Horizontal Silos
Michigan State University Agricultural Experiment Station
Circular Bulletin – Farm Building Series
T. J. Brevik, W.H. Friday, R.L. Maddex, Agricultural Engineering
Issued April 1955
12 pages

Farm Building Series
Circular 723

HORIZONTAL SILOS

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MICHIGAN STATE COLLEGE

COOPERATIVE EXTENSION SERVICE

DEPARTMENT OF AGRICULTURAL ENGINEERING

EAST LANSING

Cooperative extension work in agriculture and home economics. Michigan State College and the U. S. Department of Agriculture cooperating. Paul A. Miller, Director, Cooperative Extension Service, Michigan State College, East Lansing. Printed and distributed under acts of Congress, May 8 and June 30, 1914.

HORIZONTAL SILOS

By T. J. BREVIK[1], W. H. FRIDAY[2], and R. L. MADDEX[3]

Actually, horizontal silos were in use before the upright silo. But they were generally abandoned in favor of the upright silo, because losses due to spoilage and labor requirements were higher. Today they are regaining popularity because of the increased emphasis on grassland farming, the desire for low-cost construction, and improved equipment for mechanical handling.

The horizontal silo location is not confined to banks or hillsides, which are necessary for trench silos. The silo can be built as an above-ground bunker, or partially above and below the ground. A variety of building materials, such as earth, wood and concrete, can be used.

Basically there are two general types of silos, one a *low-cost* storage and the other a *self-feeding labor saver.* Although the requirements of the construction differ, it is possible to progress from the low-cost storage to the self-feeding labor saver, provided proper planning is initially done. The silo should be made to fit the farmstead plan and the anticipated livestock needs.

Filling is not a major problem. Most farms in Michigan possess some type of equipment that can be used effectively. It is possible to use less machinery for filling than is required for the conventional upright silo.

A comparison of the two general types of horizontal silos follows:

Comparison Point	Low-Cost Storages	Self-Feeding Silos
Cost Range	$100 — $200	Up to $1,000
Way to remove silage	Mechancial unloaders	Self-feeding
Widths	Narrow (10 ft. to 16 ft.)	(16 ft., up) based upon livestock numbers
Depth of silage	8 ft. - 10 ft.	6 ft. - 6½ ft.
Floors	Earth satisfactory	All-weather surface
Walls	Stable earth satisfactory	Building materials (wood and concrete)
Maintenance	Yearly	Infrequent

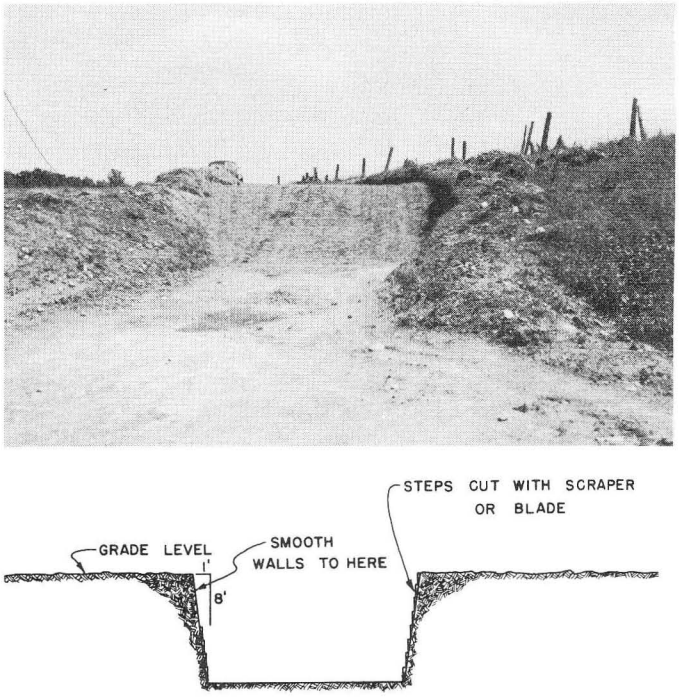

Fig. 1. Trench silo having earth walls.

Location of Silos

Involved in the selection of a good location are: (1) drainage, (2) location of buildings, (3) topography, and (4) weather conditions. Location can determine the success or failure of the silo.

Drainage is the most important factor in choice of location. Good drainage from the silo is of prime importance for self-feeding and for mechanical removal. Water draining into the silo can cause excessive spoilage and difficult working conditions. To provide for good runoff, the ground should have a slope of 3 ft. in 100 ft. away from the silo and feed lot. The silo floor should slope at least 2 ft. in 100 ft. of length toward the open end.

