AE-91

agricultural engineering

Temporary Corn Storage in Outdoor Piles

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Piling of shelled corn outdoors in either covered or exposed piles is strictly a temporary or emergency grain storage practice for most farmers and elevator operators. It is usually of interest in any year with a bumper crop, a rapid, short harvest that clogs marketing and transportation channels, or excessively wet incoming grain that markedly slows drying and receiving capacity.

Limited observations and discussions with farm and elevator operators experienced with piling dry and/or wet grain indicate various degrees of success. The risk of severe spoilage, especially over the exposed grain surface, can be high, with little opportunity to arrest the process, other than to remove the grain for either market or drying.

There are some elevator operators that pile grain outdoors almost every year with considerable success. They plan ahead, frequently invest in a well drained hard surface, possibly with some type of sidewall retainer, and install elevating and distributing equipment to build a uniform, steep sloped grain pile. They watch the grain condition closely, and remove the pile before any serious problems with heating or molding occur.

At best, piling grain outdoors is risky and should be approached with caution and serious planning. Elevator operators frequently have some advantage over a farm operator in piled storage, because: a) the piles are usually larger, thereby giving less surface to volume ratio; and b) they may be able to better control incoming grain conditions to the pile and to effectively market from the pile by blending with conventionally stored grain.

ALTERNATIVES IN EMERGENCY GRAIN STORAGE

The simplest alternative is to leave the corn in the field. This generally is not a viable alternative, since field losses increase rapidly with the onset of winter weather. Despite the substantial losses experienced by a few operators in 1971, less than one percent of the nearly two million bushels in outdoor piles were unsalable. Field losses of 10 times this amount are common for corn left in the field into the winter months.

Another alternative is to sell the grain on the market, or utilize commercial storage. Commercial storage space is frequently scarce in years of problem harvest because of the amount of grain requiring special handling. Where commercial storage space is available and workable, the use cost may be less than the losses suffered from storing corn out of doors.

There are several possibilities for emergency storage on the farm using structures not originally intended for grain storage. Extension leaflet AE-93 entitled "Adapting Silage Silos for Dry Grain Storage" is available on request for those in need of information on silo conversion for dry grain storage.

Ensiling grain in a pit, bunker, or upright silos may be a good answer if you are a livestock feeder. Such storage can be relatively low in cost and produce a highly palatable feed. Chemical grain preservatives should also be considered. Chemically treated corn, like that from ensiling, must be fed since its odor makes it unfit for marketing. Treated corn can be stored in most grain or shelter structures. Rodent and bird control must be considered. The chemicals commonly used, such as propionic acid, are mildly corrosive especially on galvanized surfaces. Chemical treated and ensiled grain does not have to be dried, an added plus for these methods.

Extension leaflet AE-92 entitled "Emergency Grain Storage in Existing Buildings" contains a complete discussion and specification for the use of shelter type building such as machinery storages and barn areas as emergency storage. Since these storages are not normally designed to withstand the pressures of piling grain against the sidewall, you are limited in the amount of grain that can be stored. Piled carefully, a triangular pile will have a height of about two feet at the center for every 10 feet of width (about 22 degree angle of repose) - see Figure 1. This is slightly less than a 1 to 2 slope. Thus, a pile 50 feet wide at the base will be about 10 feet high at the center, and will contain 200 bushels per foot of length. Sometimes the building strength will permit piling the grain 2 to 3 feet deep against the sidewall. With grain 2-½ feet deep on the sidewall, a building 50 feet wide will hold a total of 350 bushels per foot of length.

Narrow buildings, such as driveways of old barns can sometimes best be utilized by placing within them some type of container. The container achieves greater depths than is possible by piling grain on the floor. Sidewall rings from circular bins can be used as well as wiremesh cribbing with suitable lining, as long as they are placed on a sound floor and are protected from the weather. Rodent and bird control is frequently a serious problem in temporary and emergency storages.

