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Ground Pile Design and Management

Kenneth J. Hellevang, Ph.D., PE
NDSU Extension Service, Fargo, ND

The degree of success with outdoor grain piles results from variables which can be controlled, such as site preparation, storage design, use of aeration, and storage management, and some that cannot be controlled, such as weather. There is more risk of storage losses with ground piles than with storage bins, so ground piles should be considered short-term storage and must be monitored frequently.

Site Preparation

The first step is site selection. Select a naturally occurring high point on the elevator's property or at a site near the grain elevator. Run the pile north and south to allow the sun to dry off the sloping sides. Nearby trees aid wind protection but can also be a home for birds and might result in snow drifting on the pile.

During site selection, consider how big an area is required. Approximate pile heights, diameters, and volumes for wheat, soybeans, and corn are shown in Table 1 to assist with determining the area required. Also, consider that trucks need a diameter of about 130 feet to turn around.

Frequently, grain is piled outdoors by portable augers or belt conveyors, resulting in elongated triangular shaped piles. Burial of the conveyor or the under carriage may result in damage during movement, so overhead conveyors should be considered for deeper piles. Circular piles typically use stationary conveying equipment for placement and removal.

Preparation of the ground pad involves stabilizing the existing base by adding strength and decreasing permeability. Contractors with experience building roads are likely best equipped to perform this task. Pad preparation includes creating a crown at the center point of the pile and providing a gradual slope away from the center. Good drainage is provided with slopes of 1 to 2 percent. The area surrounding the pad should be well drained to remove water running off the pile and pad. One inch of precipitation on a 1-acre surface (100 x 435 ft.) results in 27,152 gallons of water.

Reduced water permeability of the pad can be accomplished by mixing lime, fly ash, or cement in the soil prior to compaction. Check fly ash prior to use to ensure the absence of heavy metals. The amount of compression necessary for a good pad should approach 98 percent of the standard proctor density. Another option is to place plastic (6 mil minimum) on the ground to keep soil moisture from wetting the grain. Assure that water drains away from the storage to reduce the wetting of soil under the pile.

Generally, a concrete or paved surface is used if the location will be used for several years.

Retaining Walls

Storage capacity is increased by using a retaining wall. Design and build the wall to support the force of the grain exerted on the wall. The force on a vertical wall is the grain equivalent fluid density multiplied by the grain depth. The equivalent fluid density for corn is 23 lb/cft.; for soybeans 21 lb/cft.; and for wheat 24 lb/cft. The force exerted at the base of a five feet tall wall holding corn is 115 lb/ft^2., 5 ft. x 23 lb/cft. The total force on the wall is calculated as the area of a triangle created by the force at the base multiplied by the wall height divided by two. For example, the total force on the five-foot wall is 288 lb per linear foot of wall, 115lb/ ft^2 x 5 ft. / 2.

Maintenance of a retaining wall includes examining the wall looking for anything out of alignment. Examine connections looking for separation or movement, check wall anchors, and look for deterioration of materials.

Grain Placement

Place only cool (less than 60 degrees Fahrenheit), dry, clean grain in outdoor piles. Maximize the pile size, height and diameter, to reduce the ratio of the amount of grain on the surface, which is exposed to weather damage, to the volume of grain in the pile. Installation of an aeration system is critical unless the pile is very small. Temperatures at the center of an 80-foot wide non-aerated pile of corn will stay warm and grain deterioration is likely.

Build the pile uniformly to achieve a maximum grain surface slope. This can be accomplished by keeping the drop distance from the spout to the pile at a minimum. The maximum angle of repose and pile height occurs when grain rolls down the side of the pile. It is important to avoid creating hills, valleys, folds, and crevices that will collect water. Sprouting and mold growth occurs first in these areas due to collecting moisture. Keep people and animals off the grain pile, since divots in the pile collect water and intensify spoilage. Placing a temporary fence around the pile helps mitigate this problem.

Grain cleanliness also determines the success of outdoor piles. Segregation occurs during free fall filling. Weed seeds and fine material accumulate in the center and lighter material flows to the outside. An accumulation of wet material at any point in the pile can result in the grain heating and quality deterioration.

The pile should be placed rapidly and immediately covered to minimize exposure to moisture. If rain falls on the pile before it is completed, there will be a wet layer which will become buried within the grain and forms a potential spoilage area.

Pile Covers

Covering the pile will reduce wetting by rain and snow and minimize damage by wind and birds. A one-inch rain increases the moisture content of 1 ft of corn by about 9 percentage points – 15.5% to 24.5%. The top surface should be smooth to aid in drainage. Condensation under the cover may cause problems unless controlled with aeration. Move airflow under the cover to carry the moisture away. A drainage tile under the cover serves as an air intake duct when the aeration fan exhausts air from the bottom of the pile. This assists with providing a uniform air distribution under the cover.

Negative pressure holds the cover. A restricted air intake for vacuum aeration systems creates the suction required to hold the cover down during when it is windy. The amount of wind exposure determines the amount of suction needed. The amount of suction can be varied by operating more fans when it is windy. Back-up power may be desired for electrical outages that occur during storms.

