PRINCIPLES & OVERVIEW OF AGRI-MEDICINE

Mark A. Purschwitz, Ph.D.
Associate Professor and Extension Agricultural Safety and Health Specialist
University of Wisconsin – Madison / Extension

Importance and Economics of Agriculture

In the United States, production agriculture – farming and ranching – generates a great deal of economic activity. Farm cash receipts, the value of livestock and crop commodities sold by farms, were approximately $194.6 billion in year 2000[1]. The supply of inputs to farms, and the processing, distribution, and sales of the products from farms, further multiplies the economic importance.

In Wisconsin, farm cash receipts totaled over $5.2 billion in 2000[2]. It is estimated that the Wisconsin "food and fiber industry" in total generates about $40 billion annually, about 22 percent of the state's economy[3].

This economic activity is not uniformly generated across the spectrum of farms. A relatively small percentage of farms produces a large percentage of the cash receipts, both in the United States and Wisconsin. The official United States Department of Agriculture (USDA) definition of a farm is quite inclusive; it includes any establishment that sold or would have sold at least $1000 of farm products during the year. Thus there are many very small, part-time farms that produce relatively little in comparison with their numbers. Tables 1 and 2 below provide a breakdown of the percentage of farms by size (based on annual sales), and the percentage of total cash receipts generated those farms, for the United States and Wisconsin, respectively, in 1999. Farms with sales of $100,000 or more accounted for only 16.1 percent of the farms in the United States, but 86.9 percent of farm production. In Wisconsin those farms accounted for only 21.6 percent of the farms but 83.6 percent of the production.

The profitability of individual farms varies widely. Most farmers cannot control the prices they receive for their products, as these products are primarily commodities and lack differentiation, and the prices are set by fluctuating markets or by government programs. Farmers' incomes can vary drastically from year to year, and sometimes the prices received are below the cost of production. Excellent weather resulting in high yields and high overall production of a particular crop inevitably results in a drop in the price received, the result of supply and demand. A good or bad production year for a crop in another country can affect the price of the U.S. crop. Minimum milk prices are set by government marketing orders, based on geography and various economic factors and formulae; the actual price received by the farmer can fluctuate widely from year to year or even month to month.

Table 1. U.S. Farms by Annual Sales, Percentage of Farms, and Percentage of Total Cash Receipts.

Annual Sales	Percentage of Farms	Cumulative % Farms	Percentage of Total Cash Receipts	Cumulative % Receipts
<$25,000	68.0 %	68.0 %	4.0 %	4.0 %
$25,00-49,999	8.8 %	76.8 %	3.5 %	7.5 %
$50,000-99,999	7.1 %	83.9 %	5.6 %	13.1 %
$100,000-249,999	8.7 %	92.6 %	15.4 %	28.5 %
$250,000-499,999	4.1 %	96.7 %	15.8 %	44.3 %
$500,000-999,999	1.9 %	98.6 %	15.0 %	59.3 %
$1,000,000+	1.4 %	100.0 %	40.7 %	100.0 %

(Note: Numbers of farms and receipts reported; percentages calculated by author. Based on 2,133,909 farms and $192,747,616,000 cash receipts reported in this survey.)

Source: National Agricultural Statistics Service, United States Department of Agriculture. 2001. 1999 Agriculture Economics and Land Ownership Survey, Table 9, Farms by Market Value of Agricultural Products Sold for States. http://www.nass.usda.gov/census/census97/aelos/tbl09.pdf

Table 2. Wisconsin Farms by Annual Sales, Percentage of Farms, and Percentage of Total Cash Receipts.

Annual Sales	Percentage of Farms	Cumulative % Farms	Percentage of Total Cash Receipts	Cumulative % Receipts
<$25,000	61.2 %	61.2 %	3.6 %	3.6 %
$25,00-49,999	7.7 %	68.9 %	3.7 %	7.3 %
$50,000-99,999	9.5 %	78.4 %	9.1 %	16.4 %
$100,000-249,999	15.7 %	94.1 %	33.8 %	50.2 %
$250,000-499,999	4.1 %	98.2 %	19.7 %	69.9 %
$500,000-999,999	1.0 %	99.2 %	9.6 %	79.5 %
$1,000,000+	0.8 %	100.0 %	20.5 %	100.0 %

(Note: Numbers of farms and receipts reported; percentages calculated by author. Based on 78,723 farms and $5,797,308,000 cash receipts reported in this survey.)

Source: National Agricultural Statistics Service, United States Department of Agriculture. 2001. 1999 Agriculture Economics and Land Ownership Survey, Table 9, Farms by Market Value of Agricultural Products Sold for States. http://www.nass.usda.gov/census/census97/aelos/tbl09.pdf

In many cases, the prices farmers receive for their products, in real dollars (accounting for inflation) are less than they received years ago, even as input costs have increased greatly. Inefficiencies from using older equipment or systems, or from small size, may make it difficult for a farmer to decrease production costs enough to maintain financial viability when prices are low. If the farmer chooses to stay in business, it may mean eliminating many family living expenses, health insurance being but one example, and living on a very low income.

To further explain the economic pressures on U.S. farmers, Table 3 below compares selected prices paid by farmers for production inputs, and prices received for farm products, with those of a decade ago. It can be clearly seen that, in general, real prices paid by farmers have risen much more than the prices received, which in some cases have even declined.

Table 3. Index Numbers for Prices Paid and Received by U.S. Farmers, April 2001, compared with Prices Paid and Received in 1990-1992.

(The index number for 1990-92 is 100. The ratio of the index numbers gives the true change when adjusted for inflation. A higher index number reflects a true increase; a lower index number reflects a true decrease.)

Index numbers for prices paid by farmers

All commodities, services, interest, taxes, and wage rates	124
Seed	134
Fertilizer	135
Agricultural Chemicals	121
Fuels	127
Farm machinery	143
Wage rates	149
Family living — Consumer Price Index	131
All farm products	107
All crops	106
Food grains	91
Cotton	72
Oil-bearing crops (e.g., soybeans)	75
Commercial vegetables	133
Potatoes and dry beans	92
All livestock products	109
Meat animals	104
Dairy products	110
Poultry and eggs	116

Source: Wisconsin 2001 Agricultural Statistics. Page 9. Wisconsin Agricultural Statistics Service, Madison, Wisconsin.

Agricultural Demographics

The number of farms and ranches in the United States is steadily decreasing. According to the National Agricultural Statistics Service (NASS) of the United States Department of Agriculture (USDA), there were an estimated 2,172,280 farms in the United States in the year 2000[4]. The percentage breakdown of U.S. farms by value of annual gross sales is given below in Table 4.

If it were assumed that a farm needs at least $100,000 of annual sales to be a viable, stand-alone business that can support its owner without outside income, only about 16 percent of the nation's farms (roughly 350,000) would be considered commercially viable as stand-alone businesses.

According to the Wisconsin Agricultural Statistics Service (WASS), a state field office of NASS, there were an estimated 77,000 farms and 16,200,000 acres of land in farms in Wisconsin in 2000[5]. There were 21,000 dairy farms, historically the most common type of farm in Wisconsin. All of these totals are decreases that continue the historical trends shown in Table 5.

Table 4. U.S. Farms by Annual Sales, 2000.

