



1988

# Temporary Silage Storage

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Overhults, Doug; Turner, Larry; McNeill, Sam; Piercy, Larry R.; and Turner, George, "Temporary Silage Storage" (1988). *Agricultural Engineering Extension Updates*. 41.

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## TEMPORARY SILAGE STORAGE (Supplement to Purdue University CES Paper No. 201)

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The following information is intended as a supplement to the attached publication entitled "Temporary Silage Storage Systems" published by the Purdue University Cooperative Extension Service.

### SILAGE MOISTURE CONTENT

Corn silage moisture contents between 65 and 70 percent (wet basis) are desired for temporary storage systems. Higher moistures may cause undesirable acids to be formed during fermentation. Lower moisture levels can produce good quality silage but dry silage is difficult to pack adequately. Water can be added to improve packing but do not expect to increase moisture content more than a few percentage points. Table 1 gives amounts of water required for increasing the moisture content of dry silage. IT IS ESSENTIAL THAT ANY ADDED WATER BE EVENLY APPLIED TO THE SILAGE.

### VERTICAL WALL STORAGE

An additional construction option for temporary above-ground storages is shown in Figure 1. It is designed to use standard 4-inch x 7 ft. fence posts and rough cut lumber to provide a 3.5' high wall along both sides of the silo. These materials are readily available and would have some potential salvage value when the silo is no longer needed.

TABLE 1. AMOUNT OF WATER REQUIRED TO MOISTEN SILAGE

Initial Moisture Content, %	Final Moisture Content, %		
	60	65	70
	gal/ton		
56	24	63	112
58	12	49	96
60	--	35	80
62	--	21	64
64	--	7	48
66	--	--	32

Higher walls may be constructed at considerable extra expense and would not be practical unless continuing use of the silo is anticipated. Plans for aboveground bunker silos are available in Book No. 3, FEED STORAGE, of the KY BUILDING and EQUIPMENT PLANS series. Plans 6021, 6048, and 6109 are for wood construction. Tilt-up concrete construction, above or below grade, is shown in plans 6055, 6175, and 6347.

### SIZING

Tables 2 and 3 give data for determining the maximum width and capacity of horizontal silos. In Table 2, maximum width is based on removing a 4-inch slice of silage daily. In the attached paper (Purdue CES No. 201) a 3-inch slice is suggested as the minimum daily removal. Either number is acceptable; using a 4-inch slice gives a more conservative design width.

### SAFETY TIPS FOR PACKING HORIZONTAL SILOS

Wheel type tractors have proven to be an effective method of packing silage in a horizontal silo but carries with it a high risk of tractor overturn. For this reason, special precautions should be taken to minimize the risk of serious injury or death to the operator and damage to the equipment.

1. Only tractors equipped with an approved roll-over protective frame or cab should be used for this high risk activity and the operator should use seat belts for both safety and comfort.
2. Use low clearance, wide front end tractors (not tricycle type) with the wheels extended for maximum stability. The use of dual tires will also increase stability.
3. Adding weights to the tractor will assist in packing and can provide stability. Add weights to both the front and rear of the tractor to maintain safe weight distribution on the front of the tractor. Avoid rear wheel weights that will interfere with packing close to any wall on the silo.

4. Wheel type tractors should not be driven on silage surfaces with slopes steeper than 4 to 1 (1 foot of rise in 4 feet of run).
5. Back up or drive down steep slopes to avoid the risk of an overturn. A rear mounted blade for leveling may provide some protection from rear overturns.
6. Use blades or other methods to distribute silage in uniform 6-inch layers for even packing and to help prevent "soft spots".
7. Front wheel assist drive tractors can provide extra traction and stability for packing and towing on the silage.
8. Only mature experienced operators should be allowed to operate the packing tractor or the unloading tractor and forage wagon on the silage. This is no job for youth, the older or inexperienced workers or those who are high risk takers.

TABLE 2. MAXIMUM SILO WIDTH PER 100 ANIMALS

SILAGE DEPTH, feet	Feeding Rate, lb/animal-day						
	20	30	40	50	60	70	80
	Average Width, feet						
8	21	32	43	54	64	75	86
10	17	26	34	43	51	60	69
12	N.R.	21	29	36	43	50	57
14	N.R.	18	25	31	37	43	49

Assumes 35 pounds per cubic foot and removing a 4-inch slice from the face each day.

Width in table is average of top and bottom widths.

N.R. - Not recommended because width is less than 16 feet.

TABLE 3. HORIZONTAL SILO CAPACITY

SILAGE DEPTH, feet	Average silo width, ft							
	20	30	40	50	60	80	100	120
	Wet tons/10' length							
8	30	40	55	70	85	110	140	170
10	35	50	70	90	105	140	175	210
12	40	65	85	105	125	170	210	250
14	50	75	100	120	145	195	245	295

Based on silo level full, 35 pounds per cubic foot.

Corn silage at 65% m.c. (35% dry matter).

COST DATA

Most temporary silage storage systems can be installed at a cost between \$0.50 and \$3.50 per ton of silage stored. Following is some data that may be helpful in analyzing specific situations:

5-6 mil plastic .....	\$0.03/sq. ft.
Rock (at quarry) .....	5.00/ton
4" x 7' fence post .....	3.60 ea.
4" drain tile .....	0.45/ft.
1" rough oak lumber .....	0.22/sq. ft.
Earth moving .....	0.75 to 1.50/cu. yd.

