



Silo Capacities

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Why is silo capacity important?

Silo capacity may be needed for one of several reasons. A person purchasing a new silo would want an appropriate size; also, any decision making related to feed budgeting requires knowledge of feed inventories. For example, in a decision of setting the forages in the diets for a herd of animals, you may want to have a target of emptying the silo on a particular date — this cannot be done unless you know how much you have. We can easily comprehend the capacity of a 10,000 bushel grain bin. Estimating the capacity of forage silos is not as straightforward and is a function of several factors including silo dimensions.

The purpose of this fact sheet is to present some of the important factors related to silo capacity and figures useful for determining silo capacity and feed inventory.

Note: Any silo capacity figures, regardless of the source, should be considered approximate. Accuracy within 5% (100 tons DM +/- 5 tons) would be excellent. Expect differences of about 10%.

Factors affecting silo capacity

Capacity of **TOWER** silos can be affected by the feedstuff, moisture content, particle size, material used to build the silo, and the silo's dimensions. Silages (corn, alfalfa and grass) are less dense than grains such as ground ear corn or whole shelled corn. Moisture content affects the compressibility of silages much more than grains; since capacities are usually expressed on a dry matter (DM) basis, moisture of grains does not significantly affect silo capacities. The effect on capacities with silages can be large, however. Silo structural material, being concrete, glass-lined steel, or steel has a small effect on capacities as the

smoother materials allow for more compaction of material near the walls; this effect amounts to about 3 to 9% in added capacity.

Silo dimensions obviously have an effect on capacity, but the effect involves more than proportions. Increasing the diameter of a 20 ft. silo to 24 ft. increases its diameter and perimeter by 20%, but the increase in volume is 44%. The increase in capacity may be even higher due to compaction effects. The effect of silo height on capacity is a bit involved also because the amount of DM in the bottom one foot of a 70 ft. silo is much higher than the amount of DM in the top one foot of the same silo. This compaction effect is important in planning feed inventories because a uniform feedout rate in terms of lbs DM/day will not result in a uniform rate of height change. The compaction effect is illustrated in Figure 1 which shows that 17% of the capacity is in the top 25% of the example silo while 29% of the capacity is in the bottom 25% of the same silo. The improved compaction is a distinct advantage of taller silos as storage losses are smaller when densities are high.

BUNKER (and Trench) silos have differing capacity characteristics than tower silos. The main difference is the fact that material density is nearly constant throughout the structure. Silage harvested at the proper moisture content packs well in a tower silo due to the natural tendencies of gravity; however, when using a bunker silo, the density of the silage is dependent upon the moisture content, packing equipment and packing method. It is imperative that you do a good job of packing the material before sealing it — otherwise losses will be excessive (over 20% in some instances). The best packing method is to layer the material in layers of 1 ft. or less, with each layer packed before addition of more material. Packing can be done with a heavy tractor on wheels or a track-type dozer.

For estimating capacity and amount in bunker silo storage, these typical densities can be used:

alfalfa silage	12 lb. DM per cubic foot
corn silage	14 lb. DM per cubic foot
ground ear corn	33 lb. DM per cubic foot
whole shelled corn	39 lb. DM per cubic foot
ground shelled corn	42 lb. DM per cubic foot

Top-unloaded tower silo example

Consider a 20' x 70' top-unloaded concrete silo filled with alfalfa silage chopped at 60% moisture. The silo, when filled, contains 195 tons DM (Figure 2). Suppose the silo now contains 40 ft. of silage. How many tons are left to be fed? The 30 ft. removed is from the top of the silo where density is lowest. Note that the amount removed in 30 ft. is equivalent to the capacity of a 20' x 30' silo since there was no material above it to provide compaction; a 20' x 30' silo has a capacity near 65 tons DM (Figure 2). The amount left is the total capacity less the amount removed or 130 tons DM (195-65). For 60% moisture corn silage in a silo with the same dimensions, the capacity would be 170 tons DM and the amount left would be 110 tons DM (Figure 3).

Bottom-unloaded tower silo example

Consider a 18' x 60' bottom-unloaded, glass-lined steel silo containing alfalfa silage at 50% moisture content. Assuming the moisture effect on capacity is small (and it is relatively small), figure 2 (which is based on 60% moisture) can be used to estimate capacity. When filled, the capacity should be near 140 tons DM (130 tons DM from Figure 2 times 1.09 which is a silo type factor = 140 tons). Suppose 30 ft. of material has been unloaded and the current height is 30 ft. Is the amount in current storage 1/2 of 140 tons DM? No. From a capacity perspective, what is left is equivalent to an 18' x 30' silo since it had no material above it to provide compaction. An 18' x 30' silo has a capacity of 60 tons DM (55 times 1.09). Note that the first 30 ft. removed contains more feed since it was more dense. This is reversed in top unloaded tower silos.