$1000-2499	26.8 %	582,000 farms
$2500 to $4999	15.1 %	328,000
$5000 to $9999	12.1 %	263,000
$10,000 to $19,999	10.2 %	222,000
$20,000 to $39,999	9.0 %	195,000
$40,000 to $99,999	10.7 %	232,000
$100,000 to $249,999	9.3 %	202,000
$250,000 to $499,999	3.8 %	83,000
$500,000 +	3.0 %	65,000
All U.S. Farms	100 %	2,172,000

(Note: The percentages in column 2 were reported; the numbers in column 3 were calculated by the author, rounded to the nearest 1000, to provide a sense of magnitude.)

Source: National Agricultural Statistics Service, United States Department of Agriculture. 2002. On-line Published Estimates Database, U.S. and State Data, Farm Numbers and Land in Farms: U.S. Only by Economic Sales Class. http://www.nass.usda.gov:81/ipedb/.

Table 5. Estimated Number of Farms, Acres of Land in Farms, and Number of Dairy Farms, Wisconsin, 1960-2000.

1960	138,000 farms	22,200,200 acres	105,000 dairy farms
1965	124,000	21,400,000	86,000
1970	110,000	20,100,000	64,000
1975	100,000	19,300,000	53,000
1980	93,000	18,600,000	45,000
1985	83,000	17,900,000	41,000
1990	80,000	17,600,000	34,000
1995	80,000	16,800,000	28,000
1996	79,000	16,600,000	27,000
1997	79,000	16,500,000	25,000
1998	78,000	16,400,000	23,000
1999	78,000	16,300,000	22,000
2000	77,000	16,200,000	21,000

Source: Wisconsin Agricultural Statistics Service. 2002. Dairy, Current Data: Number of Farms and Land in Farms, Wisconsin and United States, Selected Years. http://www.nass.usda.gov/wi/dairy/dynfarms.htm.

Just as with the rest of the country, many Wisconsin farms are quite small in terms of product sold. Assuming $100,000 of sales is necessary for a farm to be commercially viable, only slightly more than 23 percent of Wisconsin farms fit that description. The breakdown of Wisconsin farms by annual gross sales is given below in Table 6.

Table 6. Wisconsin Farms by Annual Sales, 2000.

$1000 to $9999	34,500 farms	44.8 %
$10,000 to $39,999	13,300	17.3 %
$40,000 to $99,999	11,200	14.5 %
$100,000 +	18,000	23.4 %
All Wisconsin Farms	77,000	100 %

(Note: The numbers in column 2 were reported; the percentages in column 3 were calculated by the author.)

Source: Wisconsin 2001 Agricultural Statistics. Page 7. Wisconsin Agricultural Statistics Service, Madison, Wisconsin.

Wisconsin farms produce a variety of commodities, with many farms producing more than one. A farm can be categorized by its primary product, which is the product having the highest dollar value of sales. A percentage breakdown of Wisconsin farms by primary product is available from the 1997 Census of Agriculture, the most recent Census for which data are published. This breakdown is given below in

Table 7, for various size farms.

(Note: Due to different procedures and techniques used, the total number of farms given by the Census of Agriculture is different than that given by NASS and its state offices. The totals calculated by NASS are generally used by the Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP) and the agricultural community. However, Census of Agriculture data are more extensive in scope and are the only data available on many topics.)

Table 7. Percentage of Wisconsin Farms by Primary Product, 1997.

Farms with This Primary Product	Percent of All Farms	Percent of Farms w/ Sales of $10,000+	Percent of Farms w/ Sales of $100,000+
Dairy cattle and milk production	31.9 %	51.7 %	72.0 %
Oilseed and grain	24.3 %	18.4 %	9.5 %
Beef cattle farming, ranching	14.4 %	9.7 %	5.7 %
Hay and other crops	11.0 %	6.7 %	1.8 %
Animal aquaculture, misc. other animals	4.4 %	1.5 %	0.9 %
Cattle feedlots	3.9 %	3.3 %	1.7 %
Greenhouse, nursery, floriculture	2.6 %	2.3 %	2.0 %
Vegetables and melons	2.0 %	2.2 %	1.8 %
Hogs	1.8 %	2.1 %	2.3 %
Fruit and tree nuts	1.3 %	1.0 %	1.3 %
Sheep and goats	1.2 %	0.4 %	0.0 %
Poultry and eggs	0.7 %	0.5 %	1.0 %
Tobacco	0.4 %	0.2 %	0.0 %
Total, all products	100.0 %	100.0 %	100.0 %

(Note: Actual farm numbers were reported. Percentages were calculated by the author, based on 1997 Census of Agriculture totals of 65,602 Wisconsin farms, 40,257 farms with sales of $10,000 or more, and 15,772 farms with sales of $100,000 or more.)

Source: National Agricultural Statistics Service, United States Department of Agriculture. 1999. 1997 Census of Agriculture Volume 1: Part 49, Chapter 1, Wisconsin State-Level Data: Table 51. Summary by North American Industry Classification System (NAICS): 1997. http://www.nass.usda.gov/census/census97/volume1/wi-49/wi1_51.pdf.

Table 8 lists those commodities in which Wisconsin ranked 1st, 2nd, or 3rd among the states in 2000.

Table 8. Farm Commodities in which Wisconsin Ranked 1st, 2nd, or 3rd in Production or Total Number Among the States, 2000.

Commodity	Rank
Beets for canning	1
Cabbage for kraut	1
Cheese, total (excluding cottage cheese)	1
Corn for silage	1
Cranberries	1
Dry whey	1
Mink pelts	1
Snap beans for processing	1
Butter	2
Lactose	2
Milk cows, total number of	2
Milk production	2
Carrots, all	3
Green peas for processing	3
Oats	3
Potatoes, all	3
Sweet corn for processing	3

Source: Wisconsin 2001 Agricultural Statistics. Page 3. Wisconsin Agricultural Statistics Service, Madison, Wisconsin.

Virtually all Wisconsin farms are family operated. Most are operated as sole proprietorships, meaning the farm is owned by an individual or married couple, and the business and personal affairs of the owner are merged together. In a sole proprietorship, from the standpoint of nearly all legal rights and responsibilities, the business and the proprietor are considered to be one and the same. Of those farms that are not sole proprietorships, most are partnerships or family corporations. There are very few non-family corporations operating farms. The breakdown of Wisconsin farms by business organization is given below in Table 9.

Table 9. Wisconsin Farms by Business Organization, 1997.

Sole proprietorship	56,598 farms	86.3 %
Partnership	5,746	8.8 %
Family corporation	2,651	4.0 %
Non-family corporation	219	0.3 %
Other (trust, institution, etc.)	388	0.6 %
All Wisconsin farms	65,602	100 %

(Note: Numbers in column 2 were reported; percentages in column 3 were calculated.)

Source: National Agricultural Statistics Service, United States Department of Agriculture. 1999. 1997 Census of Agriculture Volume 1: Part 49, Chapter 1, Wisconsin State-Level Data: Table 47. Summary by Type of Organization: 1997. http://www.nass.usda.gov/census/census97/volume1/wi-49/wi1_47.pdf.

There is of course much more to production agriculture than numbers of farms or dollars of product. There are the people who live or work on farms. The farm resident population of the United States is relatively small, and continues to decrease. The percent of the U.S. labor force made up of farmers is also relatively small and decreasing. Table 10 gives an historical picture of the U.S. population, farm population, and related information, from 1900 to 1990.

Table 10. Total U.S Population, Farm Population, Number of Farms, and Percentage of U.S. Labor Force Made Up of Farmers.