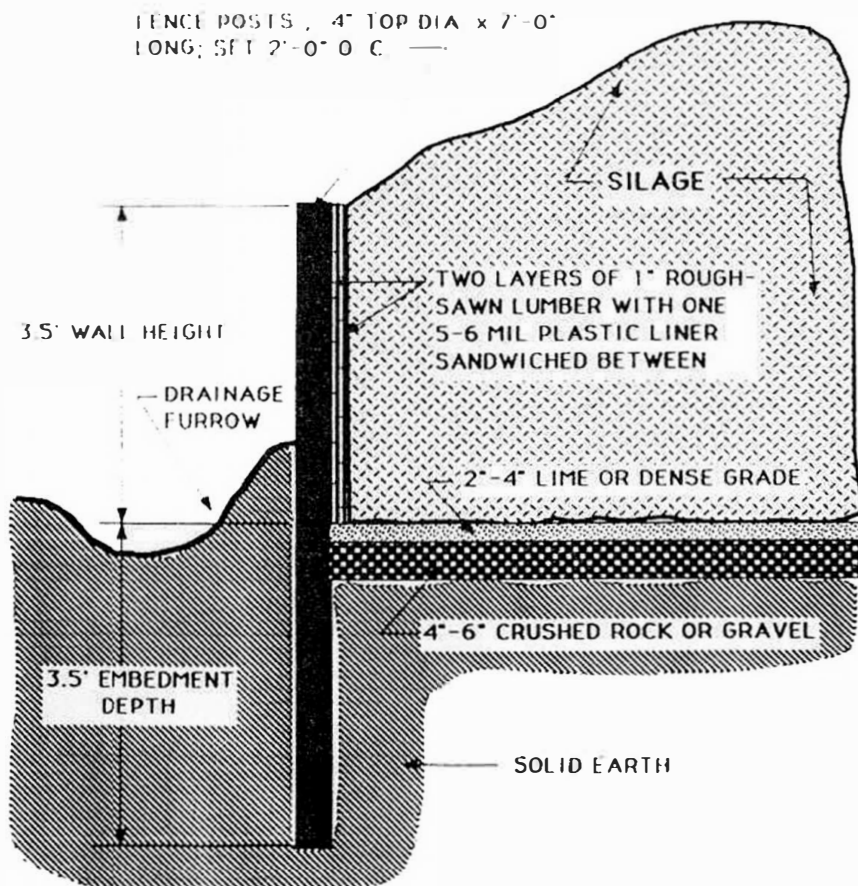


Figure 1. Temporary vertical wall above-ground silage storage option.

## TEMPORARY SILAGE STORAGE SYSTEMS

by

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Extension Agricultural Engineers\*  
Purdue University

This special publication is directed to farmers who need emergency silage storage to offset forage production loss due to the drought. Hay availability on the open market is very limited, and current and projected hay prices may make it uneconomical for many farmers.

The primary forage material available in heavily drought-damaged areas is corn, which, because of drought stress, may have little grain content. While grain content level may not be adequate for shelled corn harvesting, it would compliment the corn's silage value.

Harvesting corn stover as a hay crop does not seem to be a realistic alternative. Experiments that involve cutting the corn to field dry prior to gathering have resulted in mold and rot problems in the high-moisture stalk material before adequate curing occurred.

Ruminant animal feeders perhaps know neighbors who don't have livestock but do have corn that is salvageable only as silage material. They may also know of silos available in the community to lease. However, renting a silo located far from the feeding site adds significantly to the cost and the inconvenience of an emergency system.

Farmers should also be cautious about using upright silos that have not been in regular service for several years. Old tile silos with reinforcing embedded in the mortar joints are especially

dangerous. Aged metal ones may have serious corrosion in the bottom sections. Heavily pitted and eroded concrete stave silos may be equally risky. The condition and strength of the reinforcing steel in old poured concrete upright silos is almost impossible to evaluate. Unused trench and bunker silos are probably the best bet for leasing.

This publication deals with the development of low-cost, temporary storage systems for silage to help producers effectively use drought-stressed forage material, primarily corn. The goal of such systems is to get through the 1988-1989 winter feeding season. The techniques presented here are not intended as continuing practices, nor are they intended for storage into the summer (warm weather) season. Some of the options may be planned as a first step in what would eventually become a long term permanent system. Publications dealing with permanent silo designs and silage harvesting and handling technology are referenced.

### TEMPORARY SILAGE STORAGEES

There are basically four types of temporary or free-standing silage storage systems — (1) stacks, (2) movable/portable bunker systems, (3) trenches, and (4) horizontal plastic bags. The stacks and portable bunkers can have earth or crushed stone floors, but usually work best when built on a section of paved lot *if* adequate space and drainage are available. The trenches will likely have unprotected sloped earth walls with either an earth or crushed stone floor.

Spoilage is higher in temporary horizontal silage storages than in upright silos; but this

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increased loss is at least partially offset by their lower construction cost. The amount of spoilage is directly related to their higher-surface-area-to-volume ratio compared to upright silos, plus the quality of the packing and surface sealing. Table 1 lists some typical storage losses for alternative silage storage methods.

Table 1. Estimated Losses with Alternative Silage Storage Methods.\*

Type of silo	Average loss
Gas tight	5%
Concrete stave	6%
Bunker	15%
Trench	20%
Stack	25%

\*See MWPS-6 "Beef Housing and Equipment Handbook, 4th Edition, 1987, Figure 8-9, Pg. 8.4 for a more complete illustration of silo storage losses.

