One industry in the United States that many people take for granted is the farming industry. Agriculture and agriculture-related industries contributed $75.8 billion to the U.S. Gross Domestic Product in 2012, a 4.8 percent share. Of that amount, American farms contributed $166.9 billion, or about 1 percent. That translates into 16.5 million full- and part-time jobs, accounting for about 9.2 percent of total U.S. employment. More than 2.6 million of those jobs are directly connected to U.S. farms.

Why all the stats? Agricultural deaths in 2012 totaled 475, making the death rate 21.2 per 100,000 full-time workers. And to make matters worse, in 2013, the number of deaths climbed to 479 and the rate increased to 22.2 deaths per 100,000 workers. These numbers shouldn’t be accepted by anyone.

Having spent time on farms, I have seen several unsafe acts involving different age groups. On family farms, the “young ones” are always helping out, from driving tractors and combines to working closely with the animals.

Of the many safety hazards that exist on a farm, the atmospheric hazards often go unaccounted for or are simply forgotten. This is due to either lack of caring or just being unaware of the potential gas hazards on a farm. Because of this, an increasing number of farmers and their family members are dying from gas exposures.

Areas in a farm that should be of concern are silos, outbuildings, barns, and manure pits. The most hazardous of these locations, by far, is manure pits. Some of the gases that can be found on a farm are hydrogen sulfide (H₂S), nitrogen dioxide (NO₂), methane (CH₄), chlorine (Cl₂), and ammonia (NH₃). In addition to these hazardous gases, another threat is the depletion of oxygen (O₂), which is a very common problem. The areas where these gases appear on a farm’s property are numerous. For example, ammonia is used as a fertilizer, while nitrogen dioxide can be found when corn and other crops along with silage are stored in silos, while methane and hydrogen sulfide are present in manure pits. The list goes on.

**Manure Pit Gas Hazards**

As mentioned, the most hazardous area on a farm is the manure pit. Look at any fatality report regarding farming, and you’ll see that the manure pit generally gets top billing as one of the most dangerous locations. Why are manure pits so dangerous? A typical dairy cow that produces approximately 2,000 gallons of milk per year also produces more than 7,000 gallons of liquid manure. The manure requires storing and overall managing by the farmers.

The Agricultural and Biological Engineering group of Penn State University is currently conducting a research project on hydrogen sulfide releases from manure pits, with a focus on farms using gypsum products as bedding for dairy cows.

Before gypsum was introduced to the dairy industry, there needed to be an understanding of the working of the manure pits and the dangers associated with them. The cow manure is moved from the barn into the manure pit. The first layer of manure is covered with bedding, which is then covered with a second layer of manure. This process is repeated until the pit is full. When the pit is full, it is sealed with a layer of dirt to prevent the gases from escaping.

Gypsum is a natural mineral that is mined and processed to remove impurities. It is then used as an agricultural product, primarily as a soil amendment. Gypsum has several beneficial properties, including:

- Improving soil structure
- Increasing water retention
- Stabilizing soil pH
- Providing nutrients to the soil

Gypsum is also used as a soil amendment in agriculture. It helps to improve soil structure and water retention, which can lead to better crop yields. Gypsum is also used to control soil pH, which can help to improve the growth of certain crops.

Gypsum is applied to the soil in the form of a powder, which is then worked into the soil with a plow or a tiller. The amount of gypsum needed depends on the specific needs of the soil and the crop being grown. Gypsum is generally applied at rates of 50 to 100 pounds per acre, but the exact amount needed may vary depending on the specific soil and crop conditions.

Gypsum is a natural, safe, and effective soil amendment that can help to improve soil structure and water retention, which can lead to better crop yields. It is also used to control soil pH, which can help to improve the growth of certain crops. Gypsum is a valuable agricultural product, and its use can help to improve the sustainability of agriculture.
a manure pit either by a built-in conveyor system or manually by the farmer, depending on the size of the dairy operation. For example, one farm included in the research study has 275 dairy cows and a 1 million-gallon manure pit. The pit is emptied twice a year, with the manure spread over the fields for fertilizer. Typically this is done in late fall after the crops have been harvested and then again in the spring before the crops are planted.

This long storage time of the manure allows it to go anaerobic (without oxygen) and allows the bacterial action to produce hydrogen sulfide. Sometimes a “crust” forms on the top of the manure, acting as a lid trapping the gases. The danger occurs when the farmer needs to “stir” the manure pit to prepare for the disposal or spreading of the manure. The stirring releases the hydrogen sulfide, along with any methane. The presence of these gases also can contribute to low-oxygen atmospheres. There are numerous accidents on record of farmers and members of their families who have been overcome by these deadly gases.

While gypsum benefits the welfare of cows, it increases the presence of hydrogen sulfide. Gypsum is a sulfur-based ore. Also known as calcium sulfate, CaSO₄, it provides a sulfate source within the manure storage that reduces to form H₂S. The Penn State research is focused on the use of gypsum as bedding and its contribution to the increased levels of H₂S. When farms using gypsum were studied, H₂S was detected at life-threatening levels.

OSHA has a PEL of 20 ppm that is stated as the ceiling level, with an Immediately Dangerous to Life or Health level of 100 ppm. When the manure pits containing gypsum were stirred, levels as high as 500 ppm were encountered. A breath or two at these levels could have serious effects on a farmer, including respiratory distress and/or unconsciousness, potentially leading that farmer to fall into the manure pit. This could lead to higher gas exposures, asphyxiation, and even drowning.

One farm visited during the study experienced a very close call related to the safety of the family’s two young boys. Playing slightly downhill from the manure pit one day during a stirring process, the boys were observed by their father to be lying next to their bikes. Thinking the boys were just playing, he continued his work. A short time elapsed and he noticed the boys were in the same position. They had been overcome by hydrogen sulfide. He immediately attended to the boys and was able to revive them. No long-term damage occurred, but the younger boy was kept overnight at the hospital for observation.

There must be ongoing education of farmers, their families, and hired hands on these gas dangers on farm properties. Mike Platek is a Gas Detection Specialist at Industrial Scientific Corporation.

Mike Platek is a Gas Detection Specialist at Industrial Scientific Corporation.

**REFERENCES**

2. Centers for Disease Control (CDC) NIOSH Publication NIOSHTIC-2
3. Occupational Safety & Health Administration (OSHA); NEWS Release: 13-1921-NAT (234)