Year	U.S. Population	Farm Population	# of Farms	% of U.S. Work Force
1900	75,994,266	29,414,000	5,740,000	38 %
1910	91,972,266	32,077,000	6,366,000	31 %
1920	105,710,620	31,614,269	6,454,000	27 %
1930	122,775,046	30,455,350	6,295,000	21 %
1940	131,820,000	30,840,000	6,102,000	18 %
1950	151,132,000	25,058,000	5,388,000	12.2 %
1960	180,007,000	15,635,000	3,711,000	8.3 %
1970	204,335,000	9,712,000	2,780,000	4.6 %
1980	227,020,000	6,051,000	2,439,510	3.4 %
1990	246,081,000	4,591,000	2,143,150	2.6 %

Source: Economic Research Service, United States Department of Agriculture. 2002. A History of American Agriculture 1776-1990. http://www.usda.gov/history2/text3.htm.

From Table 10 it can be seen that in 1990 the farm population made up about 1.9 percent of the U.S. population. In Wisconsin, the percentage of farm residents was somewhat higher, although still relatively small. Based on the 1990 Census of Population and Housing (the most recent census for which farm residence data are available), the Wisconsin population was 4,891,769, and the farm resident population was 195,550, or 4.0 percent of the Wisconsin population[6].

Farm resident population is not the same as farm labor, since not everyone who lives on a farm works on that farm or any other, and hired farm workers do not necessarily live on farms. According to USDA, in Wisconsin in 2000 there was an average of 90,700 people working on farms. These included 54,000 self-employed workers (farm owner/operators), 19,800 unpaid workers (e.g., family members) and 16,900 hired farm workers[7].

The total number of workers given above does not include workers hired through labor contractors, which is typical of migrant labor. These are known as "agricultural service workers", and USDA only provides figures for California, Florida, and the U.S. Examples of farm work done by migrant workers in Wisconsin include hand-picking fruits and vegetables, and trimming and harvesting Christmas trees. The Wisconsin Department of Workforce Development reported 5541 migrant workers in 2001, based on reports from registered employers and other documentation, including workers in food processing (canneries) as well as on farms[8]. United Migrant Opportunity Service (UMOS), a multi-state non-profit organization headquartered in Wisconsin and providing services to migrant workers and their families, estimated the number of migrant workers in Wisconsin at around 8000, due to undercounting[9].

Large dairy farms frequently need hired labor to milk cows and keep the milking parlors running for long periods of time, nearly around the clock in some cases. Due to difficulties in finding dependable local labor, these farms report hiring more Spanish-speaking workers. These workers are moving to and permanently residing in Wisconsin, to work on these farms and in other agricultural businesses, such as packing plants. No data are available on the numbers of these workers.

More is known about farm operators themselves. Wisconsin farm operators are predominantly male and overwhelmingly white. Many are not full-time farmers, and the number of full-time operators is decreasing. Farm operators work many days off the farm, and the number of operators that do is increasing. Table 11 provides data from the 1997 and 1992 Census of Agriculture for comparison.

Table 11. Selected Characteristics of Wisconsin Farm Operators, 1997 and 1992.

Farm Operators	1997	1992
Total	65,602	67,959
Male (%)	61,201 (93.3 %)	64,136 (94.4 %)
Female (%)	4,401 (6.7 %)	3,823 (5.6 %)
White	65,418 (99.7 %)	67,848 (99.8 %)
All other races	184 (0.3 %)	111 (0.2 %)
Principal occupation		
Farming (%)	39,030 (59.5 %)	46,180 (68.0 %)
Other (%)	26,572 (40.5 %)	21,779 (32.0 %)
Days worked off the farm		
None (%)	31,334 (47.8 %)	36,165 (53.2 %)
Any (%)	31,303 (47.7 %)	28,081 (41.3 %)
1 to 99 days (%)	5,364 (8.2 %)	5,366 (7.9 %)
100 to 199 days (%)	4,851 (7.4 %)	4,419 (6.5 %)
200 days or more (%)	21,088 (32.1 %)	18,307 (26.9 %)
Not reported (%)	2,965 (4.5 %)	3,703 (5.4 %)

Source: National Agricultural Statistics Service, United States Department of Agriculture. 1999(1994). 1997 (1992) Census of Agriculture Volume 1: Part 49, Chapter 1, Wisconsin State-Level Data: Table 51. Summary by North American Industry Classification System (NAICS): 1997(1992). http://www.nass.usda.gov/census/census97/volume1/wi-49/wi1_51.pdf
http://www.nass.usda.gov/census/census92/volume1/wi-49/wi1_51.pdf

The ages of farm operators vary widely, but an increasing number of operators are senior citizens. In 1997, over 30 percent of Wisconsin farms were operated by persons age 60 and over. As indicated in Table 12 below, the average age of Wisconsin farm operators increased to 52.2 in 1997, compared with 50.6 in 1992. The average age has been increasing for many years, although not as rapidly as between 1992 and 1997; the average age in 1959 was 48.8[10].

The breakdown of Wisconsin farms by age of operator is given in Table 12 below.

Table 12. Wisconsin Farms by Age of Operator, 1997 and 1992.

Age	Farms, 1997	Farms, 1992
Age < 25	632 (1.0 %)	1,111 (1.6 %)
25-34	5,294 (8.1 %)	8,537 (12.6 %)
35-44	15,535 (23.7 %)	15,729 (23.1 %)
45-49	8,715 (13.3 %)	7,836 (11.5 %)
50-54	8,091 (12.3 %)	7,488 (11.0 %)
55-59	7,168 (10.9 %)	7,303 (10.7 %)
60-64	6,501 (9.9 %)	7,212 (10.6 %)
65-69	5,387 (8.2 %)	5,599 (8.2 %)
70 +	8,279 (12.6 %)	7,144 (10.5 %)
All Wisconsin farms	65,602 (100 %)	67,959 (100 %)
Average age	52.2	50.6

Source: National Agricultural Statistics Service, United States Department of Agriculture. 1999(1994). 1997(1992) Census of Agriculture Volume 1: Part 49, Chapter 1, Wisconsin State-Level Data: Table 51. Summary by North American Industry Classification System (NAICS): 1997(1992).
http://www.nass.usda.gov/census/census97/volume1/wi-49/wi1_51.pdf
http://www.nass.usda.gov/census/census92/volume1/wi-49/wi1_51.pdf

Farmers' Perception of Risk

Farmers are by nature risk takers. They are dependent on weather for the production of crops, and since weather cannot be controlled, they are taking a risk each season. They are risk takers in the production of livestock, since disease, weather, and other factors can and will affect animals' growth, production, reproduction, and lifespan. Additionally, they are economic risk takers, since they cannot control prices and prices can be quite volatile.

This risk taking seems to carry over into the area of safety and health. Farmers will work for years around potentially life-threatening hazards, or use unsafe practices, that would never be allowed in another work place. They will do so even while knowing the hazards or practices can cause serious or fatal injury, or knowing of other farmers who have been injured or killed by these same hazards or practices. Many feel that injury is just a normal risk of farming, something to be accepted. Some feel that "accidents" just happen, like bad weather, are not preventable, and thus should not be a source of worry. Others feel that because they themselves have not been injured, their work practices and habits are reasonable and they are able to safely compensate for the hazards.

Acceptance of safety and health risks may also be somewhat related to acceptance of financial risk. Because many farmers operate at very low or even zero profit margins, they can become accustomed to limiting expenses to those that are absolutely necessary for the functioning of the farm or increasing production. Instead of spending money on equipment that would protect or improve their safety and health, they may save the money and rely on behavior to protect them. In addition, if an employee is hired, even part-time, the farmer may feel it only reasonable to expect the employee to accept the same risks he/she has accepted, and to work with the same hazards that he/she works with regularly.