### Stack Silos

Stack silos are little more than a compacted hay stack of high moisture material. The primary problems in silage stacks are lack of adequate packing and surface sealing.

**Packing** is difficult because silage stacks usually do not have retainer walls along the sides. Therefore, it is difficult to keep the sides of the stack steep-sloped and very risky to run any type of packing vehicle near the outside edges. Consider the increased traction, stability and safety of a track-tractor with a blade as a packing vehicle. The track-tractor can more easily push material up, onto, and around the stack surface, than can a wheeled tractor.

An **earth wall** along one side of a stack may be possible if the stack base is dug parallel to a hill or crest. The earth that is removed is piled on the up-hill side to form a low, relatively flat sloped wall 3-4 ft. high. The sidewall slope should be as steep as is workable, typically a 1:3 or 1:2 ratio (Figure 1).

**Surface sealing** of stack silos is difficult because both the top and sides must be covered. A 4 or 6 mil polyethylene black plastic covering held down with old tires is commonly used for

silos covers. Plan on enough tires to cover at least 30% of the top surface. On stack units, run the plastic to the ground, and cover the end with soil, stone or silage.

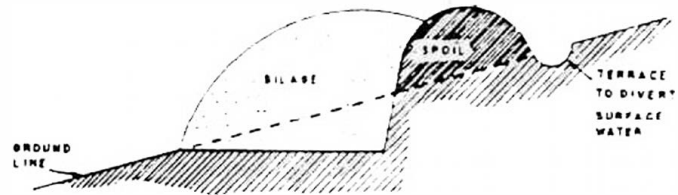


Figure 1. A one-sided silage stack. Soil removed to form the base is used to increase the depth of the up-hill side.

### Movable/Temporary Bunker Systems

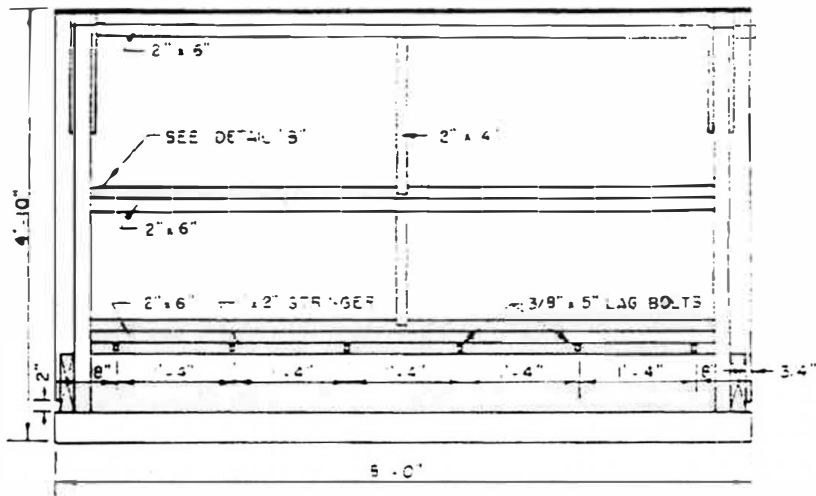
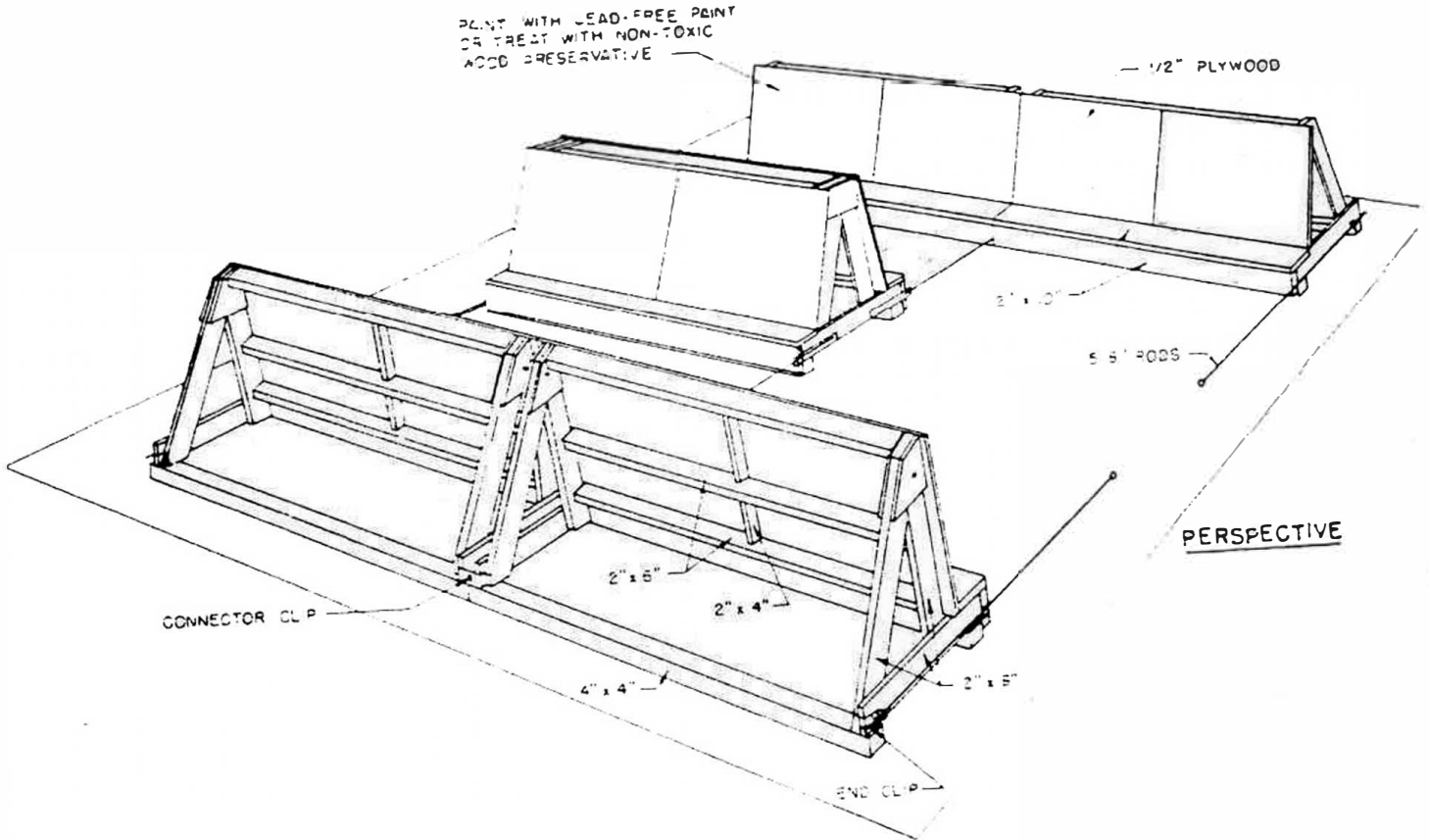
Two temporary or portable bunker systems have merit for emergency storage — a wooden "A" frame system and a sidewall system formed with big round bales of hay or straw.