The cover should carry the water away from the piled grain to prevent wetting the grain, so make sure the cover extends over the pile edge. Assure that water drains away from the storage by sloping the ground around the storage.

Examine the cover for perforations from rodents, wear points, wind, ice or vandalism and repair any perforations.

Two companies that provide grain covers are Integra Plastics, Madison, SD, (800) 578-5257 (grain storage covers) and Raven Industries, Sioux Falls, SD, (800) 635-3456, (Dura-Skrim, Canvex, and Fortress).

Aeration

Cooling the grain with aeration is vital for proper storage. Cool temperatures minimize mold growth, limit moisture migration, and control insects. Run fans as soon as cooling becomes available. Operate aeration fans until piled grain temperatures are uniform and equal to the average outdoor temperature. Cool the grain to about 20 to 25 degrees or as cool as is possible for winter storage. Use of an inexpensive aeration controller that turns fans on and off based on outside temperature will facilitate rapid cooling.

An aeration airflow rate of about 0.10 cubic feet per minute per bushel is frequently recommended for dry grain. However, dry grain can be aerated using lower airflow rates and operating fans for a longer period. The time in hours required to cool stored grain can be estimated by dividing 15 by the airflow rate. For example, about 150 hours of fan operation will cool grain aerated with an airflow rate of 0.1 cfm/bu. Using a smaller aeration airflow rate will reduce the size of ducts and fans required, and reduced aeration will reduce the amount of grain shrink that occurs if aerating with low humidity air.

Aeration ducts are positioned to provide uniform airflow through the grain and to provide suction to hold the grain cover. Information on the design of aeration systems for dry grain is available in the “Dry Grain Aeration Systems Design Handbook” available from the MidWest

Plan Service, http://www.MWPS.org Aeration system design was also covered in a presentation at the 2006 GEAPS Exchange.

Management of Temporary Grain Storage is Extremely Important

Quality deterioration in outdoor grain piles can occur rapidly. Check frequently for heating, moisture accumulation and general condition of the grain. Check the grain temperature and moisture content at several locations every 2 to 3 weeks. Exposed grain pile tops get trampled on, windblown and damaged by moisture. Coverings are loosened by temperature changes, changing winds, ice, animals and vandalism. Walls can suddenly burst open from extra pressure caused by wetted grain.

Grain Removal

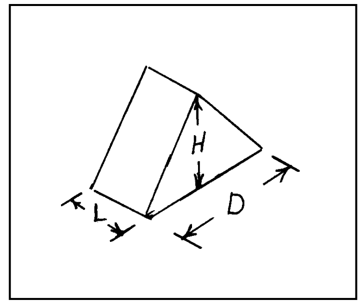
Unload from the center to prevent uneven wall loading which may lead to wall collapse. During grain removal, spoiled grain becomes commingled with sound grain, contaminating the entire amount with damaged kernels and commercially objectionable odors. While no easy answers exist to solve this problem, leaving spoiled grain along the base and edge of the pile on the ground as the rest of the pile is removed may help grain handlers avoid having to blend all the grain stored in outdoor piles. Likewise, piles with the long axis pointing east-west may experience greater quality deterioration along one face of the pile. Segregating grain from the half of the pile with less damage limits the amount of grain that requires additional conditioning via cleaning, drying, and blending.

Outdoor piles should be removed as soon as space becomes available.

Table 1. Approximate capacities of unconstrained piles.

Wheat & Soybeans (Angle of Repose 25º)

Pile Height	Pile Diameter	Bushels in Cone	Bushels per additional 1 ft. of Pile Length
15 ft.	64 ft.	13,000	390
20 ft.	86 ft.	31,000	690
25 ft.	107 ft.	60,000	1,075
30 ft.	129 ft.	105,000	1,555
35 ft.	150 ft.	166,000	2,110
40 ft.	172 ft.	249,000	2,765
45 ft.	193 ft.	353,000	3,490
50 ft.	215 ft.	487,000	4,320
55 ft.	236 ft.	645,000	5,220
60 ft.	258 ft.	841,000	6,220



Additional pile length is the triangular portion between the cone that forms the ends of a pile that is longer than the pile diameter.

Corn (23º)

Pile Height	Pile Diameter	Bushels in Cone	Bushels per additional 1 ft. of Pile Length
15 ft	71 ft.	16,000	430
20 ft	94 ft.	37,000	750
25 ft	118 ft.	73,000	1,190
30 ft.	142 ft.	127,000	1,710
35 ft.	165 ft.	200,000	2,320
40 ft.	189 ft.	301,000	3,040
45 ft.	212 ft.	426,000	3,830
50 ft.	236 ft.	586,000	4,740
55 ft.	259 ft.	777,000	5,725
60 ft.	283 ft.	1,012,000	6,825

Note: *pack factor not included in bushel calculation.*

Cone V (ft^3) = 0.262DDH, Bu. = 1.244 ft^3
Triangular pile per linear foot of length V(ft^3) = DH/2

For 25° H=0.233D D=H/0.233
For 23° H=0.212D D=H/0.212

V- Volume (ft^3), D-diameter (ft.), H-height (ft.), Bu.- bushel