GUIDELINES FOR STORING CORN OUTDOORS

If you have exhausted all the better possibilities of temporary farm and elevator storage and have decided to try piling grain outdoors, the following recommendations may contribute to your success.

1. **Store dry and cool corn in preference to wet or warm grain.** Dry corn (preferably 15 to 15-½ percent wet basis or below) cooled to a temperature of 50-60°F or below is safest for piling. The low moisture content and cold temperature reduces the rate of respiration of the grain and sharply diminishes mold, bacterial and insect activity. Piling cold dry grain can usually eliminate the need for aeration for the recommended maximum three month late fall to mid-January storage period. In exposed piles (no top cover), surface grain wetted by weather has a greater probability

of staying below moisture contents that can cause severe spoilage, than does grain stored initially wet.

2. **Provide a firm, well-drained base on which to build the pile.** Elevator operators who have been successful in storing grain outside usually list adequate drainage and a good base as prime requirements. Since some operators store grain outside on a more or less every year basis they can well afford to build a hard surfaced area, crowned slightly in the center, of perhaps concrete, blacktop, or compacted limestone, as a base for the grain pile. Incidentally, it is no accident that the pictures you see from the Great Plains area show wheat and grain sorghum piled in the street or around the courthouse square. A street is a good base for an outdoor grain pile. It is usually crowned in the center to shed water, and it has drains at the side to take water away from the pile and provides for any rain that goes down through the grain to drain to the outside of the pile.

   Compacted limestone or gravel can be used to form a base for the grain pile. If the base is compacted or otherwise stabilized on the surface, grain can be removed rather cleanly. The base can be covered with plastic or a screen such as hardware cloth, to keep stone and corn separated. However, these flexible surface covers may present grain removal problems by clogging equipment and/or contaminating grain with shredded material. If the base is not covered, the bottom layer of corn may get mixed with stone and have to be cleaned. The grain near the base should be removed carefully to avoid excessive mixing with base material.

3. **Build the pile carefully and uniformly.** To achieve a maximum slope on the side of the pile, the grain stream should not be permitted to drop more than a very short distance to the surface, particularly when the pile is topped off. A maximum angle of repose and pile height will be achieved if the grain is placed at the top of the pile and allowed to roll down the sides. One of the best ways to get an elongated triangular-shaped pile is to add the grain at one point until it piles to the required height, then use an open horizontal auger to elongate the pile. A means of supporting the auger in a horizontal position at the desired height is required. As the pile elongates the auger will form its own trough in the top grain.

   It is important to avoid hills, valleys, folds, and crevices that will collect water in small areas and funnel it down into the pile. Attempting to build the pile by dumping trucks along the side or using short augers or conveyors that will deposit the grain only part way up the pile, will give a very undesirable surface geometry and substantially increase the amount of water that will penetrate the grain.

4. **Stay off the pile after it is built.** Keep animals and children away. Climbing the side of a pile of grain will flatten the pile and reduce its

height. Foot prints will collect water and disturb any surface crust on the grain surface that tends to shed water.

5. **Do not try to cover the pile with plastic film.** Thin surface covers are usually not successful because of wind damage and moisture condensation directly under the plastic. Wind damage may be partially overcome by either a vacuum air system hold-down or possibly by covering 25 to 30 percent of the surface with old tires to stabilize the plastic. Tears, folds or laps in the plastic film may result in funneling rain and melted snow from a large surface area into one concentrated spot, almost sure to cause severe spoilage. Loss of power on a vacuum hold-down system is most apt to occur in a storm with high winds, resulting in loss of vacuum and failure of the corn.

   It is difficult to aerate a pile that is covered. The plastic film on suction or vacuum systems prevents any appreciable amount of air from entering the pile. Aeration is not effective.

6. **After starting a pile, complete it as quickly as possible.** If rain falls on the pile before it is completed, there will be a wet layer on the surface which will be covered when more grain is added. Unless there is provision for aerating the pile, placing additional grain over a wet layer should be delayed until the wet layer has dried or is removed.