Bunker silo example

The total volume of a bunker silo cannot be used. A good approximation for most operations is to assume a 45 degree slope along the front filling surface (Figure 7). With this, the fillable volume of a bunker, expressed as a fraction of total volume is a direct function of silo length and height (Figure 8). Total volume per 10 ft. of silo length is plotted in Figure 9 as a help in determining capacity.

Consider a 40 ft. wide, 80 ft. long bunker silo which is 12 ft. high. How much corn silage does it take to fill the silo? The total volume is about 38,400 cubic feet (4800 cubic feet per 10' of length from figure 9 times 8). Fillable volume, as a fraction of total volume, is about 0.925 or 92.5% (Figure 8). Then, the fillable volume is about 35,500 cubic feet (38400 x 0.925). If the corn silage density is 14 lb DM/cubic foot, the filled silo contains about 497,000 lb DM or about 250 tons DM. This is nearly equivalent to the capacity of a 24' x 70' tower silo.

How much is left in 15 ft. of length in the same bunker silo? Assuming a vertical wall where the feed is removed, the volume is 7200 cubic feet (4800 x 1.5). With the same density of 14 lb DM/cubic foot, about 50 tons DM are left. This sort of information is vital in feed budgeting and ration building.

Removal Rates

The recommended removal rate for silage is 3 to 4 inches per day; however, this is can be affected by either the degree of compaction or season. Suggested removal rates are given to minimize the amount of spoilage that may occur. It should be kept in mind that in larger silos the recommended removal rate will result in a greater amount of material fed per day than in smaller silos, because of more compaction effect. In cold weather the removal rate is not as crucial but should still be followed. In warm weather the rate may need to be increased to decrease spoilage.

References

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Jofriet, J.C. 1984. *Determination of Silage Content in Full or Partially Full Tower Silos*. Univ. of Guelph. AGDEX 732.

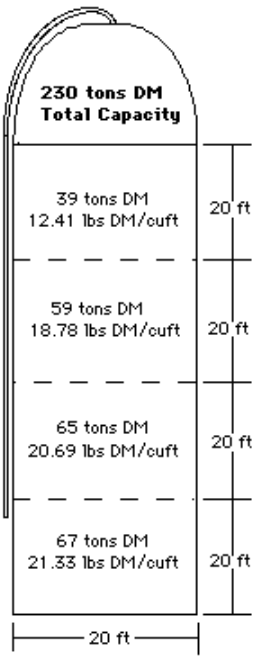


Figure 1. Illustration of density variation in tower silos. Alfalfa silage at 60% moisture in a 20' x 70' concrete tower silo.

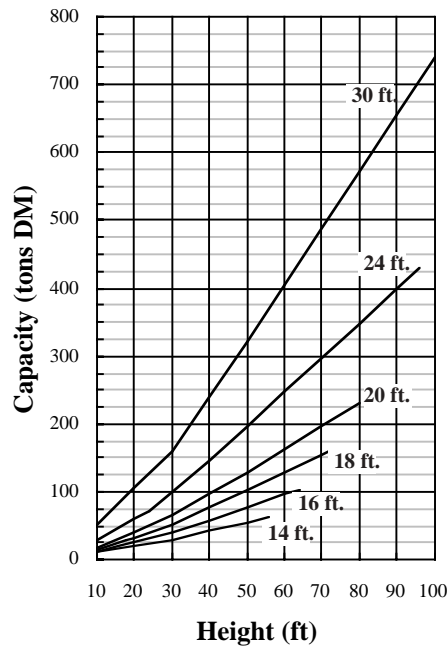


Figure 2. Approximate capacity of concrete tower silos filled with 60% moisture alfalfa silage. For steel or glass-lined silos multiply by 1.09.