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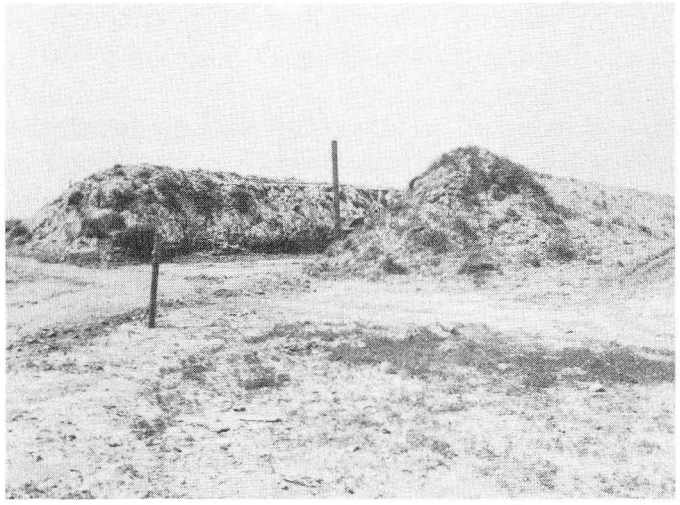
The location with respect to existing farm buildings is important for both filling and feeding. A clearance of 20 ft. from the buildings is recommended for machinery movement. A silo parallel to a building may be located closer, provided there is room for movement into and out of the silo. The distance from the barn or feeding area should depend on convenience and method of feeding. A distance of 100 ft. is generally considered good. A location just off the feed lot with the open end of the silo in a direct path from the housing area is recommended.

Self-feeding will work best when the silo is readily available to the animals. Don't locate it so that prevailing spring and summer winds will carry odors toward the farm house.

Topography will determine the type of silo; above-ground, below-ground or partly-above-ground. Below-ground silos are suited for hillsides, while above-ground work well on nearly level land.

Low-cost storages need not be as conveniently located as the self-feeding silos. Manure loaders and movable feed bunkers allow the distance from the housing area to be increased, although 100 ft. is still considered a desirable distance. Windbreaks are desirable but not necessary.



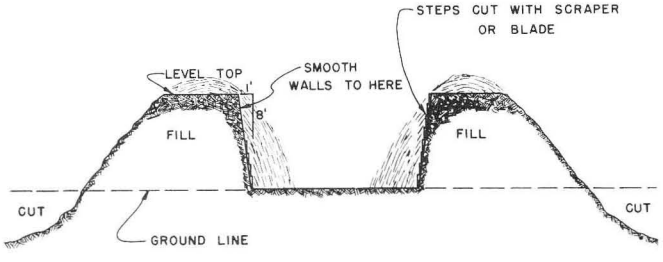
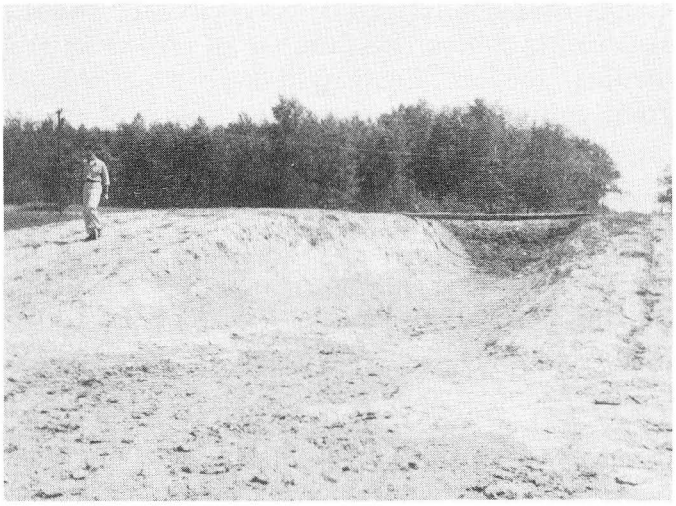


Fig. 2. Above-ground, earth-walled trench silo.



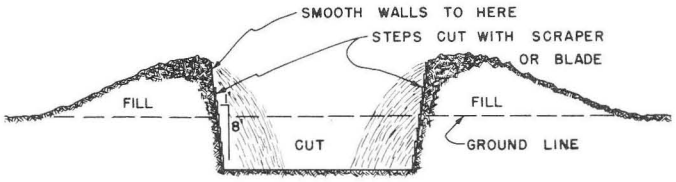


Fig. 3. Partly-above-ground, unlined silo.

LOW-COST STORAGE SILOS

Planning the Size of Low-Cost Storage Silos

Factors affecting the size are influenced by the machinery used in filling and the need to keep spoilage low. The machinery requires that the minimum width should be 10 ft., so that wagons can be moved through the silo freely and packing tractors have sufficient room to maneuver. On the other hand, spoilage will vary directly with the silage feeding area exposed. It is desirable to have the silo narrow to reduce the face of silage exposed during feeding.