7. **Remove the grain from the outdoor pile as soon as possible.** Most successful experiences in open piling of grain suggest that it not be left outdoors more than three months. Remove the grain by the middle of January. Obviously, the longer the pile is outdoors, the greater the weather exposure, and the greater the probability of significant losses. Remember that it may be most necessary to remove the pile for marketing when an extended period of wet, relatively warm weather prevails, risking severe spoilage. Place the pile where all-weather access is possible. Be aware that the ground under the pile will not freeze, which may influence choice of site and unloading period.

TO AERATE OR NOT TO AERATE

Many operators with experience of piling grain outdoors say the grain should be aerated. Corn up to 20 percent moisture content has been stored successfully in aerated piles in Nebraska. But the climate in Nebraska is usually dryer than it is in Indiana. In Indiana in 1971, there was a period of rainy, high humidity weather shortly after the grain was piled outdoors. In that year, aeration may have done more harm than good. On the other hand, aeration will dissipate any local hot spots and prevent their spread. Aeration will also keep wet grain cool and eventually reduce the moisture in wet spots.

Aeration is required if wet grain (up to 18 percent wet basis) is placed in the pile or the grain is warmer than 50 to 60°F. If dry grain can be piled outside after it has cooled to a temperature of 50 to 60°F, or below, there is a good chance that it can be stored without

aeration for up to 2 to 3 months in the late fall and winter, without serious spoilage. Remember that aeration of an outdoor pile will cost as much or maybe more than aeration of an equivalent amount of grain in a storage bin. Therefore, the more expense you add to an outdoor grain pile, the more the cost will approach conventional grain storage. Suggested aeration schemes for triangular- or conical-shaped piles of grain are given in Figure 1.

AERATION DESIGN FOR OUTDOOR PILES

(1) Provide one hp of fan power for each 20,000 bushels for piles up to 20 foot peak depth.

(2) Provide one fan hp per 10,000 bushels for peak depths up to 30 feet.

(3) Use a single duct in center of pile for peak depths to 10 feet.

(4) Use two ducts spaced a distance apart equal to the maximum grain depth for piles more than 10 feet peak deep. (See Figure 2.)

(5) Run perforated ducts under the grain to a point where they are the same distance from the end of the pile as they are from the sides.

(6) Connect perforated ducts to fans with solid (non-perforated) air supply pipes.

(7) Attach solid air supply pipe preferably at the center of each perforated duct or at one or both ends.

(8) Duct should have a cross section area of one square foot for each fan hp connected.

(9) Duct length should be at least 30 feet long to insure an ample amount of air inlet area to efficiently inject air into the grain pile.

(10) The fan should force air into duct and out through the grain.

SOME OTHER CONSIDERATIONS

An air support or "bubble" type structure may be a workable cover system with plastic films over small piles, or with special fabrics over large piles. A unique combination drying-aeration system is possible by exhausting the pressurized air under the bubble, downward through the grain and into aeration ducts that are tubed or vented to the outside. The air supported film acts as a shelter and as a solar collector, warming the air before it exhausts through the grain. The warmed air increases the drying potential, but also warms the grain, which will tend to increase spoilage.

Temporary storages can be constructed using a retaining ring, such as several courses of a round metal bin wall, or by constructing a bulk head or retaining wall, much as in a bunker silo. The pile may be the shape of a circular based cone, a pyramid, or a rectangular wedge. These more permanent structures are frequently equipped for a tie-down or suction cover of plastic, rubberized fabric, or canvas.

The problem with air support structures and other semi-permanent systems is one of economics. The annual use cost of these units may equal or exceed that of permanent storage. As the investment in such facilities increases, the need to use them every year increases, to reclaim the investment. Annual use forces a more critical evaluation in

comparison to conventional storage systems.