A **movable wooden "A" frame system** is illustrated in Figure 2. The unit will produce excellent quality silage if you can use a portion of the concrete slab in your cattle lot. Pick a spot where lot drainage is *away* from the silo. Surface runoff into the storage area will grossly increase losses.

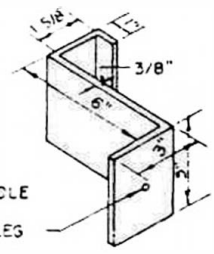
The center "A" frame in Figure 2 is an optional feature for a double bunker design. The ends of each 8 ft. section are tied to the opposite "A" frame by 5/8 inch rods. This anchors each frame without a ground attachment and makes it possible to move and/or modify the unit's location and size.

Using **big round bales** as sidewall retainers for a temporary bunker silo is illustrated in Figure 3. Like the wooden "A" frame system, the big bale system works best when placed on a section of paved cattle lot with the drainage away from the silo and bales.

Using big bales as a retainer is safest when they are set side by side such that the end of each bale forms the silo sidewall. The bales are, therefore, set at right angles to the length of the silo (Figure 3). In this configuration, the bales must



**BACK ELEVATION**  
SCALE 1/2" = 1'-0"



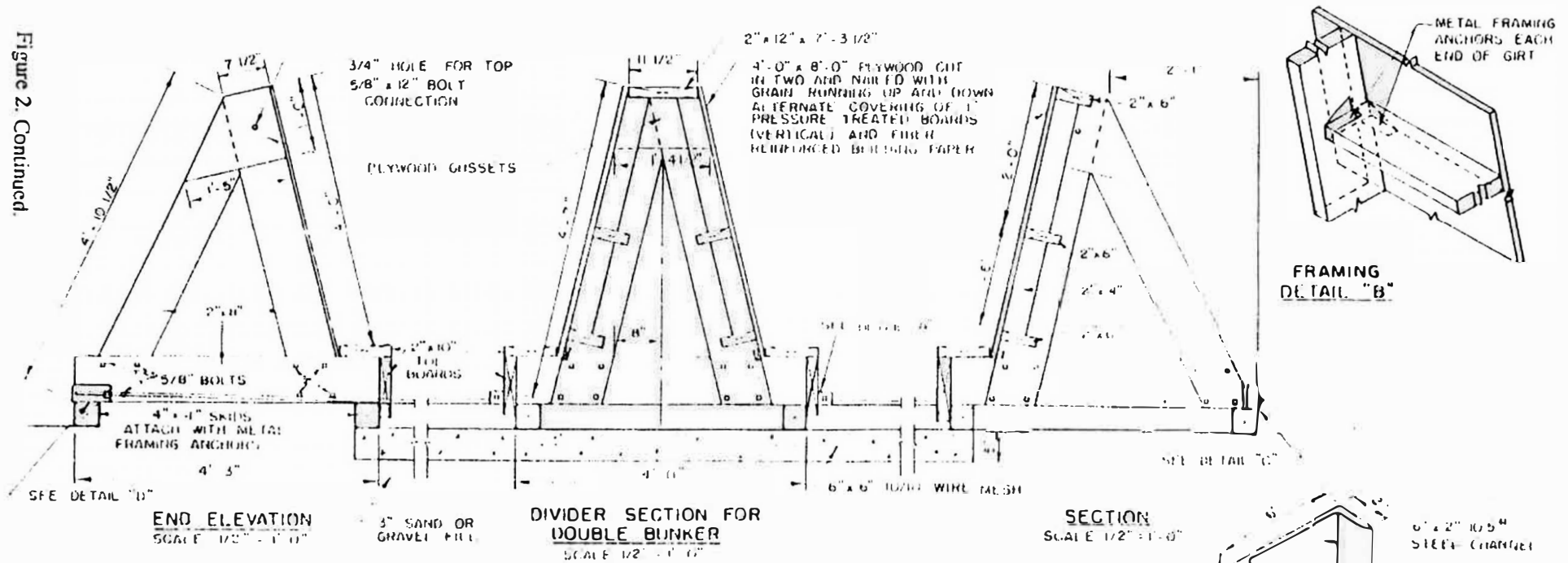
**END CLIP  
DETAIL "D"**

NOTE: ALL PLYWOOD 1/2" OR THICKER, EXTERIOR TYPE, C-C GRADE OR BETTER WITH GALVANIZED NAILS 4" TO 5" ON CENTER  
  
SKIDS AND TOE BOARDS PRESSURE TREATED

Figure 2. Moveable "A" frame retaining wall for a shallow bunker silo.



Figure 2. Continued.



**MATERIALS LIST**

ITEM	NO.	DESCRIPTION	ITEM	NO.	DESCRIPTION
<b>OUTSIDE SECTION</b>			<b>CENTER SECTION</b>		
FRAMING	3	2" x 6" x 8' 0"	FRAMING	4	2" x 6" x 8' 0"
	4	2" x 6" x 10' 0"		1	2" x 12" x 18' 0"
	1	2" x 4" x 8' 0"		1	2" x 8" x 8' 0"
	1	1" x 2" x 10' 0"		2	2" x 8" x 10' 0"
SKIDS	1	4" x 4" x 16' 0"		2	1" x 2" x 8' 0"
TIE BOARDS	1	2" x 10" x 12' 0"		1	2" x 4" x 8' 0"
PLYWOOD	1	4' x 8' x 1/2"	SKIDS	1	4" x 4" x 16' 0"
GUSSETS	1	4' x 6" x 2' 0"	TIE BOARDS	2	2" x 10" x 10' 0"
<b>HARDWARE</b>			<b>HARDWARE</b>		
CONNECTOR CLIP	1	100" 2" x 6" x 4"	STRAP IRON	4	3/8" x 2" x 1 1/2"
END CLIP	1	3" x 5" x 3/8" STRAP IRON	PINS	4	3/4" x 6"
FRAMING ANCHORS	4		BOLTS	16	5/8" x 5"
LAG BOLTS	6	3/8" x 5"	FRAMING ANCHORS	4	
BOLTS	16	5/8" x 5"	LAG BOLTS	12	3/8" x 5"
	2	5/8" x 12"			