The width is directly related to the number of animals and the amount of silage fed daily per animal. Table 1 gives recommended sizes

More length is needed as the number of weeks or months of the feeding season increases. It is desirable that a slice of silage covering the whole cross-sectional area of the silo, and having a thickness of between 2 and 2½ ft., be fed in a one-week period. This

means that the length of a silo in feet should be 2 to 2½ times the number of weeks in the feeding season. Feeding faster than this is good, especially if summer feeding is planned.

Construction

How to build silos with earth is shown in Figs. 1, 2, and 3. Below-ground (trench silos) are dug in a conveniently located bank or hillside. Above-ground or partly-above-ground are formed by mounding soil to build the sides. When sandy-gravel soils are encountered, wall construction similar to that used for self-feeding is necessary (Figs. 4 - 13).

Undisturbed Soil

In a firm soil where steep banks will not readily crumble (Fig. 1) a trench can be cut, using scrapers, bulldozers, draglines or other soil-moving equipment. Attempt to keep the sides as straight as possible. A side slope of 1 inch per foot of height is desirable (Fig. 1). More slope may be needed if soil tends to slough off, but the silo should not be more than 4 ft. wider at the top than at the bottom. The walls should be scraped to produce a smooth surface.

Filled Soil

In areas not suitable for trenches, earth can still be used for the side walls by mounding the soil in two parallel piles (Fig. 2). The soil should be packed as much as possible while building and allowed to settle. During construction the inside walls should be kept as straight at possible. After settling, smooth the walls with a square point shovel, keeping the slope as steep as possible. The top of the silo should not be more than 4 ft. wider than the bottom.

Partly-Above-Ground Silos

This silo is perhaps the most practical construction type for most farms. The structure is built by cutting a trench about one-half the silo depth and placing the soil to form the side walls above grade (Fig. 3).

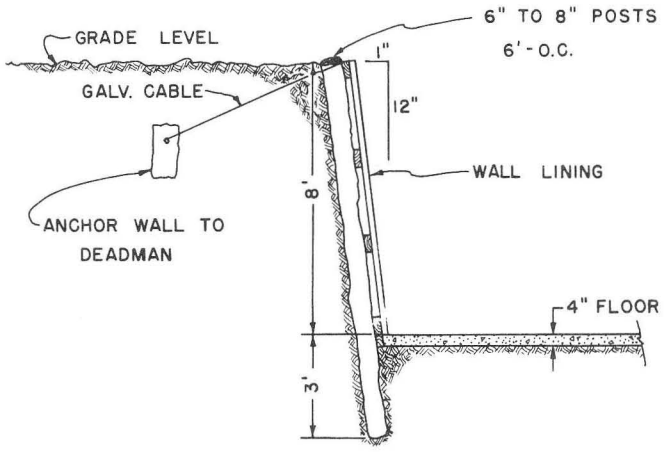


Fig. 4. Typical lined trench.

As in other earth structures, the inner walls should be kept as straight as possible during construction and smoothed when finished.

TABLE I — Low-cost storage size*

Number of Animal Units	*Months* 6	6½	7	7½	8	8½	9	9½
	Weeks 26	28	30	32	34	36	38	40
	(w x l)†	(w x l)	(w x l)	(w x l)	(w x l)	(w x l)	(w x l)	(w x l)
15	10 ft. x 50 ft.	10 ft. x 50 ft.	10 ft. x 50 ft.	10 ft. x 55 ft.	10 ft. x 60 ft.	10 ft. x 65 ft.	10 ft. x 70 ft.	10 ft. x 75 ft.
20	10 ft. x 60 ft.	10 ft. x 64 ft.	10 ft. x 68 ft.	10 ft. x 70 ft.	10 ft. x 75 ft.	10 ft. x 80 ft.	10 ft. x 85 ft.	10 ft. x 90 ft.
25	12 ft. x 60 ft.	12 ft. x 65 ft.	12 ft. x 70 ft.	12 ft. x 75 ft.	12 ft. x 80 ft.	12 ft. x 85 ft.	12 ft. x 90 ft.	12 ft. x 95 ft.
30	14 ft. x 62 ft.	14 ft. x 68 ft.	14 ft. x 72 ft.	14 ft. x 75 ft.	14 ft. x 80 ft.	14 ft. x 85 ft.	14 ft. x 90 ft.	14 ft. x 95 ft.
40	18 ft. x 65 ft.	18 ft. x 70 ft.	18 ft. x 75 ft.	18 ft. x 80 ft.	18 ft. x 85 ft.	18 ft. x 85 ft.	19 ft. x 90 ft.	18 ft. x 95 ft.
50	22 ft. x 65 ft.	22 ft. x 70 ft.	22 ft. x 75 ft.	22 ft. x 80 ft.	22 ft. x 85 ft.	22 ft. x 90 ft.	22 ft. x 95 ft.	22 ft. x 100 ft.

* Based on 50 Pounds Feed Per Day: Depth between 8ft. and 9 ft. — Silage Weight 40 lb. per cu. ft.

