

## Silo fires-protect your investment

By Davis E. Hill, program director  
Managing Agricultural Emergencies Program  
Department of Agricultural & Biological Engineering  
Penn State University

You prepare the land; purchase the seed and fertilizer; plant the crop; manage the pests; nurture that crop throughout the season; harvest when the crop matures and/or when the weather allows. All in all, a tremendous investment in time and materials goes into your cropping program. If all is right, the investment you make in putting the crop in the silo is less than what you would spend if purchasing the crop from someone else.

This investment is going to enable you to feed your livestock economically into the next year. If all is well with your silage production and storage, your bottom line will be better off than if you have to purchase feed from an outside source. Sometimes however, harvest conditions are less than ideal, and material is put into the silo drier than it should. When this happens, excessive heating can occur which could lead to a spontaneous combustion fire.

When a silo catches on fire, a farm operator can lose a tremendous investment and be faced with an unmanageable cost to replace ruined feed. Let's say you have 20' x 60' silo that has 400 tons of corn silage in it. If you had to purchase that 400 tons of feed, it would cost you nearly \$20,000 (\$50 per ton). Good hay crop silage would be considerably more.

The goal to managing a fire inside this silo has to be in locating the fire area and controlling that area without affecting the rest of the material. Better to lose a few tons than a few hundred tons. This is not an easy task but not an impossible one either. The earlier you can detect a fire, the easier it becomes to control so it is important to regularly monitor your silos for a good three weeks post harvest. This is a critical time when natural fermentation and heating is taking place inside the silo.

Internal combustion of silage material occurs when the silage is put in too dry for the silo. In order for anything to burn, you need three ingredients: a heat source; air; and fuel. With silage, the heat source is the heat generated by the material going through the fermentation process. This is naturally occurring and happens with any material being stored. With proper moisture, the moisture helps keep the heating of the material from getting too hot.

For the air part, air is trapped in the chopped forage during harvest and blowing the material into the silo. Obviously, the drier the material, the more air that will be trapped. The wetter the material, the less air that will be trapped.

The fuel is the forage material itself. Generally this is not a good source of fuel from a burning standpoint because even material that is too dry for good silage is too wet to burn quickly. This is a good thing to keep in mind when beginning to manage a silo fire. Taking out any one of the ingredients will put out the fire. This is the goal of fighting a silo fire.

Besides material going into the silo too dry, another common cause of spontaneous combustion is when new silage is put on top of old silage, especially if the old silage has not been removed (fed out for several weeks). This old silage can be quite dry. Remember, the dryer the material, the more air that can be trapped in that material.

When fresh material is put on this older material, the natural heating that the new material will go through could be too hot at this location. This would be the first place to look if a fire does occur. Likewise, if you know that

some of the material you are blowing into the silo is drier than ideal, you might make a mental note of where in the silo that might be placed.

Another less common way fires can start in a silo is from the outside. The most common causes of these external heat sources is a fire starting in the chute from either a shorting out electrical wire or from an adjacent barn fire. Both causes results in dried material in the chute catching on fire and then burning through one or more wooden silo doors. Once the fire burns through the doors, the material inside the silo can begin to smolder and burn.

Another less common way that a silo fire can occur is from exposure of the silo to the direct heat of a barn fire. Tremendous heat is generated from a barn fire and if that heat is allowed to be exposed to the side of the silo long enough, the heat will transfer into the silage and cause it to ignite. There is often not much that can be done to prevent this situation. By the time a fire company arrives to fight a barn fire, resources are very limited to worry about keeping a silo cool. Once a silo is heated, it is best to keep water away from it.

A silo fire is usually discovered when someone sees smoke coming from the top of the silo or the smell of something burning is evident. The initial decisions made can mean the difference between salvaging a viable crop or ruining it. First off realize that silage does not make a good fuel source. Even silage that is too dry is most likely too wet to burn quickly.

A fire inside a stack of silage inside a silo does not have adequate air to burn aggressively. So this means don't panic. The fire is not going anywhere in a hurry. You have time to evaluate what you have and develop a plan of attack. The goal to controlling a fire in a silo is to remove one of the critical ingredients: (heat source, air, or fuel). Doing a thorough analysis of the situation is a critical first step.

First, what type of silo is this? Here we are talking about differentiating between an oxygen-limiting and conventional silo. You treat them differently in a fire situation. In an oxygen-limiting silo, you assure that there is no air going in to the structure and allow the fire to be smothered.

Once the smoldering fire consumes the residual air, the fire should burn out. This might take two to three weeks. If this does not work, you may need to inject a gas such as carbon dioxide or a liquid nitrogen into the silo. These gases will consume any oxygen that is trapped by the silage, which in turn will smother the fire.

A conventional silo is not meant to be airtight so you cannot effectively "smother" a fire by closing off air to the silo. Removing the air ingredient is not a good option with the conventional silo. The best method is finding the heat source and removing that. Flooding the silo with water will not achieve this mission. Too often, this is what some fire companies want to do. Never allow a fire company to arbitrarily flood your burning silo with water as their first extinguishing strategy.

