any on-the-job injury or illness that may affect their health or the health of the animal herd. Use of vaccines, such as influenza vaccine, to prevent spread of disease to coworkers or to animals should also be a component of a worker health and safety program (Langley & Morrow, 2010).

Proper design of animal facilities may relieve animal stress and make movement of animals easier. Properly designed facilities should also reduce injuries from slippery uneven surfaces. Dr. Temple Grandin has developed plans for animal facility construction that incorporates basic animal behavior issues (Grandin & Deesing, 2008).

More research is needed to develop programs that lead to a decrease in injuries, that is acceptable and easy to use, and that maintains animal welfare. The following are some suggestions for future research. It is recommended that NIOSH update national surveys of injuries in livestock handlers to look at the types of injuries that ocur and the circumstances behind the injuries. Studies should be conducted to determine if there is a decrease in animal handler injuries following species-specific training programs for the handlers. These studies should include pig, sheep, and goat farms as well as the traditional cattle and horse farms. Studies should be conducted to determine the incidence of needle stick injuries by species and agent injected and if redesign of equipment is needed. An evaluation of needleless injection systems should be included to see if they can be successfully used on animals. Studies to determine the incidence of all-cause/all-species injuries and death on small farms compared to larger farms are needed to see if there are different risk factors that may play a role. Insurance industries' databases for all deaths/injuries on livestock and poultry farms should be evaluated to look for trends in types of injuries (Langley & Morrow, 2010).

Safety Reminders for Livestock Handling

- Good housekeeping is essential, not only for your personal safety, but also for the health and well being of your stock.
- Keep children away from animals, particularly in livestock handling areas.
- Most male animals are dangerous. Use special facilities for these animals and practice extreme caution when handling them.
- Be calm and deliberate when working with animals.
- Always leave yourself an "out" when working in close quarters.

- Respect all animals. They may not purposely hurt you, but their size and bulk make them potentially dangerous.
- Most animals tend to be aggressive when protecting their young; be extra careful around newborn animals.
- Stay clear of animals that are frightened or "spooked." Be extra careful around strange animals (Baker & Lee, 1993).

Provide workers with the knowledge of animal behaviors and habits

A good understanding of animal behaviors and habits can help handlers maintain control of routine handling as well as emergency situations.

- Most animals respond favorably to calm and deliberate movement and responses from a handler.
- Animals have a personal space or “flight zone”: if a handler gets too close, they will move away.
- Animals have difficulty judging distances and cannot see directly behind them. Quick movement behind them may frighten them.
- Animal vision is in black and white, not in color. Animals move more readily from dark areas into light. Bright lights and shadows tend to make animals skittish.
- Animals have sensitive hearing and can detect sounds that human ears cannot. Loud noises frighten animals. High frequency sounds actually hurt their ears, causing animals to become skittish and balky.
- Animals do not like surprises. Cattle become uneasy or skittish when their routines or surroundings change. Cattle can also be easily frightened by strangers or around small children who tend to make sudden movements.
- Stressed animals that are sick, injured, in heat or just mated can be easily agitated and highly unpredictable. Males are generally more aggressive by nature. Female animals tend to be more aggressive when with their young.
- Animals that are stressed show signs of fear or aggressiveness. Warning signs may include raised or pinned ears, raised tail or hair on the back, bared teeth, pawing the ground or snorting.

Provide employee training in the hazards associated with animal handling and in safe handling techniques

- Approach and handle animals in a calm, steady and consistent manner; don’t shove or bump them.
- Approach animals from the front or side. Move slowly and deliberately. Avoid startling animals with quick movements or loud noises.
- Wait until an agitated animal calms down before resuming working with the animal.
- Stop and seek additional help when handling animals that are unusually aggressive or in a situation that is not safe to perform the work. Use proper animal restraints and take adequate safety precaution.
- Promptly remove dangerous animals from farms or facilities to prevent worker injury.

- Plan ahead to allow plenty of time when moving animals. Be patient. Never prod an animal when it has nowhere to go.
- Whenever possible, move and isolate animals from livestock areas prior to performing work in those areas.
- Use a soft light that does not cast shadows that could spook the animals when trying to move cattle at night.
- Exercise extra caution when handling animals that are sick, hurt, new mothers, in heat or just mated.
- Position yourself so that you are not between a mother and her young.
- Use special facilities to separate male animals.
- Keep strangers and children out of animal handling areas.
- ALWAYS plan an escape route when working with animals in close quarters.
- Require workers to wear proper and necessary personal protective equipment such as protective safety shoes or boots with non-slip soles, sturdy clothing, gloves and helmets.

Design, construct and maintain a safe animal handling facility

Many animal handler injuries are directly related to unsafe features or design of the animal handling facilities. A safe animal handing facility can both protect workers and prevent injuries to animals that often cause considerable economic loss.

- Eliminate tripping hazards such as high door sills, cluttered alleyways and uneven walking surfaces that can contribute to falls.
- Build concrete floors with a roughened finish.
- Groove high traffic areas such as alleyways.
- Keep floors dry in working and walking areas. These areas should drain easily.
- Provide non-slip surfaces when possible.
- Construct “man passes” or narrow escape routes in barns where a person can safely get away, but an animal cannot follow.
- Plan and design escape routes from open animal yards.
- Build alleys and chutes wide enough for animals to move through but not wide enough to allow them to turn around.
- Build strong fences and gates to contain crowded livestock using strong and durable materials.
- Build chutes with solid walls instead of wires, fences, or open sides. Solid walls can shield the animals from outside distractions.
- Eliminate or remove any potentially hazardous protrusions and sharp objects in the livestock area, such as nails, bolts and broken boards. These may startle or distract animals and create a dangerous situation for workers.
- Provide lighting that is even and diffused to avoid casting shadows. Avoid layouts that force animals to look directly into the sun.
- Use handling equipment in livestock confi nement work operations to reduce the risk of injury. These include hydraulic chutes, portable alleys and headbenders (FACE, 2012).

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