† (w x l) = width times length

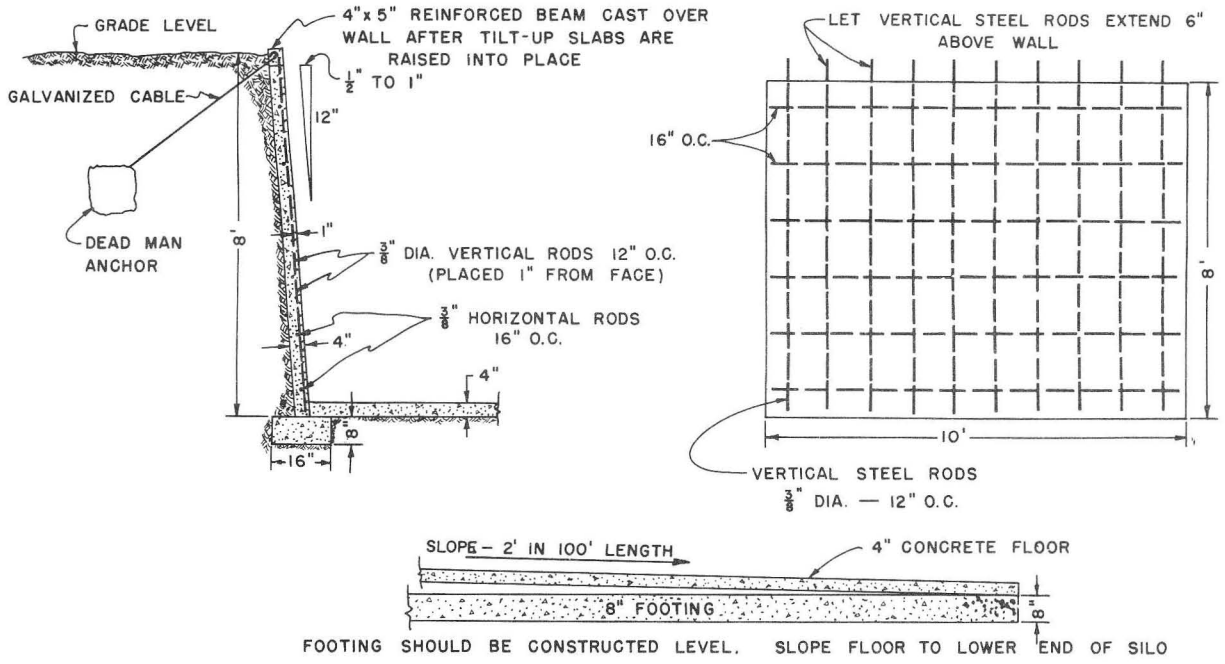


Fig. 5. Below-ground, "tilt-up" concrete silo.

SELF-FEEDING SILOS

Planning the Size of Self-Feeding Silos

Size is determined by the number of animals to be fed (Table 2). It is recommended that 6 to 9 inches of width be allowed for each mature animal, if the silage is available 24 hours daily. A minimum width of 16 feet should be used to reduce "boss cow" trouble. The silage depth should not exceed 6 to 6½ feet to permit the animals to feed from the entire face of the silage.

In planning the capacity, remember that animals will eat large amounts of the silage when given free access. It is not uncommon for mature animals to eat 75 pounds per day.

Construction of Self-Feeding Horizontal Silos

The construction of a self-feeding silo involves more materials and labor than the low-cost horizontal silo. It is a permanent structure requiring little yearly maintenance. For successful self-feeding the requirements are: (1) a concrete floor; (2) lined sidewalls which aid in guiding and holding feeder racks, as well as containing the cattle; and (3) sufficient floor slope for good drainage (at least 2 ft. fall in 100 ft. of length).

Undisturbed Soil — Lined Silo

Since the walls of the silo will be lined (Fig. 4), the side slopes should be made steep. A top silo width 1 to 2 ft. wider than the bottom is recommended.

The banks behind the wall should be smoothed so that a uniform slope is obtained. The use of guide lines and batter boards will prove helpful in aligning the wall. Dig the postholes larger than necessary to simplify setting and aligning posts.