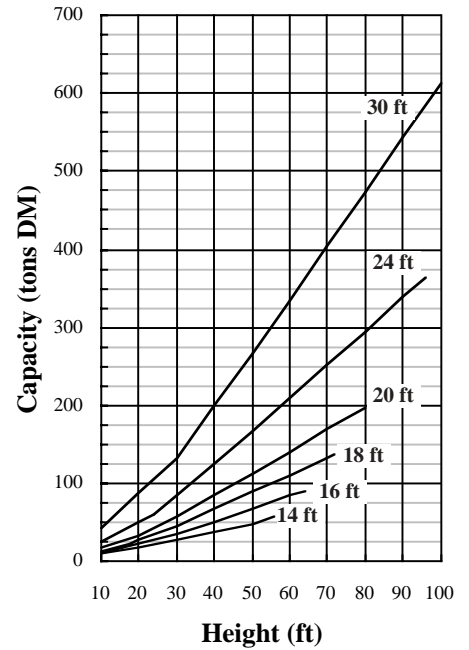


Figure 3. Approximate capacity of concrete tower silos filled with 60% moisture corn silage. For steel or glass-lined silos multiply by 1.09.

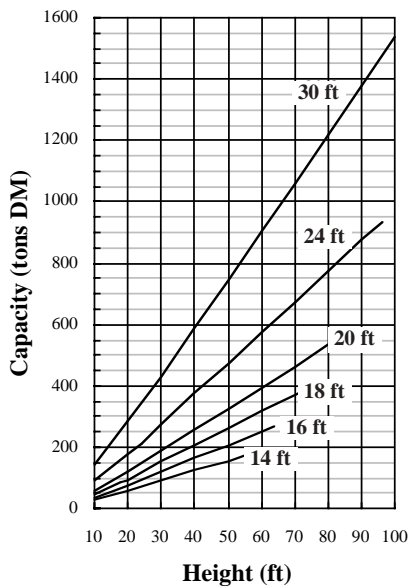


Figure 4. Approximate capacity of concrete tower silos filled with 30% moisture ground shelled corn. For steel or glass-lined silos multiply by 1.03.

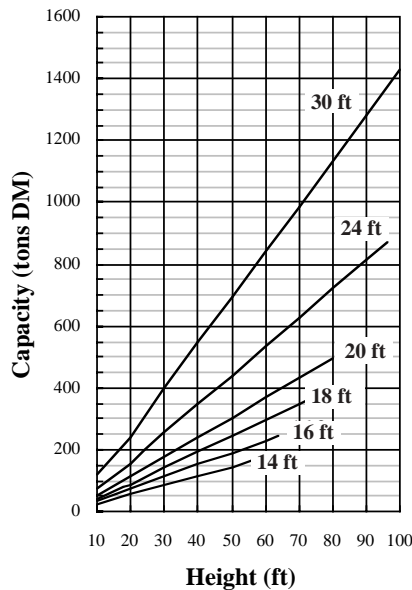


Figure 5. Approximate capacity of concrete tower silos filled with 30% moisture whole shelled corn. For steel or glass-lined silos multiply by 1.03.

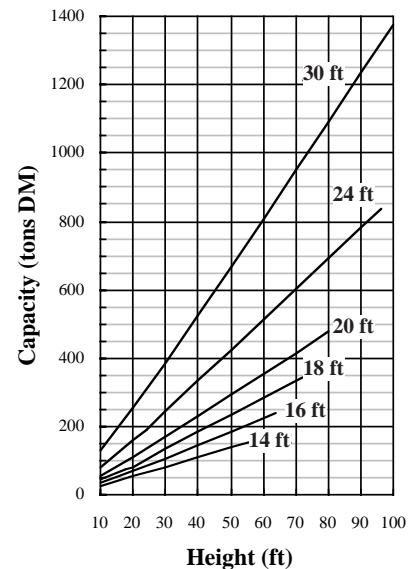
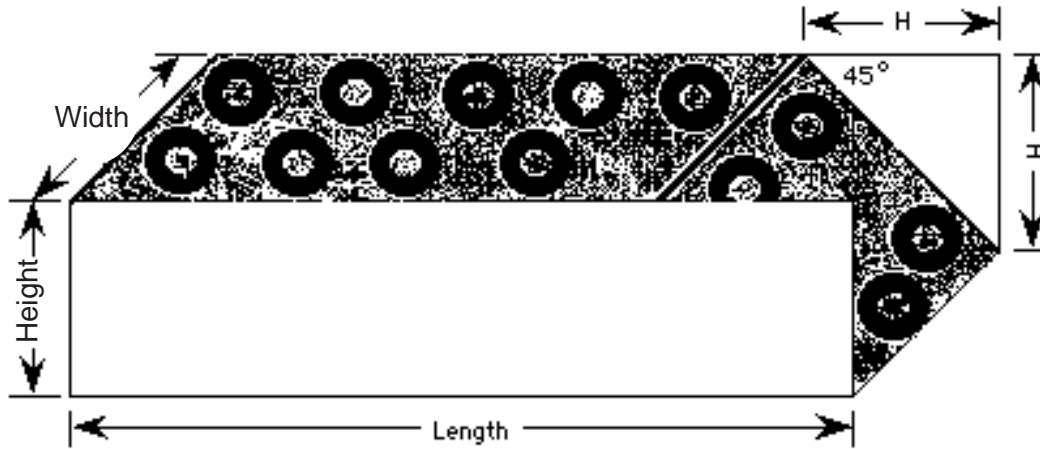


