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UNIVERSITY OF NEBRASKA COOPERATIVE EXTENSION IN LANCASTER COUNTY

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Emergency/Temporary Grain Storage —Unconstrained Piles of Grain—

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Piling Loose Grain

Unless space is limiting at the site, the least expensive temporary/emergency grain storage scheme will be to construct an unconstrained pile. (One that slopes all the way to the ground with no "walls".) All outside storage needs to be placed on a site which has been graded to conduct drainage away from the pile on all sides with plastic sheeting under the pile to prevent moisture migration from the soil into the grain.

Estimating the Diameter of a Conical Pile

When planning a temporary grain pile, it would be useful to know the size of pile necessary to store a given quantity of grain so proper site preparations can be made in advance. Grain that is elevated using a stationary auger or bucket elevator and then dumped into a pile will come to rest in a cone-shaped pile. Since volume is a function of the height and diameter of the cone-shaped pile, one can estimate the required diameter of a pile of grain necessary to hold a desired quantity (bushels) of grain provided the angle of repose is known for the particular type of grain.

The author has worked out a simple equation (**Equation 1** below) which can be used to predict the diameter of a conical pile of grain to hold any given quantity (bushels) of grain. Only two variables are necessary for the computation: the number of bushels and the base conversion factor (B.F.) from Table 1.

Few calculators have a button for cube root. Extracting the cube root usually requires using the Y^x function on a scientific calculator, where Y is the result of (Bu. × B.F.) and ^{x} is ⅓ for cube root. Procedure: First find the result of (Bu. × B.F.), then press the Y^x button, key in 0.3333 and press the = button.

Example 1: One could use Equation 1 to estimate the diameter of a conical corn pile necessary to contain 10,000 bushels of corn.

$$D_{(ft)} = (10{,}000 \text{ Bu.} \times 22.52)^{1/3} = 60.8 \text{ feet}$$

The process of solving for the diameter of the pile using Equation 1 also implies the height of the pile necessary to contain the stated number of bushels. However, at times it is useful to estimate the height of a pile of grain once the diameter is known. This can be done using **Equation 2**.

Example 2: The height of a pile of corn 60.8 feet in diameter can be estimated using Equation 2 and the height conversion factor (H.F.) from Table 1.

$$\begin{aligned} H &= D \times H.F. \\ &= 60.8 \times 0.2122 \\ &= 12.9 \text{ feet} \end{aligned}$$

Please turn to reverse side

Equation 1

Estimating Diameter of a Conical Pile

$$D = (Bu. \times B.F.)^{1/3}$$

alternately stated

$$D = \sqrt[3]{Bu. \times B.F.}$$

Where:

D is the Diameter of the pile of grain (in feet)

Bu. is the number of Bushels of grain in the pile

B.F. is the Base Factor from Table 1

Table 1

Conversion factors for calculations on grain resting at the angle of repose

Crop	Avg. Filling Angle	Base Factor (B.F.)	Height Factor (H.F.)
Barley	28	17.95	0.2659
Corn (shelled)	23	22.52	0.2122
Oats	28	17.95	0.2659
Grain Sorghum	29	17.24	0.2772
Soybeans	25	20.49	0.2332
Sunflower (non oil)	28	17.95	0.2659
Sunflower (oil)	27	18.76	0.2548
Durum Wheat	23	22.52	0.2122
Wheat	25	20.49	0.2332

Equation 2

Estimating Height of a Conical Pile

$$H = D \times H.F.$$

Where:

H is the Height of the pile (in feet)

D is the Diameter of the pile (in feet)

H.F. is the Height Factor from Table 1

Estimating Bushels in a Pile of Grain—Conical Piles

The basic equation for determining the volume of a cone is

$$V = \tfrac{1}{3} \times \pi \times R^2 \times H$$

Using the diameter of the base of the cone instead of the radius

$$V = \tfrac{1}{3} \times \pi \times D^2 \div 4 \times H$$

Reducing this equation to its simplest form (using 3.1416 for π)

$$V = 0.262 \times D^2 \times H$$

Expressing volume in terms of bushels instead of cubic feet

$$V = 0.209 \times D^2 \times H$$

When the diameter and height of a conical pile of grain are known, the bushels in the pile can be calculated using **Equation 3**.