A detail of tilt-up concrete walls is shown in Fig. 5. Edge-forms can be placed on the previously poured silo floor and positioned just opposite the place where the slab fits into the wall. Inexpensive paper should be placed on the floor before pouring the concrete. The vertical steel should be placed 1 inch from the floor or the slab face that is to be the inside surface of the wall. The slab should be allowed to cure 4 or 5 days before tilting into place. An 8 ft. x 10 ft. slab, 4 inches thick, will weigh about 4,000 pounds. When tilting

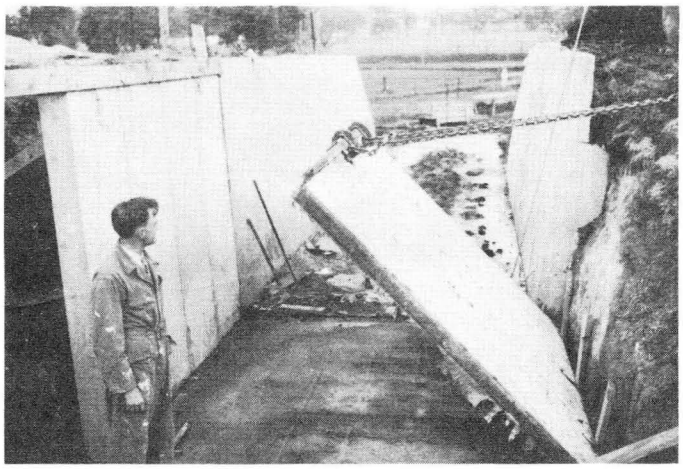


Fig. 6. Tilting an 8 x 10 ft. concrete wall panel into place for a line horizontal silo.

(Fig. 6), 2,000 pounds will have to be lifted. This should be possible with available farm equipment.

Partly-Above-Ground Lined Silo

This type of construction (Fig. 7) for self-feeding works well when a site permits the silo to be partly above or entirely above grade, and to have an earth backfill against the walls.

Poles should be set and aligned on the silo location at the proper spacing. When excavating, move the soil off the site so it does not interfere with construction. The four corner-posts should be braced with 4 to 6 inch poles to hold them firmly in place; the remainder of the poles should be tied back to deadmen. Brace several of the posts along each side to help support them while the earth fill is settling.

When the side walls are complete, earth should be filled along the wall to complete the silo. Be careful that the soil is not packed directly against the wall by the bulldozer when backfilling, but is allowed to fall freely against the wall. Proper backfilling may take a year or more to complete (Fig. 8).

Above-Ground Lined Silo

This type of silo can be constructed on locations that do not have sufficient slope to permit below-ground or partly-above-ground silos (Fig. 9). The walls must be strong enough to support silage pressures without the aid of soil. However, it is good

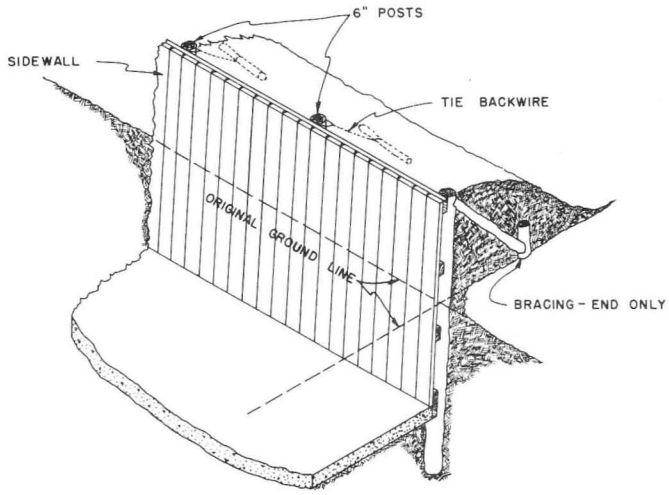


Fig. 7. Typical wood wall for below-ground or partly-above-ground horizontal silos.

practice to fill earth at the base of the wall to prevent air leakage underneath.

TABLE 2—Self-Feeding Size*

Number of Animal Units	*Months*	6	6½	7	7½	8	8½	9	9½
	Weeks	*26*	28	30	32	34	36	38	40
		(w x l)†	(w x l)	(w x l)	(w x l)	(w x l)	(w x l)	(w x l)	(w x l)
20		16 ft. x 65 ft.	16 ft. x 70 ft.	16 ft. x 75 ft.	16 ft. x 80 ft.	16 ft. x 85 ft.	16 ft. x 90 ft.	16 ft. x 90 ft.	16 ft. x 100 ft.
30		20 ft. x 80 ft.	20 ft. x 85 ft.	20 ft. x 90 ft.	20 ft. x 95 ft.	20 ft. x 100 ft.	20 ft. x 110 ft.	20 ft. x 115 ft.	20 ft. x 120 ft.
40		30 ft. x 70 ft.	30 ft. x 75 ft.	30 ft. x 80 ft.	30 ft. x 85 ft.	30 ft. x 90 ft.	30 ft. x 95 ft.	30 ft. x 100 ft.	30 ft. x 110 ft.
50		35 ft. x 75 ft.	35 ft. x 80 ft.	35 ft. x 85 ft.	35 ft. x 90 ft.	35 ft. x 95 ft.	35 ft. x 100 ft.	35 ft. x 110 ft.	35 ft. x 120 ft.

* Based on 75 Pounds Feed Per Day. Depth approximately 6½ ft. — Silage Weight 40 lb. per cu. ft.