MOISTURE INCREASES FROM RAIN

Grain moisture increase from rain will depend on a number of factors, but mainly on how deep the pile of grain is and how well the pile is made. Moisture increases from rain are not as extensive as one would first think. A one-inch rain is sufficient to increase the moisture content 5 points (e.g., 15 to 20 percent) in a layer of corn approximately one foot deep, assuming all rain is absorbed. The depth the rain will penetrate into the grain depends on how rapidly it falls and how well the pile sheds water. The water will either be absorbed in the surface grain, run through the pile, or run off the slope. Thus, a one-inch rain will probably affect less than a one-foot depth over the entire pile. If the pile averages five feet deep (10 feet at the highest point) then the one-foot depth affected would be equivalent to 20 percent of the corn in the pile. On the other hand, if the pile averaged 20 feet deep over the entire width then the one-foot depth affected would constitute only 5 percent of the pile. This is the reason it is impractical to place small piles of grain outside exposed to rain.

If the initial rain on the pile comes slowly, most of the moisture will be absorbed in the surface layers of grain. A crust may form over the surface which will tend to help shed additional water from the pile.

It may be workable to separate moist grain from dry grain during the unloading process. The moist grain then may be dried to bring it down to desirable moistures for storage or marketing. Where the amount of moist grain is small, it will blend with the dry grain during the unloading process and drying will not be required.

A FINAL PRECAUTION AND WARNING

Conditions conducive to mold growth may develop in parts of the grain pile. If grain temperatures or moisture contents increase, molds are likely to develop. Under certain conditions molds may grow that produce aflatoxin, or other toxic substances, some of which are known to cause cancer in animals, and possibly in humans. Grain contaminated with mold toxins are subject to seizure by the Food and Drug Administration (FDA). If there is any evidence of substantial mold activity in the pile of grain, the affected grain should be separated and discarded. Precautions should be taken to assure that none of the grain from a pile containing mold toxins is marketed for use as human food.

A second word of caution: piling grain outdoors or in open, exposed piles in driveways, machinery storages, and barn areas exposes the grain to rodent and bird contamination. It also can bring about accidental exposure to manure, oil, fertilizer, insecticides, herbicides, and similar residues that might remain from previous alternate use of the area. One of the truly good things that has come about in grain storage, with the advent of shelled grain and predominately metal structures, has been the high quality of the storage system. We must not lose sight of this high performance standard in planning and using emergency and temporary storage techniques.