Example 3: How many bushels would a pile of grain 60.8 feet in diameter and 12.9 feet high contain?

Using Equation 3 we find

$$\begin{aligned} \text{Bu.} &= 0.209 \times D^2 \times H \\ &= 0.209 \times (60.8)^2 \times 12.9 \\ &= 9{,}967 \text{ Bu.} \end{aligned}$$

This reconciles (within rounding error) with the estimated diameter and height of the conical pile required to hold 10,000 bushels of corn.

Estimating Bushels in a Pile of Grain—Windrow Piles

Sometimes temporary piles of grain are created using a portable auger that is moved periodically. Grain is piled under the auger until the pile reaches a given height (or diameter). The auger is then moved a few feet and additional grain is piled until the height and diameter match the original pile. The auger is moved again and again until the pile is complete, leaving a windrow of grain that is more or less uniform in height and width throughout its length.

Windrows of grain consist of three sections, a half cone on each end and a section between the conical ends that is triangular in cross-section. The two ends together make a full cone. As previously shown, the total volume in the conical section can be calculated using Equation 3.

The basic equation for determining the volume of the triangular section is $V = 0.5 \times W \times L \times H$

Expressing volume in terms of bushels instead of cubic feet

$$V = 0.4 \times W \times L \times H$$

The bushels of grain in the interior of the windrow, (between the conical ends of the windrow) is calculated using **Equation 4**.

Example 4: Calculate the bushels of corn in a windrow-shaped pile whose base measures 50 feet wide by 120 feet long.

Note: This pile would contain three sections. Half of a 50 foot diameter cone on each end and a triangular-shaped section in the center that is 50 feet wide by 70 feet long.

Using Equation 2, the height can be calculated

$$H = (50 \times 0.2122) = 10.61 \text{ feet.}$$

Using Equation 3, the two half cones together contain

$$0.209 \times 50 \times 50 \times 10.61 = 5{,}544 \text{ Bu.}$$

Using Equation 4, the interior of the pile contains

$$0.4 \times 50 \times 10.61 = 212.2 \text{ Bu./feet} \times 70 \text{ feet} = 14{,}854 \text{ Bu.}$$

This windrow-shaped pile of corn contains 20,398 bushels.

Additional Examples

Example 5: Calculate the dimensions of a pile of oats that contains 5,000 bushels.

The width is calculated using Equation 1

$$\begin{aligned} D &= (\text{Bu.} \times \text{B. F.})^{1/3} \\ &= (5{,}000 \times 17.95)^{1/3} \\ &= 44.77 \text{ feet} \end{aligned}$$

The height is calculated using Equation 2

$$H = D \times \text{H.F.} = 44.77 \times 0.2659 = 11.9 \text{ feet}$$

Example 6: Calculate the number of bushels in a windrow-shaped pile of grain sorghum whose base measures 55 feet wide by 120 feet long.

Using Equation 2, the height can be calculated

$$H = (55 \times 0.2772) = 15.25 \text{ feet}$$

Using Equation 3, the two half cones together contain

$$0.209 \times 55 \times 55 \times 15.25 = 9{,}641 \text{ Bu.}$$

Using Equation 4, the interior of the pile contains

$$0.4 \times 55 \times 15.25 = 335.5 \text{ Bu./feet} \times 65 \text{ feet} = 21{,}808 \text{ Bu.}$$

This windrow-shaped pile of grain sorghum contains 31,449 bushels.

Equation 3

Calculating Bushels in a Cone-Shaped Pile

$$\text{Bu.} = 0.209 \times D^2 \times H$$

Where:

D is the diameter of the base of the pile (in feet)

H is the height of the pile (in feet)

Equation 4

Calculating Bushels in Interior of Windrow

$$\text{Bu.} = 0.4 \times W \times H \times L$$

Where:

W is the width of the pile (in feet)

H is the height of the pile (in feet)

L is the length of the pile (in feet)