Most farmers are also quite comfortable with family members working on the farm or at least being present in the workplace. These family members may be children, perhaps even infants or toddlers. Sometimes it seems a matter of necessity, as some jobs take more than one person to perform, or simply because there is so much to do. For example, when baling hay in the summer and making the traditional small rectangular bales, one person is needed to operate the tractor and baler, a second person is needed to drive a tractor and wagon loads of bales to the barn and unload them, and depending on the system used, a third person may be needed to stack the bales on the hay wagon pulled behind the baler. If the bales are to be stacked inside the haymow, more people are needed. This does not include the work needed to cut the hay prior to baling.

Many farm parents say that an important part of farm life is being able to spend lots of time with their children. This includes being able to work together. They also stress that development of a strong work ethic is very important to them. These two factors together make it more likely that family members are in the workplace, and make the risks more acceptable.

Children who are too young to work may be brought along into the workplace, such as riding on a tractor or being with a parent in the barn, or be allowed to play nearby. If both parents are doing farm work at the same time, there may be nobody else to watch the children. If money is tight, the expense of a babysitter will be foregone. If money is not an issue, it may be inconvenient or difficult to get a sitter or take a child to day care in town. Since, for many farm parents, having children in the workplace is simply part of farm life and an acceptable risk, this is not even considered an issue regardless of finances or convenience.

It should be noted that, because the farm is a home as well as workplace, farm children are as likely to be around the farmstead as urban or suburban children are to be in their back yard. In addition to the yard around the house itself, there are many other areas which are attractive places to play, climb, or explore. These would include areas around farm buildings, storage structures, and livestock pens; the interiors of the buildings and structures; and on or around parked machinery. Thus children are at risk from hazards inherent in these areas, and also risk being run over as unseen bystanders by vehicles and other machines operating in or entering these areas.

Farm Hazards

Hazards of Farm Machines

Tractors

Tractors are involved in many incidents (so-called “accidents”) resulting in serious and fatal farm injuries, and are the largest single agent of fatal injury in Wisconsin and many other states. Tractors are ubiquitous, are used many hours, and are used for a multitude of tasks. Tractors are involved in rollovers (when the tractor overturns), runovers (when someone is run over by the tractor), and other incidents.

The most common fatal farm incident involving tractors, and indeed the single most common of all fatal farm incidents, is the tractor rollover. This may occur for any one of a number of reasons, but has much to do with the fact that tractors must have relatively high centers of gravity for ground clearance, and are operated in a variety of places and terrains. There may be slopes, obstacles and other things that can cause the tractor to tip or become unbalanced. A tractor may overturn sideways (the most common type of rollover), ending on its side, ending upside down, or making one or more complete revolutions. A tractor may also overturn to the rear, flipping over backwards and ending upside down.

An estimated 50 percent of people involved in rollovers of tractors without rollover protective structures (ROPS) are killed, another 45 percent suffer various injuries ranging from severe to minor, and perhaps five percent are uninjured[11]. The heavy weight of the tractor can easily crush its victim, but depending on how a person is trapped beneath the tractor, the severity and location of the injuries will vary. Occasionally people have jumped or been thrown clear

The second-most common fatal incident involving tractors is the runover. This may occur in several ways. One way is when a person falls from the tractor and is run over. The victim may be the operator or, more commonly, a passenger. The tractor may hit an unexpected bump, or move in an unexpected manner, and the person loses his or her grip. Even on a tractor with a cab, a passenger may fall out the door or window if they lean or are jostled against it.

A second way tractor runovers occur is when the victim is already on the ground. The person may be an unseen bystander; this is especially common with young children who are observing or playing in the area and do not understand the danger, but it can occur to people of other ages. Sometime the victim is in the area to assist with the work, but due to miscommunication with the operator, or because the operator makes an inadvertent or unexpected move, the person gets run over. A tractor that has been parked without the transmission being placed in "park," or the parking brake set, may unexpectedly move and roll over someone.

A third way tractor runovers occur is when an operator is attempting to start a tractor from the ground instead of from the seat. If the tractor is in gear, and does not have safety devices or these devices have been bypassed, it may start and move forward unexpectedly. One "method" involves standing beside the engine and taking a tool to activate the starter, perhaps because the ignition switch is broken. This is called "bypass starting," because it bypasses the starter switch and safety devices.

Other circumstances of injury or fatality involving tractors may be a motor vehicle collision on a roadway; a person on the ground being pinned by the tractor against a building or trailing implement; an operator pinning his/her head while driving or backing into a low shed; or slipping and falling while mounting, dismounting, or performing maintenance.

It should be noted that some lists of farm tractor-related incidents include Power Take-Off (PTO) driveline entanglements. These will be discussed in the farm machinery section below. Some of these entanglements may occur at the point where the PTO driveline attaches to the tractor, and can be prevented by a shield that is part of the tractor. However, because the PTO driveline itself is part of the trailing farm machine and not the tractor, these incidents are included with machinery entanglements.

Prevention of tractor-related incidents involves both a permanent change to the tractor and proper operator behaviors. Changing the tractor means installation of a Roll Over Protective Structure (ROPS), which is the single most important way to prevent serious and fatal rollover injuries. On open-station (non-cab) tractors, a ROPS is a steel frame or "roll bar" attached to the rear tractor axles, behind the seat, and extending above the operator's head. On tractors with cabs (excluding older cabs designed only for weather protection), a crush-proof frame is built into the cab. ROPS became standard equipment on tractors sold in the United States in 1985, and was either standard or optional on many tractors prior to that time, as early as 1966. However, the majority of Wisconsin tractors and U.S. tractors do not have a ROPS.

Retrofit ROPS are available for many tractors, and cost anywhere from several hundred dollars to well over a thousand dollars. However, compared to the number of tractors without ROPS, relatively few retrofit ROPS have been sold, as many farmers feel the risk is acceptable and choose to not spend the money.

Proper operator behaviors can improve tractor stability and reduce the chances of an overturn. These include pre-operation activities such as choosing a tractor large enough to safely control the towed load, setting the wheel spacing as wide as feasible before operating on slopes, weighting the tractor appropriately, and hitching the load properly. During operation, proper behaviors include operating carefully on slopes, keeping speed down on turns, keeping a safe distance from stream banks and ditches, and if using a tractor with front-end loader, carrying loads low.

One other hazard of tractor operation must be considered, and that is noise. It has been well known for many years that farmers operating tractors for long periods of time, over years or decades, have suffered hearing loss. The noise reaching an operator on an open-station tractor at full throttle is well in excess of allowable noise exposure, perhaps reaching 100 dB if the muffler is worn out. Modern tractor cabs have been carefully designed to achieve sound level ratings of 80 dB and below, assuming the doors and windows are shut and the cab has been properly maintained. Absent a quiet cab, operators should always use hearing protection.

Other Farm Machines

Tractors are farm machines, but are also mobile power units and thus considered a unique category. Farms have many other types of machines, which are designed to cut, strip, compress, chop, grind, shred, separate, mix, throw, transport, dump, move, lift, pump, spray, and/or otherwise process anything from soil to plant materials to chemicals to waste products. These machines are powerful, often heavy, capable of handling tough and difficult materials, and thus can cause serious or fatal injury if a person comes in contact with the operating components. Operators are cautioned to always shut off machines, and the engines or motors powering them, before making repairs, adjustments, unplugging, etc., these machines.

Serious or fatal injuries can result from entanglement in a machine, including even momentary contact; being pinned beneath a machine that has dropped during operation or maintenance; being run over by a machine; and various other ways.