Originally published as MWPS-73301 - Bunker Silo of Portable Sections. (now out of Print) Contact the Plan Service, Agricultural Engineering Department, Purdue University, West Lafayette, IN 47907.

slide on the concrete (or soil) rather than roll, as might be the case if placed parallel to the silo length. The disadvantages of placing the bales with their ends facing into the silo is that the silo sidewall is essentially vertical, making packing difficult, along with the potential for increased bale spoilage due to water runoff into the bale creases.



Figure 3. A temporary bunker silo using big round bales as sidewall retainers. Bales are set end wise to eliminate rolling and are blocked with a post at the outer end.

In an orientation parallel to silo length, the bales, which naturally settle into a somewhat wedge shape over time, present a sloped-sidewall surface that will transfer some of the silage weight onto the bales. However, they may still tend to roll, especially high-density straw bales, which are very compact and present very little flattening on the bottom. If the bales are laid end to end parallel to the long dimension of the silo, a large chock block (e.g., a railroad tie or larger) should be wedged under the outside rolling surface of the bale. Ideally, these chock blocks should be anchored to the base by driven rods.

Both designs have been used by farmers, but the side-by-side rather than end-to-end orientation is significantly safer in terms of bale movement.

Farmers have successfully used the bale retainer system either with or without a plastic liner draped over the end of the bale. Figure 4 shows a system in which the same plastic sheet that covers the inside bale surface is large enough to extend across the center peak of the finished silage fill. The sheet on the opposite side also overlaps across the peak to complete the top cover. Weighting is required, generally 30% of

the surface area with old tires.

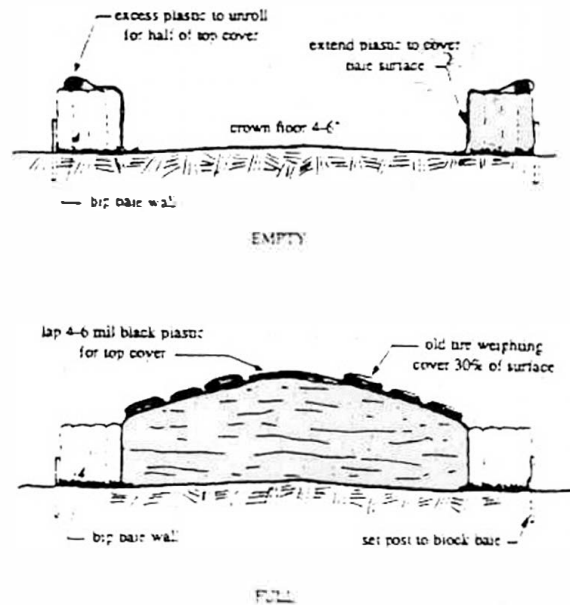


Figure 4a and b. Cross section of a bunker silo with large bale sidewalls. Plastic film drapes the inside walls (top view) with the excess rolled and parked atop the bales. Each unrolled sheet extends slightly over the center peak of the completed fill (bottom view) to overlap for a complete top seal.