† (w x l) = width times length

Posts, at least 6 inches in diameter, should be spaced no more than 6 feet apart, set 3 feet deep, and braced with 4-inch poles. Use guide lines to aid in digging and aligning the post holes. Framing of 2 x 6's spaced evenly on the poles provides sufficient support between posts. For an air-tight wall, use one of the constructions shown in Fig. 10 or that in Fig. 11. Figure 11 also shows details of an above-ground concrete silo, using "tilt-up" or lift-slab construction.

This slab weighs approximately 6,000 pounds and will be too heavy to lift with ordinary farm equipment. The steel is placed 1 inch above the bottom of the slab when pouring and must be near the outer face when in position. The slab has to be lifted to a vertical position and moved into place against previously poured buttresses.

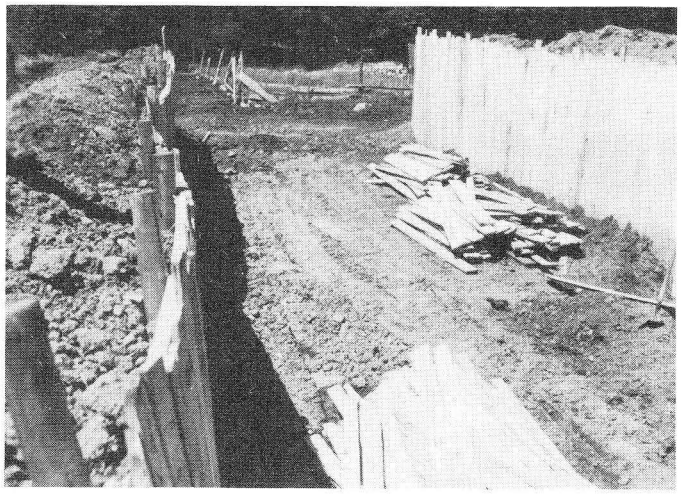


Fig. 8. Wavy wall produced by improper back-filling of a partly-above-ground silo.

Floors

Floors are as important as the walls. They should be smooth, sound, and possess sufficient slope for good drainage.

Earth floors are satisfactory for low-cost silos, provided they are able to support the unloading machinery in the spring. A 2 ft. fall per 100 ft. of silo length is needed for surface drainage.

But concrete floors are a "must" for self-feeding silos. Complete failure of the system can result when cattle are self-fed on an earth floor. It is recommended that the thickness of the concrete be increased from 4 to 6 inches as the floor approaches the open end of the silo (Fig. 12), to support heavier traffic and resist frost action. This should be taken into consideration when the floor is graded, prior to pouring the concrete.

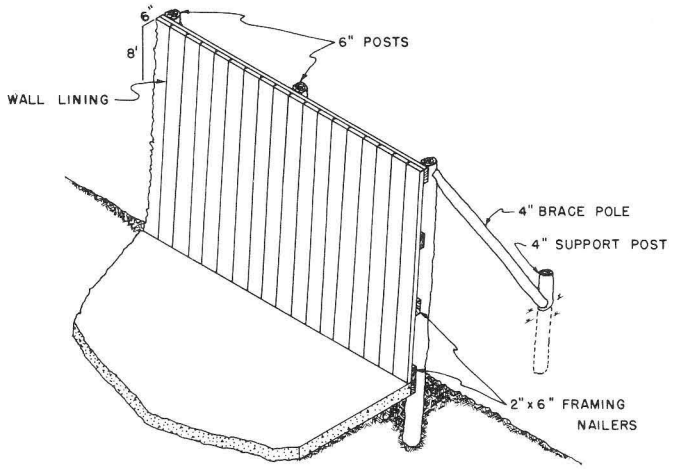


Fig. 9. Above-ground wood construction. The posts should be spaced 6 ft. on centers and set to a depth of 3 ft.

Floors can be crowned 1 inch at the middle or sloped 2 inches to one side for cross-silo drainage.

Steps in placing a concrete floor for a horizontal silo are as follows:

1. Grade the silo location to a 2 ft. per 100 ft. slope toward open end.
2. Set posts for silo walls.

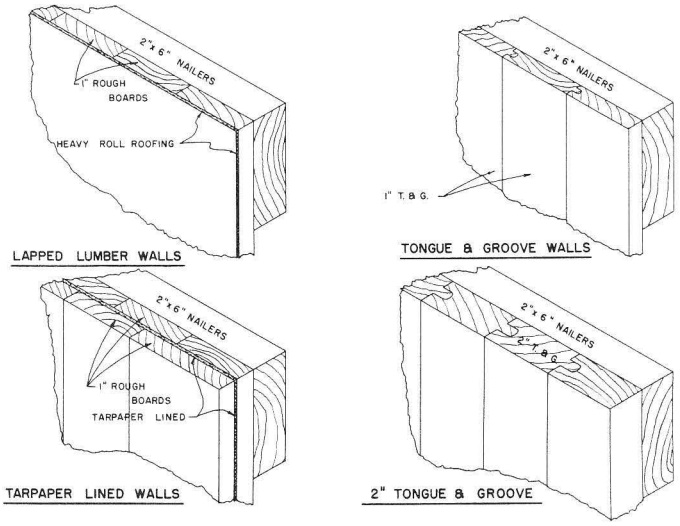


Fig. 10. Wall construction details.