Even though farmers use many types of farm machines, too many to be individually discussed here, there are common components that can be discussed in terms of operation and injury causation. These components include power-transmission components like rotating shafts, gears, chains and sprockets, and belts and pulleys; feed rolls; augers; and other shear points, pinch points, crush points, and pull-in points. In addition, hazards posed by flying objects and stored energy may also be present. These will all be discussed below.

Rotating shafts are common on farm machines and may entangle clothing or extremities and cause serious skin burns, lacerations, fractures, amputation, spinal injuries, or overall mutilation. A shirt or jacket entangled on a rotating shaft may even cause suffocation if it ends up around the neck. Shafts with protrusions are especially likely to catch clothing and entangle. Entanglements may occur quickly and violently, or more slowly, depending on the machine and the speed at which it is being operated. Rotating shafts and their connectors should always be guarded, such as covered by a shield or being located beneath a screen or other guard that prevents contact.

The Power Take-Off (PTO) driveline is a telescoping shaft between a tractor and a mounted or trailing implement, named because the implement "takes power" from the tractor. It is part of the implement itself, and is manually connected, without tools, to a short shaft protruding from the back of the tractor. PTO drivelines are very common, since many implements have moving parts which require power.

It rotates very fast, with rated speeds of 540 or 1000 rpm (revolutions per minute), which equal 9 or 16 revolutions per second. The PTO driveline is intended to be shielded from end to end with a set of shields. This includes a shield on the tractor (often called the "master shield") that protects the connection at the tractor end, a similar shield at the implement end, and a tubular shield in between. If any one of these shields is missing, broken, or non-functional (e.g., rusted to the shaft so it turns as if it is part of the shaft), there is risk of entanglement.

Gears, chains and sprockets, and belts and pulleys are commonly found on farm machines, and can entangle loose clothing or extremities if unguarded. They can seriously lacerate, crush, or amputate extremities. These components should always be guarded.

Augers are screw-type devices that move materials like grain or seeds (e.g., individual kernels of corn, grains of wheat or oats or barley, soybeans, etc.) or chopped plant material from one end to the other. The auger is another common machine component that carries risk of serious injury. Some augers turn very slowly, while others rotate so fast that the auger is just a blur. In order to move material, most augers are partially or totally surrounded by some sort of stationary surface or housing. The points where the rotating auger nears or contacts this surface are where extremities can become seriously lacerated or amputated. Sometimes an extremity can be pulled into the housing and be mutilated, with or without amputation. Even away from the housing, an auger may entangle like an open rotating shaft. Augers should be completely covered where possible, the exceptions being at places where materials are fed into the auger or where the auger is used for scraping or mixing. Where grain is fed into the open end of an auger housing, the end should be guarded by a cage that keeps feet and hands out.

Feed rolls are twin parallel rollers that contact or are very close to each other, designed to grab plant material and feed it into a machine for further processing. Aggressive feed rolls are necessary because plants can be slippery, especially when wet, and for high capacity without plugging. It is difficult to guard feed rolls because they must be able to freely grab the material and pull it in. Unfortunately, feed rolls cannot distinguish between plants and human extremities. Sometimes when a machine is plugged, an operator will use a hand or foot to push material in or pull material out, and if the machine is still running, contact with the feed rolls can result. Potential injuries include severe skin burns or tissue destruction, crushing and mutilation, amputation, or in severe cases, the entire person being pulled into the machine.

Stored energy in farm machines can be a hazard. Hydraulic oil, under high pressure, is used to operate extendable hydraulic cylinders that lift or move extremely heavy loads. This pressurized oil is also used to turn hydraulic motors for rotary power. If a leak or rupture occurs in the rubber hose, metal tubing, or associated fittings that transport this oil, the heavy load may drop suddenly and trap or crush a person beneath. The oil itself, with pressures approaching 3000 psi (pounds per square inch) can be injected through the skin, killing tissue.

Spring-loaded or spring-supported components can snap back or fall if improperly disassembled during maintenance or repair, resulting in severe injury. Air or other gases and liquids stored under pressure can result in injury if the container leaks or ruptures. Some truck tires can explode during inflation if proper procedures are not followed, sending portions of the rim flying with fatal force.

There are many other moving parts on farm machines that may be able to pinch, shear, pull in, entangle, throw or eject, or otherwise cause injury to persons coming in contact with them. Farm machines are designed to do many different things and the variety of specialized components is large, from knives to conveyors to swinging arms. Some machines such as mowers or shredders throw or eject material at high speed, and carry the risk of injury by flying material. Some machines are tall and operators can fall from them while mounting, dismounting, or doing maintenance. Some machines are quite large and obstruct visibility to the rear, and an unsuspecting person can be run over while the machine is being backed up. A person can be run over by a trailing machine after first falling from a tractor and being missed by the tractor wheels. A person might be struck or run over by other vehicles on the farm, such as milk trucks or trucks hauling harvested crops.

Many machines in or near farm buildings or structures are electrically operated. This poses the additional risk of electrocution if a person comes in contact with an energized wire or component during repair or adjustment. Furthermore, because the power switches of many machines are not in sight of the machine, there is the risk of one person turning on the machine without knowing that a second person is adjusting or repairing it. These situations can be avoided by using "lockout/tagout" procedures, where the person working on the machine places a lock, or in some cases a warning tag, on the switch box to prevent activation.

Just as for tractors, some farm machines are very loud and require hearing protection. For example, grain dryers are stationary machines that blow hot air through grain to lower its moisture level, for the purpose of preventing spoilage. The fans on grain dryers are quite loud, and people working near them should have hearing protection. Some mobile farm machines powered by tractors are operated in a stationary mode, and may require the operator to stand beside them to monitor the process. Even if the machine itself is not loud, and the tractor has a quiet cab, the machine brings the operator outside the cab and thus creates the need for hearing protection from the tractor engine.

It is incumbent on operators to read owners manuals and otherwise become familiar with their machines and the hazards they pose. Farm machines in general are heavy, powerful, and designed to operate under extreme and widely varying conditions, and the human body is no match for them.

Hazards of Farm Structures

Farm structures, which include buildings and storage systems, pose risks to farmers and others workers and bystanders. These can include risks of falls; electrocution; entanglement in machines inside the structures; general respiratory hazards, and even noise. They also may have the risk of poisoning, asphyxiation, or drowning in confined spaces; these will be discussed in a separate section below. Although fatalities and injuries involving farm structures are less common that those from tractors and other farm machines, they are significant nonetheless.

Falls from heights

Farmers can fall from ladders on their barns, silos, grain bins, and associated equipment. They can fall from portable ladders used during painting or other building maintenance. They can fall from the roofs of buildings and storages, while checking on a crop or performing maintenance and repairs. They can fall down through the floor openings of hay mows in two story barns.

Falls on same surface

Farmers can trip or slip on barn floors or outdoor cattle lots, especially with manure present, or on old uneven concrete, since many farm buildings are old. They can slip on wet floors in milking parlors or milk houses (the room where the stainless steel bulk tank is located to store milk). They can slip on oil in shops and machine sheds.

Electrocutions

Many farm buildings are old and have wiring that may be outdated or in poor repair from corrosion or rodent activity. In addition, these older buildings may not have modern safety systems or devices such as three-wire systems, dust-proof light fixtures, or ground-fault circuit interrupters for circuits in wet areas. Overhead power lines around buildings and other structures can be hazardous if they are located where tall equipment will be used. For example, portable grain augers or hay elevators may contact these lines if moved without being properly lowered.