Note that water from off the top of the silo will run between the end of the bale and the silage pile. This will result in spoilage, but the level is manageable if surface drainage around the area carries water away from the silo. As the silo is unloaded, the exposed bales can be fed as needed.

One might use plastic wraps on the surface of round bales to reduce spoilage. However, do not put plastic *under* the bale as this will reduce friction and increase sliding. Do not encase a dry forage bale to where it becomes air tight. Moisture moves back and forth through a bale due to daily, weekly, and seasonal temperature and humidity changes. If it is tightly encased, moisture condensation could form over the top surface under the plastic, and cause serious molding and rotting.

The authors or other Purdue specialists have no experience with plastic wrap in this application. It may be better to use in the side-by-side bale orientation (Figure 3), than in an end-to-end arrangement. Our concern is that some portion of the bale be exposed to the atmosphere, without a cover of either silage or plastic.

If the *big bale sidewall retainer system* is to have an earth or crushed stone floor, the surface drainage, floor slope, and floor detail are discussed in the construction specifications section later. The same details apply to trench silos.

The *danger of sidewall movement* (slippage) in any sidewall system that is not tied from side to side, or otherwise anchored to the silo or soil base, must be recognized. Packing with a tractor in horizontal silo systems is at best always fraught with some risk of tractor tipping.

The danger with a non-anchored silo wall is that a section may slide outward, *quickly*, once the lateral force due to the silage depth plus the packing vehicle exceeds the sidewall systems resistance to sliding. Once the movement starts, the sliding friction coefficient is less so movement can be rapid. A 1200 lb. round bale of dry material with a 2 ft. wide by 5 ft. long ground contact area is estimated to give only 25-50% of the sliding resistance that a 5-6 ft. deep silage fill plus the packing vehicle may exert.

A wood post set or driven in soil or a steel pipe or rod in concrete should be considered to retain the outer end of the bale (see Figures 3 and 4). Packing at the wall along the bales should be heavy for the first 2-3 ft. of fill but should be reduced by moving inward as the depth accumulation continues. The value of the potential silage loss due to reduced packing is nothing compared to the human risk involved.

### Trench Silos

A *trench silo* is usually dug into a hill or bank, with its long dimension either perpendicular or parallel to the hill. In the latter case, one side is dug full depth into the hill, while the other (low) side may involve from zero to possibly half depth. The soil removed (spoils) is piled on the

low-sidewall to raise its height (see Figure 5).

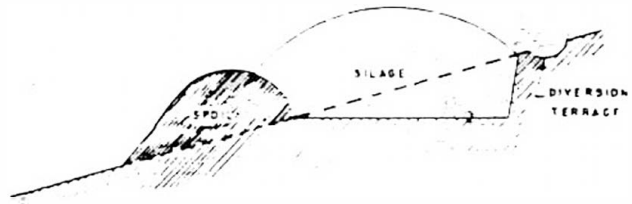


Figure 5. A side-hill trench silo using soil removed to form the base, as fill to build the down-hill (low) side.

A trench silo need not be completely submerged below ground line. In fact, the most economical unit is placed partially below grade, with the spoils piled up on the sides to extend the height of one or both walls (Figure 6). If cut and fill are balanced, the construction cost should be only about 60% of the cost of a trench silo located completely below grade. This half below, half above-ground construction tends to minimize ground water problems in dug silos.

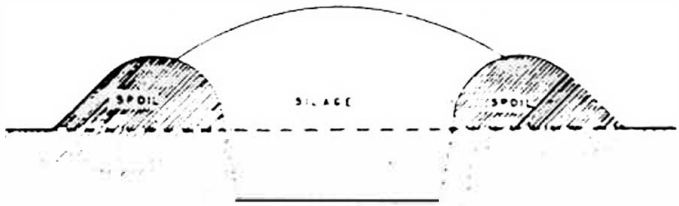


Figure 6. A half-below, half-above ground trench silo formed by using the soil from the cut to increase the sidewall height.

*Earthen sidewalls* are satisfactory on an emergency basis, to get the crop in storage. However, considerable annual maintenance may be required if use is continued. Walls sloped 1 ft. out for each 4 ft. of rise will usually have a minimum cave-off and good storage performance. Walls formed by piling excavated soil along the sides of the silo will usually have a flatter sidewall slope. Walls tend to cave off some following each use. A row of baled straw placed along the upper edge of the soil bank will reduce erosion, particularly in the first several years until the sidewalls become stabilized.

Earthen sidewall stability may be improved in sand and gravel laden soil with addition of a

plastic liner. The plastic will reduce the amount of soil that caves off into the silage. It should extend several feet above the silage fill, and be laid over onto the silage pack when the fill is completed. The top cover will then overlap, shedding water at least to the outer wall of the liner, and possibly onto the surrounding grade, to drain away from the silo surface.

Earthen walls with a heavy clay content will retain their shape, thus can be more vertical than walls with a fairly high sand or gravel content. Walls dug with a backhoe rather than a bulldozer are usually better shaped. It may be feasible to dig the outer perimeter of the silo with a backhoe, then remove the center island by any technique that is workable.

*Earth floors* are not very satisfactory for trench silos except on an emergency basis. Place 4-6 in. of coarse gravel or crushed limestone on the surface to improve all weather performance. Earthen floors may be adequate in sandy or gravelly soils. Several inches of fine limestone added to a crushed rock fill and wetted by rain or hose will give a firm work and maneuver surface.