All that will do is ruin the good feed that is not involved with the fire, and add more areas where additional heating will occur, possibly causing more fires in other locations in the silo. The more water that is put on the silage, the harder it will become to unload the silage with the silo unloader. Wet silage does not unload well through silo unloaders.

Looking up the chute should reveal whether the source of the fire might is the chute area. Before entering the chute, it would be wise to disconnect the power to the unloader at the circuit box. If the source of the fire is from an electrical short in that wire, there could still be stray electricity within the chute. Observe each door on the way up the chute. Be very careful when climbing the chute as stepping on the foothold of a door that is burned out from the inside can be extremely dangerous.

Feel each door with your hand before stepping on that foothold. A smoldering fire in the chute can create considerable smoke and might appear worse than it really is. It might be fairly easy to extinguish with a normal

garden hose if the fire has not progressed far. If silo doors are burned through, then a fire inside the silo has occurred and a fire company should be summoned.

It is more difficult locating a fire inside a silo. On rare occasions, you might be able to see flames or thick smoke coming from near the surface of the silage or through one of the doors. Normally the burning area will be below the surface and in the middle of the silo. If there are spaces around the doors or cracks or holes in the silo staves through which air can get in, these areas should also be suspect.

Locating hotter areas requires using some sort of instrumentation. An infrared heat gun can be effective at helping to locate areas on the outside of the silo that are warmer than other areas on the silo. The heat generated by a fire will transfer outward, so chances are the blocks will absorb the heat and will be warmer than blocks that are further away from the fire source. These devices can be effective at locating changes in temperature.

Most fire companies now have thermal imaging cameras. These devices can be very effective at locating hot spots in a silo. These tools are much more sophisticated than the infrared thermometers and are quite accurate from considerable distances. Calling the fire company to help size up the silo is a legitimate use of local resources.

Go all around the outside of the silo with the thermal imaging camera, scanning it slowly to be sure to locate all of the potential hot spots. Operators should draw a sketch of where the hot spots are on the silo so they will know where to begin efforts to cool the fire pockets. Once the outside of the silo is scanned, fire fighters should scan across the surface of the silage (from the loading door -- not physically inside the silo). This will tell how far across the silo and how deep they might need to probe.

Once the hot spots have been located, a strategy needs to be put in place. Remember, to put out any fire, you remove the heat source, the air or the fuel. Taking the air out of the formula is not going to be a good option in a conventional silo. There is just no good way to make most conventional silos air-tight.

So efforts need to concentrate on either removing the fuel source by unloading the silo to below the hot area, or probing into the hot area and cooling it down. This is done with a simple small diameter (3/8 or 1/2 inch pipe) hooked to a garden hose. Depending on the size of the hot pocket, only a small amount of water is needed (few hundred gallons possibly).

A hammer drill will drill through most concrete stave silos as well as most poured concrete silos. These holes can be easily repaired with concrete repair material. While probing and cooling, progress can be monitored with the thermal imaging camera. Fire fighters should see a marked reduction in temperature readings as the area is being cooled.

On some occasions, a silo fire has progressed to the point of very few extinguishing options. If not observed and monitored, a silo can burn for days and even weeks without being noticed. If several doors have been burned through or if you can see large flames and hollowed-out areas (like looking into a furnace), there may not be hope for salvaging the material inside the silo.

In these times, the options might be limited to letting the material burn (this could take several weeks to several months and may make for poor neighborhood relations) or flooding the structure with water and unloading the silo. On some occasions, silos have been torn down to extinguish the material. This is usually not a wise option if the silo will be needed for feed storage later.

Prevention is the key to avoiding silo fires. Make sure forage is being chopped at the correct moisture level for the structure that it is going in. Consider adding water if the material is too dry. Additives can be added to the forage that will keep the heating under control as well. Make sure your silo is checked on a regular basis for cracks in the walls and around doors. Silos should be resealed on the inside periodically to prevent the silage acids from deteriorating the concrete and creating holes to be penetrated by air and moisture.

If you have silos that are no longer in use, make sure they are empty. Many silo fires occur in abandoned silos with old silage in them. This material dries out and becomes a haven for rodents, that burrow through the silage material. These burrows serve as air shafts throughout the silo. With changing humidity, more heating will take place, causing potential fire conditions.

Normally silo unloaders that go unused for several years will not work, making unloading these structures difficult if not impossible.

Some fire companies around the state have been trained in silo fire extinguishment but many have not. There is an excellent printed resource, *Extinguishing Fires in Silos and Hay Mows*, NRAES-18, 2000 Revision, for fighting silo and hay mow fires. Not all fire companies know of or have this resource. Several technical experts are available throughout PA to help farmers and firefighters think through the many management strategies when dealing with silo fires. This emergency information can be found by calling 814-865-2808 during working hours or 814-404-5441 after hours.