Injury from machines and systems inside structures

Farm buildings can have everything from heat lamps and pumps to ventilation equipment and a variety of electrically-powered machines, all of which will require maintenance or repair. As discussed previously in the section on farm machines, these all pose their own hazards, such as entanglement or electrocution.

General respiratory hazards

Buildings and other farm structures may have dusts, molds, and other substances that are respiratory hazards. Much of the animal feeding is done indoors, and these substances often come from feeds like hay, silage, grain, or ground feed. Animal dander and particles from dried manure can also be in the atmosphere. Bedding materials such as straw or sawdust may put particles into the atmosphere, particularly during handling and spreading.

Noise

Noise can be a problem in some farm buildings. This is particularly a problem in hog confinement buildings, where the hogs themselves, and the clatter of lids on metal feeders, can be quite loud.

Hazards of Confined Spaces

A "confined space" is defined by OSHA (Occupational Safety and Health Administration) as a space which is (1) large enough and configured such that a person can enter and perform work; (2) has limited or restricted means of entry or exit; and (3) is not designed for continuous human occupancy. A "permit-required" confined space, under OSHA regulations, is one that either contains or has the potential to contain a hazardous atmosphere; contains a material that can engulf a person entering; has an internal configuration that could trap a person; or has any other serious safety or health hazard[12].

Even though the OSHA confined space standard does not legally apply to agriculture[12], there are several structures on farms that would be considered permit-required confined spaces: silos, manure storages, grain bins, and controlled-atmosphere storages for fruits and vegetables.

Tower silos

Tower silos, sometimes called upright silos, are quite common on dairy farms. Chopped plant material (also known as forage; typically corn plants, alfalfa, other legumes, or grasses) is put into silos for fermentation, which makes it an excellent cattle feed that can be stored a year or more.

There are two types of tower silos: conventional silos, which are not sealed from the outside air, and oxygen-limiting silos, which are sealed from the outside air. In a conventional silo, air is present at the surface of the silage, and will cause several inches of silage to spoil unless a certain amount is fed each day. Conventional silos, which are much more common, are typically made of concrete staves (thin rectangular concrete blocks), while oxygen-limiting silos may be made of glass-lined steel or concrete staves. Tower silos may be 10 to 30 feet in diameter and 25 to 100+ feet in height.

During the fermentation process a mixture of gases is produced, commonly known as "silo gas. " The principal component of silo gas is nitrogen dioxide, created when nitrates from the crop mix with the oxygen in the air in the silo. When inhaled, nitrogen dioxide mixes with moisture in the respiratory tract to form nitric acid, severely damaging the throat and lungs. In addition, because silo gas is heavier than air, it displaces oxygen, and thus there might not be adequate oxygen to survive should a person collapse down into the silo gas. Furthermore, a sudden exposure to silo gas may cause a person on the ladder inside the silo chute, who might be opening a door into the silo, to lose his/her grip and fall all the way down the chute, resulting in serious or fatal injuries.

Because fermentation only takes place up to three weeks after forage is placed in the silo, the potential for silo gas is temporary, and farmers are advised to stay out of the silo during those first three weeks[13]. Prior to first entry, the forage blower (a fan-like machine used to throw/blow the silage up into the silo) should be run for 20-30 minutes to supply fresh air and blow any lingering gases away.

Conventional silos have a silo unloader located at the surface of the silage, either suspended by a cable or riding on the surface. Risk of entanglement with the silo unloader exists if a person is in the silo during operation. For example, they may be present to troubleshoot it, adjust or repair it, or to push it along through frozen silage. Controls are available which allow a person to safely operate a silo unloader for short periods of time while in the silo, such as for troubleshooting.

Because oxygen-limiting silos contain little if any oxygen, little or no spoilage occurs. Some silo gas may be produced initially, until the oxygen in the silo is used up. However, lack of oxygen is the major hazard and will be fatal upon entry. These silos unload from the bottom and do not require entry for normal operation. Such a silo must always be ventilated prior to entry unless a supplied-air respirator is used.

Bunker silos and silage piles

More and more farms are using bunker silos or silage piles, in an effort to store large amounts of silage and be able to unload large amounts quickly. These are not confined spaces, but have hazards and are discussed here along with other types of silos. A bunker silo is essentially a three-walled open area on concrete or a similar surface. Forage is piled up inside the bunker, packed down, and allowed to ferment into silage. Some farmers just pile forage on a concrete pad without any sidewalls at all, and these are called silo piles. Either way, the forage is packed by driving a tractor over it repeatedly during the filling process, which is necessary to force air out of the forage and allow proper fermentation without spoilage. Silo gas may be produced, but is not confined and disperses.

Bunkers and silage piles can be quite high, 16 feet or more, depending on the height of the sidewalls and how high the farmer chooses to go. The silage is typically covered with plastic to seal the surface from air and rain, with old tires being placed on the plastic to hold it in place.

To remove silage, a front-end loader is used to scrape and knock down silage from the edge of the pile, known as the face. An essentially sheer wall is formed that is somewhat stable because the forage was packed so tightly. However, if this wall is undercut during the removal process, or is gouged out, it can collapse. Depending on the size of the collapse, it could bury the person operating the loader or anyone standing too near the face, resulting in suffocation. Also, during a collapse, anyone who is on top of the pile at the face, such as to pull back the plastic covering, could be injured from the fall or be buried in the silage.

Silage bags

Silage bags are another method of making and storing silage, but are not confined spaces. They are long white plastic bags, six to ten feet in diameter and up to 300 feet long, into which forage is packed by a silage-bagging machine, somewhat like stuffing a sausage casing. The bag is sealed to allow fermentation and prevent spoilage.

The primary hazard of silo bags is the potential for entanglement in the bagger. Silage baggers are PTO-driven or engine-driven machines with moving parts like other farm machines. Silo gas may be produced, but is normally not a problem if allowed to disperse, although it could collect between bags closely paralleling each other if there are no breezes. The bag is opened and unloaded with a front-end loader, typically a skid-steer loader, and then closed until next use. The plastic may become entangled in the loader if not removed.

Manure storages

Many livestock producers have switched from handling manure as a solid to handling it as a liquid or slurry. This is done with structures that collect both liquid and solid waste. Swine producers were the first livestock producers to widely adopt this practice, and more recently many dairy farmers are following suit, particularly on the larger farms.

Manure storages are hazardous because manure releases several gases during decomposition. The four primary gases released are hydrogen sulfide, carbon dioxide, ammonia, and methane. Hydrogen sulfide is highly toxic and also heavier than air, so it displaces oxygen. Carbon dioxide is not toxic, but is heavier than air and displaces oxygen. Ammonia is primarily an irritant, although hazardous in high concentrations, and is lighter than air. Methane is explosive at certain concentrations, and is lighter than air. Lighter-than-air gases will tend to disperse, but could be trapped by the structure.

People have been overcome and died from these gases. Upon entering a manure storage where the gases are confined, a person can either be poisoned by the hydrogen sulfide, or asphyxiate from lack of oxygen. They may even pass out and drown in the liquid manure instead of dying from the gases directly.

Prior to pumping out a manure storage, the operator must agitate the manure to suspend the solids, and this process can take several hours, particularly if the manure has been in the storage for a long time, or if the manure must be agitated at several locations. Large amounts of gas are released during agitation, and this is considered the most dangerous period.