#### *Horizontal Plastic Bag Systems*

Silage made in plastic bags or tubes can be an excellent product. A portable filler/bagger machine stuffs 8 ft. diameter by about 150 ft. long plastic sleeves. The system is readily adaptable to either emergency or normal use. The primary problems are the limited number of machines owned and the cost per ton for custom-hire or ownership.

The relatively high cost per ton for the bags and machine use may not be much of an issue when forage supplies are extremely short and prices high. However, filler/bagger machines currently owned in Indiana number possibly one per 15-20 counties. Custom service is therefore not available in many areas.

The bags can be partially filled, closed, and later completely filled. They need to be closed tightly because billowing plastic can pump air over the silage, increasing spoilage. Silage moisture content of 60-70% promotes more

fermentation but increased freezing can be a problem. A 50-60% moisture content reduces freezing and should give adequate fermentation.

Bags are not reusable and must be protected from punctures. Common causes of spoilage are tears by rodents or animals, splits at the seam, punctures from objects on the ground, and weather damage.

Choose a firm, well drained site with a 5% slope away from the storage area. Coordinate the storage area with the feeding site. Orient bags north-south to promote snow-melt and drying on each side. Unloading of the bags can be from either end. A specially designed feeding fence on each end can be adapted for self feeding.

## DESIGN, CONSTRUCTION, AND MANAGEMENT

### *Sizing the Silo*

The daily silage removal rate should be at least 3 in. of the exposed surface. In calculating the size silo needed, use silage densities of 35 lb./ft.<sup>3</sup> (57 ft.<sup>3</sup>/ton) to 40 lb./ft.<sup>3</sup> (50 ft.<sup>3</sup>/ton). Density is affected by moisture content, fineness of cut, packing, and silage depth. Expect temporary silos, which will usually average 6-10 ft. level fill, to be lower in packed density.

The usual practice is to determine the cross-sectional area of the storage from the amount of silage to be removed daily, and the storage length from the number of days to be fed. As an example, assume you want to feed 100 beef animals 20 lb. silage per day (plus some hay) for 200 days. Then:

- 1) Silage per animal times the number of animals will give the total daily pounds required, thus

$$20 \text{ lb./hd.} \times 100 \text{ hd.} = 2000 \text{ lbs./day}$$

- 2) Dividing this by the 35-40 lb./cu.ft. will give the total cubic feet of silage required daily as stored in the silo. Thus,

$$2000 \text{ lb./day} + 35 \text{ lb./ft}^3 = \frac{2000 \text{ ft}^3}{35 \text{ day}} = 57 \text{ ft}^3/\text{day}$$

If silo depth (average level fill) is known, width of the silo required for removing 1 ft. of thickness each day can be calculated. Thus:

- 3) Assume an average depth of 8 ft. for the temporary silo. Then an 8 ft. deep slice 1 ft. thick will remove an 8 ft.<sup>2</sup> cross section area, and

$$57 \text{ ft}^3/\text{day} + 8 \text{ sq. ft./1 ft. slice} = 7-1/8 \text{ ft. width required,}$$

and

- 4) If we remove only an average 3 in. slice per day, then the silo will have to be four times as wide or

$$4 \times 7-1/8 \text{ ft} = 28-1/2 \text{ ft. wide}$$

- 5) Finally, with 3 in. removed per day, this will be 4 da./ft. of length or

$$200 \text{ da.} \div 4 \text{ da./ft.} = 50 \text{ ft. long}$$

If the silo has a 1:4 side slope ratio, then for an 8 ft. depth, it would slope outward 2 ft. on each side, or the top will be 4 ft. wider than the bottom. Averaging the top and bottom for a 28 ft. width means the silo will need to be 26 ft. wide at the bottom and 30 ft. wide at the top.

(See MWPS-6 "Beef Housing and Equipment Handbook," 4th edition, 1987, Section 8.19-8.21, and/or MWPS-7 "Dairy Housing and Equipment Handbook," 4th edition, 1985, Section 10.1-10.4 for more detail on silo sizing.)

### Construction

Choose a *well drained site* with good access for filling and unloading that slopes 3-5% away from the storage area. *Silo floors* should slope 1-2 ft. per 100 ft., toward the silo entrance. The floor should be crowned in the center — typically 4-6 in. or about 1/4 in. per ft. If a continuous cross slope is desired or best adapted to the lay of the land, incline the floor 4-6 in. higher on the up side to facilitate drainage.

A *crushed rock floor* 4-6 in. thick, topped with 1-2 in. of fine limestone wetted-in, is

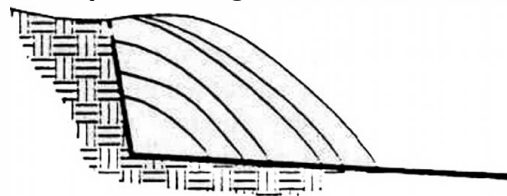
probably the best semi-permanent floor. To reduce cost, the fine limestone may be eliminated. The crushed stone size should be 3/4 to 1-1/2 in. material.

*Concrete floors* should be 5 in. thick throughout the silo, thickened to 8 in. near the silo entrance to withstand heavy machinery and frost damage. No reinforcing bar is needed in the floor, although some wire reinforcing may be used to keep small cracks in the concrete from developing into big ones. Cast the floor in 10-12 ft. wide strips of concrete, running the length of the silo.