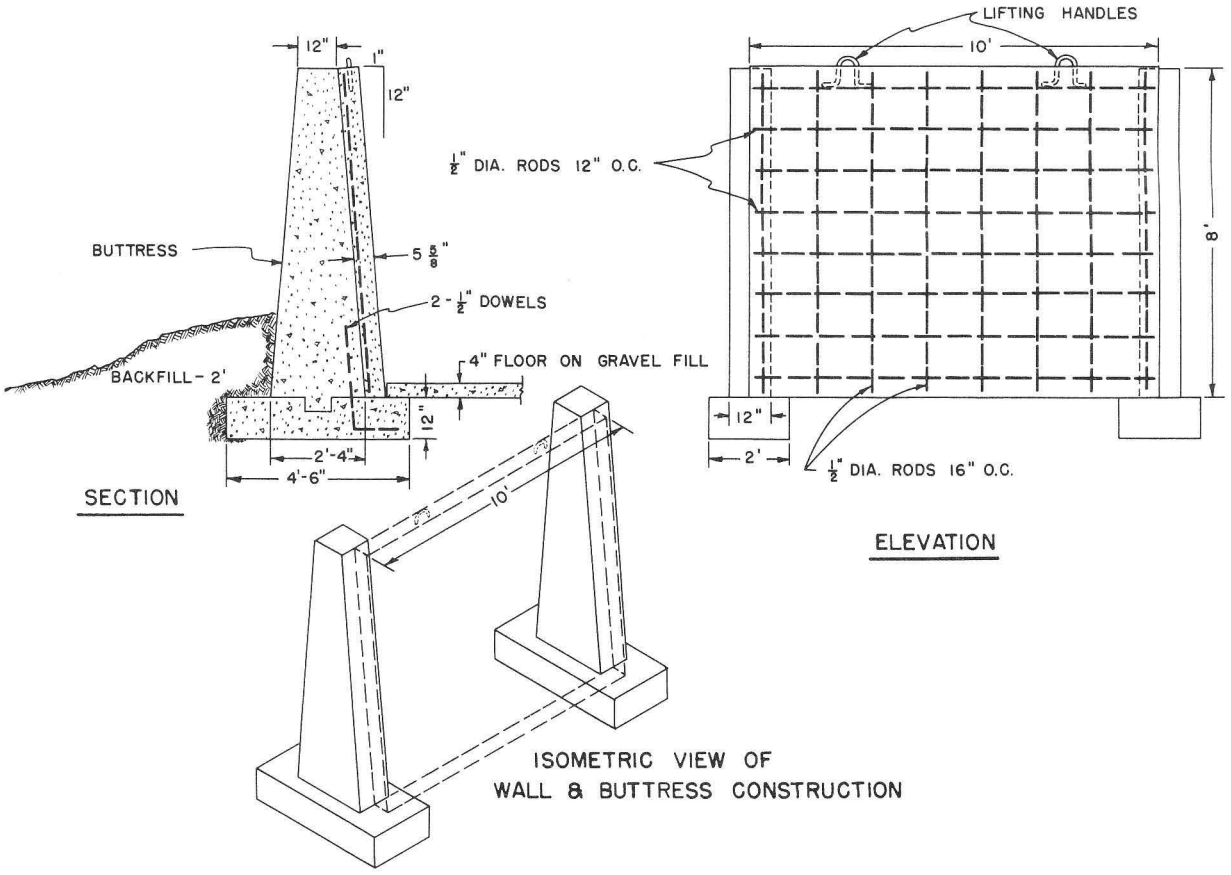


Fig. 11. Above-ground, "tilt-up" concrete silo.

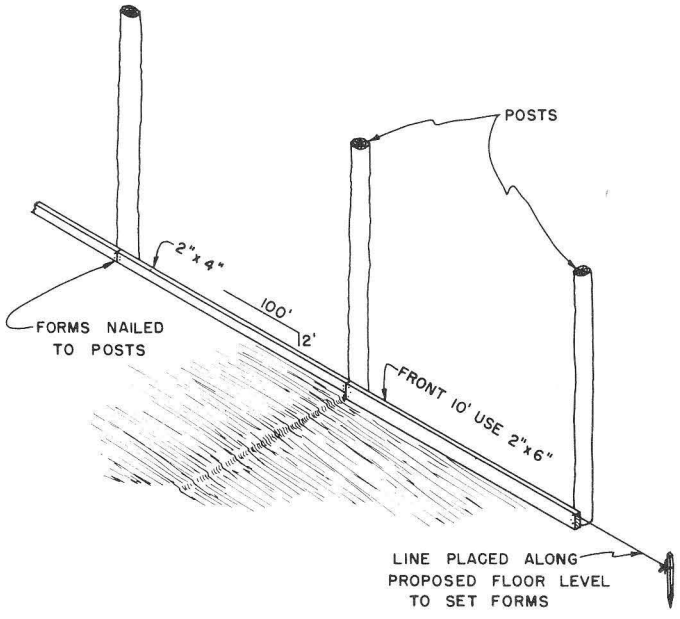


Fig. 12. Form construction for silo floors.