Below-ground manure pits

One type of liquid manure storage is a concrete pit, up to 12 feet deep, located beneath a barn or livestock building with a slatted floor. A slatted floor is basically a concrete floor with many slots that allow the urine and feces to fall into the pit below, or be pushed down by animal hooves. The pit may hold many months of manure, and is pumped out when the weather is suitable and the farmer's workload permits. Prior to pumping, the manure must be agitated to suspend the solids, and as indicated earlier, this is the time of greatest release of gases. Livestock remaining inside the building during agitation can die. This type of storage confines the gases, at least those that are heavier than air, unless thoroughly mechanically ventilated.

Another type of storage involves use of a relatively small below-ground transfer pit and a larger outdoor storage. In this system, manure is scraped or conveyed into the transfer pit, typically located at the end of the building, where it is held for several hours or days. It is then agitated and pumped, or flows by gravity, to the outdoor storage. As in pits located beneath slatted floors, the atmosphere in transfer pits is confined unless thoroughly ventilated.

Entering a manure pit at any time is considered very hazardous, and is not recommended unless either the atmosphere has been tested and shown safe, or a self-contained breathing apparatus (SCBA) is used, such as that worn by fire fighters. However, conditions inside a manure pit can be highly variable, depending on temperature, ventilation, and probably other factors. Some farmers have entered manure pits without incident, creating a false sense of security. Because of this, there have been cases of farmers dying in pits they had entered before.

Multiple fatalities have occurred in manure pits. The typical scenario involves a farmer or farm worker entering a pit, passing out, being followed by one or more would-be rescuers, and two or more people die. Perhaps the worst single incident involving multiple farm fatalities in the United States involved a manure pit, occurring in 1989 on a dairy farm in the upper peninsula of Michigan. A farm worker entered a transfer pit after it had been agitated and pumped out. He passed out, and was ultimately followed by five other workers and family members making rescue attempts. The first worker and four of the rescuers died; one person survived.

Outdoor manure storages

Outdoor manure storages are open and would not be considered confined spaces, but still have hazards. The most common type of outdoor storage is an open, earthen storage, like a lagoon or pond, although some are made of concrete. The manure is pumped, scraped, or flows by gravity into the storage, either directly from the barn or feedlot, or from a transfer pit. These storages can hold many months of manure, and require agitation before being pumped out, although in warm climates actual digestion of solids can occur. A crust typically forms on the surface of an outdoor manure storage, particularly those holding cattle manure, and sometimes the crust will even have vegetation growing on it. The crust may look deceptively solid until an animal or person tries to walk on it. Open storages should always be fenced to prevent potential drowning.

Another type of outdoor storage is a large, above-ground metal or concrete tank, open on top. The liquid manure is pumped through a pipe beneath the tank and enters at the center of the bottom of the tank, with a check valve to prevent backflow into the pipe. As with the earthen storage, these tanks can store many months of manure, and must be agitated prior to pumping. Although they are open to the air, the heavier-than-air gases could collect at the manure surface on calm, hot days when there is no wind to provide ventilation, and thus should still be considered hazardous.

Grain bins

Grain bins are cylindrical, corrugated metal bins with peaked roofs, used to store free-flowing grains or seeds, like corn, wheat, soybeans, and other similar crops. Bins normally found on farms may range in size from a bin 15 feet in diameter and 15 feet tall, holding 1800 bushels of grain, to a bin 60 feet in diameter and 60 feet tall, holding 115,000 bushels. Bins found in commercial facilities may be as large as 105 feet in diameter and hold 680,000 bushels.

These bins are unloaded from the bottom, typically having an opening in the floor with an auger beneath. When the auger is switched on, it pulls grain from the opening, and more grain flows by gravity down through the opening into the auger. Some smaller bins with sloped, funnel-shaped bottoms are elevated on legs and can empty by gravity alone.

These bins are not sealed and do not generally have a hazardous atmosphere (the two exceptions are discussed below). The hazard comes from the free-flowing grain as it travels down to the opening in the floor. When a container of free-flowing particles is emptied from a central opening at the bottom, whether grain in a bin or sand in an hourglass, a flow pattern is created in which the particles flow both downward and toward the center, and once reaching the center, flow straight down to the opening. This results in a downward-moving central column of material. The top surface of the mass of material looks like a downward-pointing cone. Particles or anything else (such as a person) at the top of this column will soon be carried down to the opening. If a person enters the bin while the unloading auger is running, or is on the surface of the grain when the auger is turned on, he or she will be pulled into this flow pattern, downward and toward the center, and can become completely submerged in 20 seconds or less. The person will continue down to the floor of the bin as long as the auger is in operation. Suffocation almost always occurs.

Another way a person can become submerged in a grain bin involves a grain cave-in. When grain is stored in poor condition (typically at too high a moisture level), a crust will typically form on the surface. If some grain is unloaded, the crust may remain intact, and give the appearance that no grain has been removed, when in fact there is a hollow cavity beneath the surface. If a person enters the bin to break up the crust, they will fall through the crust into the cavity, breaking up the crust and causing the grain to cave in around them, submerging them. Crusts should be broken up from outside the bin if possible, using a long pole, although the best prevention is maintaining the grain at proper moisture levels to prevent crusting.

Grain in poor condition can also cling to the wall of the bin and form a crust there. After a bin is unloaded, a person entering and poking this crusted grain from below can cause an avalanche and be buried. Removing grain in this situation must be done with great care, generally from above. Again, the best prevention is maintaining proper moisture content to prevent crusting.

There are two situations in which the atmosphere of a corrugated metal grain bin can become hazardous. First, if grain becomes infested with insects, it must be fumigated. The atmosphere of a fumigated bin is toxic for some period of time. Second, corn stored at very high moisture contents will ferment and give off carbon dioxide. In rare cases enough is formed to displaces the oxygen in the bin.

In addition, some oxygen-limiting silos, described earlier, are used for storing high-moisture grain for cattle feed. They are use because they are sealed from the atmosphere, thus preventing spoilage. Because the atmosphere is oxygen-deficient, the silo must be completely ventilated prior to entry.

Controlled atmosphere storages for fruits and vegetables

Some fruits and vegetables, such as apples, are stored in controlled atmospheres to extend life. These environments typically have very little oxygen, to retard respiration and ripening. Other gases may be added for particular crops. The temperatures are also reduced. These atmospheres must always be monitored and completely ventilated prior to entry, or asphyxiation from lack of oxygen will result. Refrigeration equipment that uses anhydrous ammonia could potentially develop a leak, and anhydrous ammonia at high concentrations can be fatal.

Hazards of Shops, Maintenance, and Related Tasks

Many farmers perform their own maintenance and repairs, not only on their machinery, but on structures and other systems as well. Some farmers build their own buildings or do their own machinery installation. Because these tasks are relatively infrequent, most farmers do not invest in the specialized tools, equipment or facilities used by dealers or contractors who perform these tasks on a daily basis. This lack of specialized tools, equipment or facilities can make jobs much more hazardous.

An example of this is the need to lift and support a machine during repair. Farmers have been seriously injured or killed after an inadequately supported tractor or machine fell on them. Machinery dealerships will have specialized hoists, jacks, stands, and other tools needed to remove heavy tires and wheels, do major engine and transmission repair, or otherwise support heavy machines and components. A farmer might use a simple hydraulic bottle jack and wooden blocks instead. Changing a tire or working under a machine in the field, on soft or uneven ground, may involve a precariously balanced machine if it is improperly supported on a jack rather than with a mobile hoist or other such tools.

Another example is the need to work at heights, doing such things as constructing, painting or repairing buildings, or doing roofing work. Instead of scaffolding, lifts, or other devices for safely working at heights, a farmer might use a ladder placed in the back of a truck or in the bucket of a front-end loader, to give the ladder higher reach. Lacking specialized rigging for fall protection on a roof, the farmer will just go without it and accept the risk.