Figure 6. Approximate capacity of concrete tower silos filled with 35% moisture ground ear corn. For steel or glass-lined silos multiply by 1.03.



Total Volume = $L \times W \times H$
 Fillable Volume = $L \times W \times H - (H \times H/2 \times W)$

Figure 7. Representation of a filled bunker silo illustrating fillable volume.

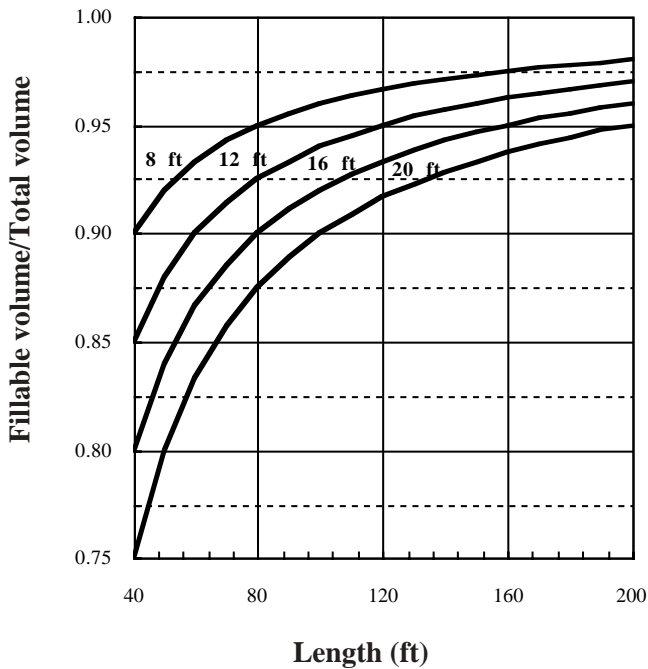


Figure 8. Fillable volume as a fraction of total volume in bunker silos of various lengths and heights.

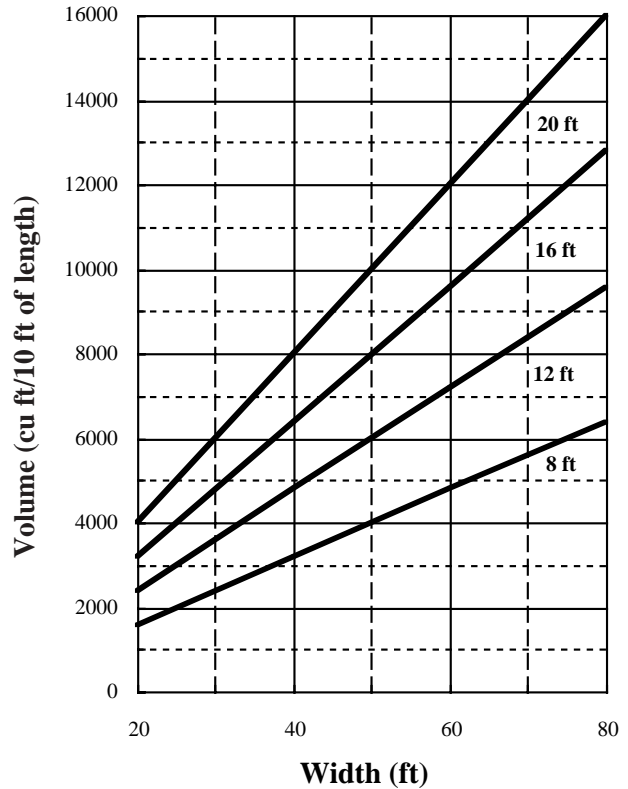


Figure 9. Volume per 10 ft. of length for bunker silos of various widths and heights.

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