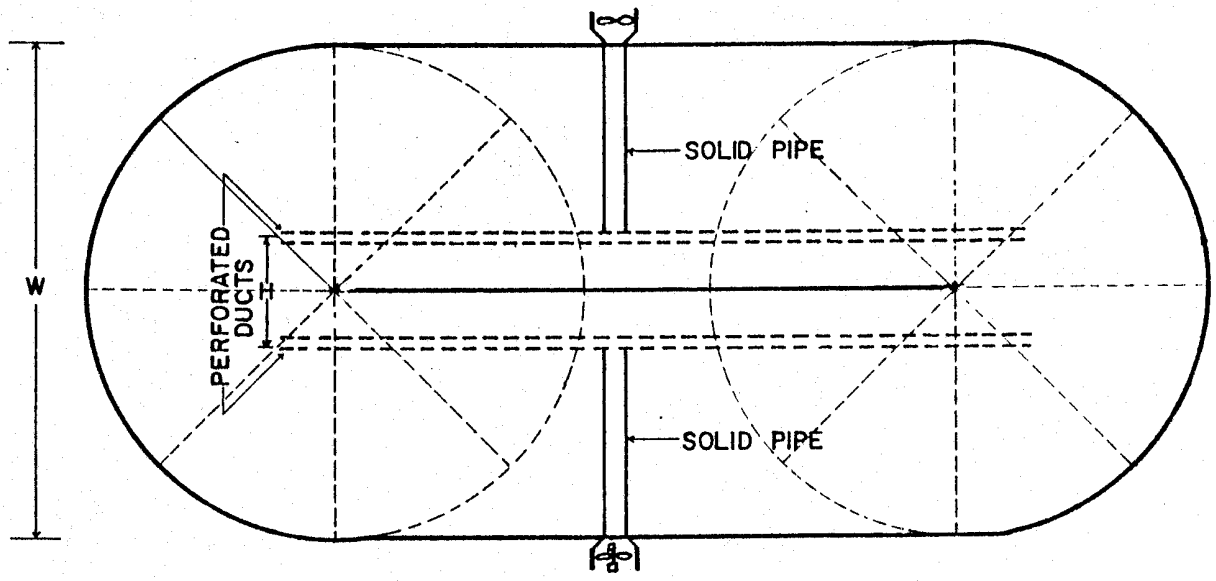

Figure 1. Grain pile schematic. Shape is based on a top center fill point. Side and end slopes depend on grain moisture and final fill drop. (See Figure 2.) Table 1 presents estimated storage capacities for selected base widths (W) and center sections (L).

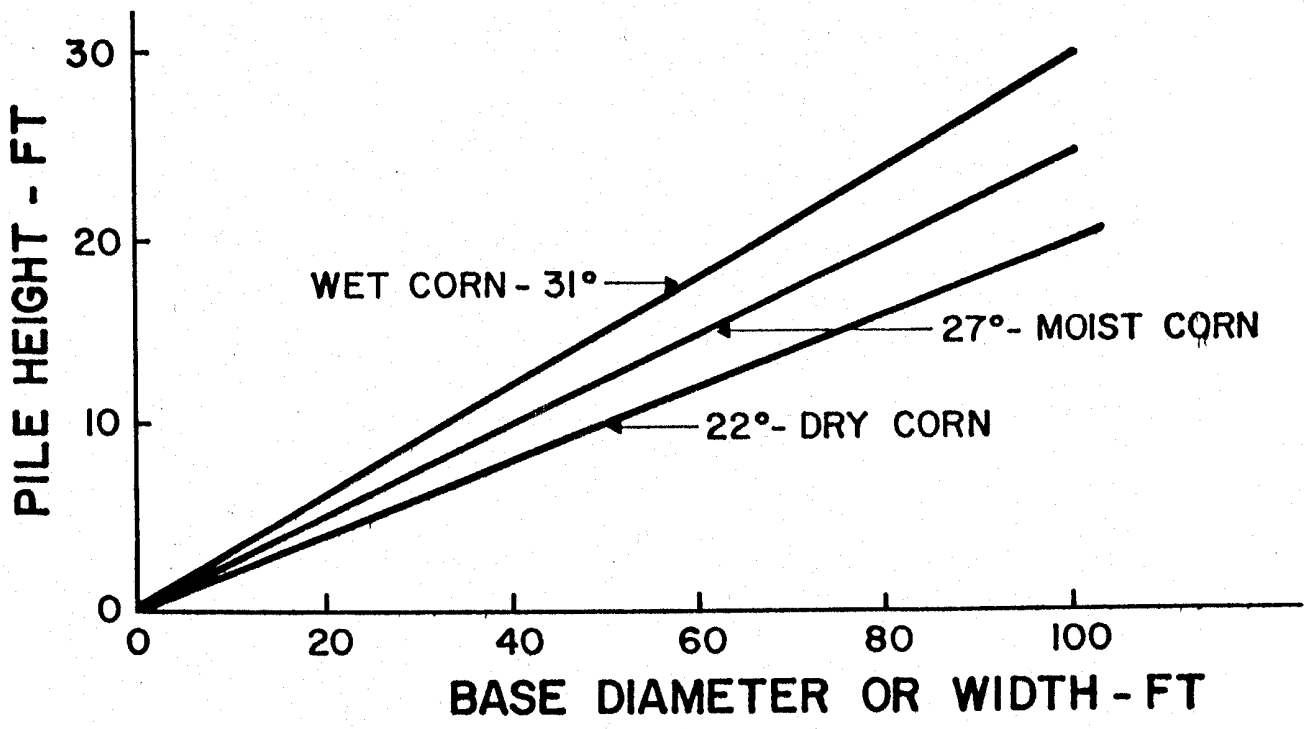

Figure 2. Increase in grain pile height with increased base diameter or width.

REVIEWED 1999 NEW 10/78