Performing machine repairs or adjustments often requires reaching into a machine. An injury can occur if a machine component rotates, drops, or otherwise moves. Sometimes a person will move or turn something without knowing another part of the machine will also move and cause injury. Lacking specialized training as well as specialized tools, or perhaps having someone help who is unaware of the potential for injury, farmers may be inadvertently injured in this way.

Ordinary shop tools such as drills, grinders, saws, welders, and others all have hazards that can cause injury. Proper guarding and setup of blades, grinding wheels, tool guides, and material clamps is necessary. More importantly, the proper personal protective equipment, such as safety glasses or goggles, work gloves, steel-toed shoes, etc., is necessary. Use of electrically-operated tools in wet places poses the risk of electrocution if ground-fault circuit interrupters are not used.

Seemingly routine work, such as drilling into a machine frame to add a bracket, can sometimes result in unexpected injury. Although quite rare, there have been several reports of farmers injured while drilling into sealed tubular frames of some tillage implements. To increase the weight of the implement, and thus improve ground penetration, ballast is often added inside the frames, and in these particular implements the ballast was scrap steel stampings. Oils on the stampings volatilized and built up pressurized gases inside the frames, exploding into flames when the drill penetrated the tubular frame.

Running a tractor or vehicle engine inside the shop is widely known to cause carbon monoxide poisoning. Lesser known, however, is the hazard of running a small gasoline engine indoors, even with the windows open, which can also result in carbon monoxide poisoning. An example would be a farmer using an engine-powered high-pressure washer to clean the interior of a hog building. Proper forced ventilation, or preferably running the engine outdoors, is required. Proper ventilation must also be provided where combustion-type (non-electrical) space heaters are used, to prevent carbon monoxide poisoning.

Sometimes farmers need to bury pipes for water or liquid manure. Burying pipes can sometimes require fairly deep trenches, and trenches can collapse. Contractors who normally perform such work have proper equipment for digging trenches, laying pipe, and preventing collapse when workers are down in the trench. Lacking such equipment, farmers may take unnecessary risks digging and entering trenches, and deaths have been reported from trench collapses.

Some farmers cut or push down trees to clear fields, cut pulpwood for sale, or cut firewood for home or sale. This involves felling trees with chainsaws or pushing them over with tractors or bulldozers, and then skidding (dragging) logs out of the woods to clearings. These tasks all carry risk of serious or fatal injury.

Felling trees with chainsaws requires knowledge of techniques necessary to prevent two types of injury: injury from the saw, and injury from the falling tree, its limbs, or the trunks and limbs of nearby trees that may be hit. Both types of injury can be fatal. Personal protective equipment is needed for hearing protection, eye protection, and protection against cuts.

Pushing down trees with a tractor or bulldozer not only requires knowledge of proper technique, but also requires a tractor or bulldozer with a FOPS (Falling Object Protective Structure) to protect the operator in case the tree or its limbs land on the machine. The machine should also have a protective cage around the operator to prevent intrusion by limbs that may fly or whip toward the machine. FOPS and protective screens are found on machines used by loggers, but not on farm tractors. Skidding logs is done professionally with log skidders, heavy tractor-like machines with winches or hoists specifically designed for the job. However, many farmers will use a farm tractor and chain attached to the log. Sometimes with older and lighter tractors they will attach the chain higher up on the tractor, above the drawbar, to gain extra traction. Tractor rollovers have occurred when the log being skidded hit a stump or other obstacle; the force, combined with the extra leverage provided by the high-hitched chain, caused the tractor to overturn to the rear.

Hazards of Farm Animals

Farm animals can injure those who work with them, either by intentional attack or through inadvertent contact. They are the leading agent of nonfatal farm injury in Wisconsin. Wisconsin's large dairy industry alone involves many people having close contact with many cows (1.33 million milk cows[14]), so the potential for injury is great.

Cows

Cows are normally docile animals, particularly those with regular human contact. Most injuries involving cows come from being unintentionally stepped on. As a typical cow weighs 900 – 1500 lbs. (Holsteins closer to 1500 lbs., Jerseys 900-1000 lbs.), a hoof coming down on a shoe or boot will hurt. A cow may step sideways and unintentionally push someone into a wall or the side of a stall, causing injury. A cow can slip and fall on someone. Some cows are more nervous than others and more prone to kick, which can be painful and break bones. However, a cow's kicking motion is limited and not likely to cause life-threatening injury, unlike a horse, which kicks far to the rear with lethal force.

A cow can intentionally cause injury. Cows and other female animals will defend their young, and a cow with a newborn calf will attack if she feels the calf is threatened. With their weight and surprising quickness, they are capable of inflicting crushing blows, pushing a person against a wall or into the ground, or trampling them. However, in spite of the large numbers of cows on Wisconsin farms, attacks by cows are rare and seldom fatal. Heifers (females yet to have a calf) can sometimes be nervous animals and may kick or butt. One seven-year-old child was killed when a heifer tried to escape a pen and hit the child hard in the chest. In general, however, the risk of serious or life-threatening injury from cows and heifers is relatively low.

Bulls

Bulls can be extremely dangerous, particularly those of the dairy breeds (the primary dairy breed in Wisconsin is the Holstein; the other breeds are the Jersey, Guernsey, Brown Swiss, Ayrshire, and Milking Shorthorn.) They are large; a mature Holstein bull will weigh 2000 - 2500 pounds, and even a Jersey bull, the smallest of the dairy breeds, will weigh 1500 pounds. They have a head and neck structure that allows them to fight each other. They are also surprisingly quick. These characteristics mean they can charge with incredible power, and can literally smash a person repeatedly against a building or against the ground. They can toss a person up into the air, and they can trample them. Bull attacks often result in fatal crushing injuries to the chest and other parts of the body.

Bulls by nature compete for dominance, normally with other bulls if two or more are together. However, a bull raised by a human will consider the human to be dominant, at least initially. At about two years of age, dairy bulls begin a metamorphosis that makes them much more likely to challenge a human for dominance, particularly if the bull has been raised alone and not in a group of bulls. A challenge to a human for dominance often comes without warning; many farmers have been attacked by bulls that had not given them trouble in the past. This does not mean that younger bulls will not attack, nor does it mean that all older bulls will attack. It just means that bulls are unpredictable, should be treated as dangerous animals that cannot be trusted, and generally should not be kept past two years of age.

Widespread adoption of artificial insemination (AI) of dairy cattle, using semen being purchased from breeding services that kept many bulls, started in the 1940's. This decreased the need for, and presence of, bulls on dairy farms. Although data are not available, the number of bulls on dairy farms seems to be increasing, as farmers try to cut costs and also use them as "cleanup" bulls. A cleanup bull is used with a cow that has difficulty becoming pregnant through AI; after one or more attempts the farmer puts the cow with the bull. Also, use of AI requires time observing the herd to identify cows coming into heat. Some larger dairy farms, and some graziers (farmers who have their cattle out on pasture instead of feeding them in confinement), use bulls instead of taking time to watch the cows.

Other animals

Other farm animals can cause injury. Hogs can bite, especially sows protecting their young, and boars with tusks can cause serious slashing injuries. Most boars have their tusks removed. Horses can bite, kick with lethal force, throw their riders, or fall and roll on their rider. Sheep, particularly rams, can butt and cause injury. Most farms have dogs, and like any dogs, can be territorial and can bite.

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