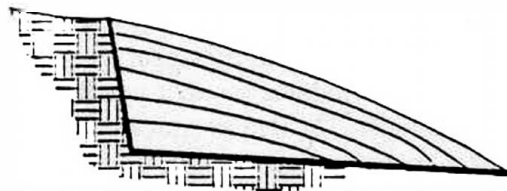
*Earth moving* in trench silos can be done with backhoes, bulldozers, and draglines. The choice depends on the quantity and distance soil is to be moved and the depth of excavation. Farm tractors with loaders may be used, but time and costs should be evaluated carefully. The larger commercial equipment will be much faster and is frequently less total cost.

### Managing Filling and Packing

The top of the silo will have spoilage in proportion to the amount of air admitted to the silage surface. Try to minimize surface exposed during filling. On trench silos, begin at one end and fill that end to the full depth, keeping the exposed face to which silage is being added as steep and short as possible (Figure 7).



Good - Steep layers minimize surface exposure



Poor - Flat layers expose entire surface

Figure 7. Minimize surface exposure during filling.

*Thorough packing* is essential to satisfactorily store silage in horizontal or stack silos. Level each load of silage and pack continuously during filling. Corn silage should be 65-70% moisture, wet basis. Too much moisture increases seepage, odors, and unloading problems. Silage that is too dry will not pack well and may not ferment properly.

*Driving through the silo* for silage filling will not be feasible on most stack silos, movable sidewall bunkers, and many earthen or stone floored trench silos. Pulling upward onto an above-ground pile presents traction problems, overturning danger and is risky for side tipping unless the pile is huge. Continuously driving over an earthen or new crushed stone floor in silo filling may cause severe floor ruts and/or mud before the downstream portion of the floor is covered.

The best and safest solution is to use either a blower or mechanical conveyor (double chain car corn elevator) to transfer material into the silo. A tractor equipped with a blade and/or scoop is quite effective for working on the silage surface for leveling and packing.

In general, the deeper the silage in storage, the better will be the packing and sealing, and the less the spoilage. Take care to pack near the sidewalls in bunker and trench silos. Observe the caution concerning sidewall movement from heavy packing in the upper fill, on non-anchored sidewall systems. (See earlier packing discussion on big bale walls.) Use only tractors with a wide front end and equipped with a roll bar or crush-proof cab. *Use a seat belt.* Set the rear wheels out wide to add stability. Backing onto the silage pile instead of driving onto the stack forward reduces the chance of overturning.

*Crown the top surface* of stacks or trenches to a smooth surface that will shed water. Work to channel drainage water off the top plastic cover such that it does not run down inside of the walls on trench and bunker units.

In *unloading from the silo*, try to minimize the amount of silage surface exposed. A tractor scoop tends to tear loose a chunk and opens the jagged face in ways that could increase spoilage.

Horizontal silo unloaders that shred the silage removed leave the face in the best possible shape. However, these machines require a fairly large volume to justify, and are simply not feasible on a short term basis.

*Sealing the top surface* with 4-6 mil black polyethylene is the most satisfactory, as discussed in the earlier section on stacks. This material is usually available at lumberyards in 100 ft. wide rolls. An earlier University of California study indicates that plastic covering done well could save \$8 worth of silage for each \$1 spent on plastic. Although price ratios have changed, the cost/benefit ratio is still quite high.

Stack and trench silo feeding is best adapted for wagon distribution to fence-line bunks, or for tractor scoop transport and feeding direct into three-sided bunks spaced along a fence-line. These distribution and feeding methods are more typical of beef feedlots than dairy. Hence, information on the construction of such bunks and layout patterns for silo/roadway/bunks are more likely in beef feed handling references.

See MWPS 6, Section 8.1-8.5 and 8.9-8.15 for bunk and feed handling details. The three-sided bunks mentioned above are quite simple to construct, and could give a quick, relatively low-cost feeding alternative.

*References:* (Available in Purdue CES Offices.)

- AED-15 "Tilt-Up Concrete Horizontal Silo Construction." Midwest Plan Service, Iowa State University, Ames, Iowa. 12 pages.
- AED-26 "Farm and Home Concrete." Midwest Plan Service, Iowa State University, Ames, Iowa. 8 pages.
- MWPS-6 "Beef Housing and Equipment Handbook." Midwest Plan Service, Iowa State University, Ames, Iowa. 136 pages (Cost:\$7.00).
- MWPS-7 "Dairy Housing and Equipment Handbook." Midwest Plan Service, Iowa State University, Ames, Iowa. 112 pages (Cost \$6.00).
- NCH-49 "Corn Silage Harvest Techniques." Purdue University Cooperative Extension Service, West Lafayette, Indiana. 8 pages.
- NCH-57 "Handling Corn Damaged by Autumn Frost." Purdue University Cooperative Extension Service, West Lafayette, Indiana. 4 pages.
- NCH-58 "Utilizing Drought-Damaged Corn." Purdue University Cooperative Extension Service, West Lafayette, Indiana. 4 pages.
- NCH-59 "Silage Preservatives and Additives for Corn." Purdue University Cooperative Extension Service, West Lafayette, Indiana. 4 pages.
- "Salvaging Drought-Damaged Corn as Livestock Feed." July 1988. Keith Johnson, Forage Specialist; Dave Petritz, Agricultural Economist; Kern Hendrix, Beef Nutritionist; Dave Mengel, Agronomist; Rich Edwards, Entomologist; and Dan Childs, Weed Specialist. Purdue University, West Lafayette, Indiana. 8 pages.