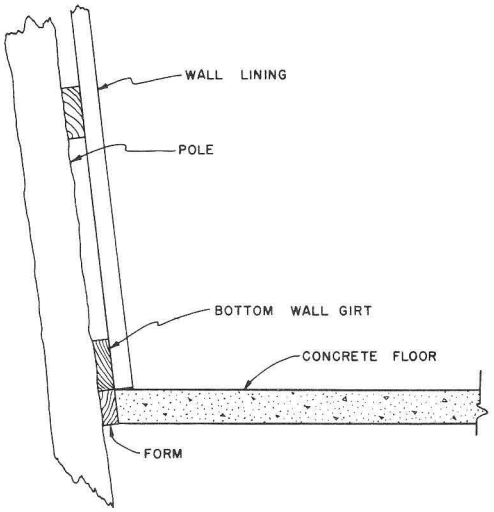


Fig. 13. Detail of floor and wall joint.

3. Stretch a line along the proposed finished floor height.
4. Start at ramp end of silo, placing the top edge of a 2 x 4 form on the line. Finish off at the last 10 ft. with 2 x 6's.
5. Place end-forms—level and pack floor base.
6. Use expansion joints every 40 to 50 ft. and grooves in the concrete every 16 to 20 ft.
7. Crowning or sloping to one side is recommended to aid in good drainage.
8. Place concrete level with top of the forms. Finish with a wood float.
9. After forms are removed, level the area outside the silo down to the concrete surface.

The bottom wall-stringer should be placed on top of the forms (Fig. 13) so that the siding will rest on the floor. It is advisable to tar this joint on above-grade silos.

Ramps

A ramp at the closed end of the silo is desirable because: (1) it provides a third wall which reduces the surface area of silage exposed to the air, (2) it acts as a diversion for surface runoff above the silo, and (3) the ramp provides an entrance over the top of the silage when filling and packing.

For above-ground and partially-above-ground silos, move earth into a mound as shown in Fig. 14. The approach should be constructed with a slope suitable for climbing. One foot rise in 5 ft. length is about a maximum slope for the approach ramp. The inner slope will vary with the stability of soil available, but should be as steep as can be safely driven over (Fig. 14, top).

In sandy soils which will not stand, it is advisable to use a pole retaining wall and backfill behind it (Fig. 14, bottom). This ramp does not allow drive-through until the inner side has been built up with a few loads of silage.

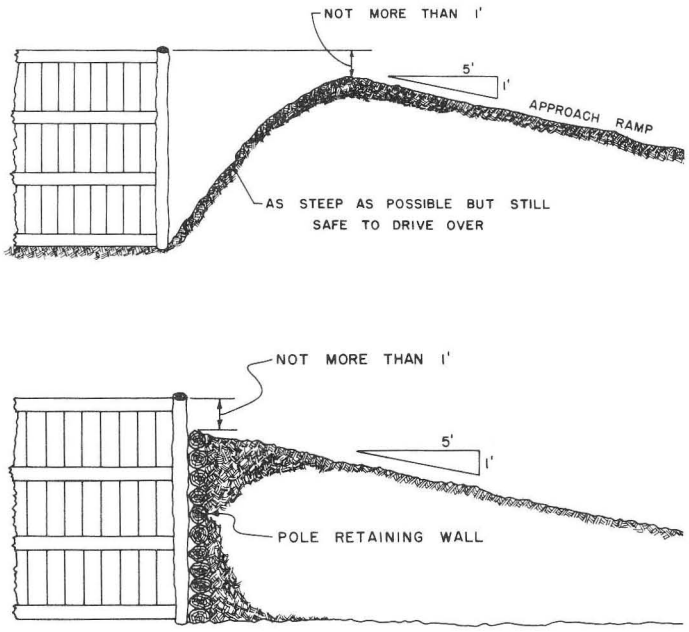


Fig. 14. Ramp construction in firm soil (top). Built-up ramp in a non-stable soil (bottom).

Filling Methods

Filling horizontal silos may not differ greatly from filling the vertical silo. However, in some situations less machinery is involved. The filling operation consists of (1) harvesting the crop, (2) hauling, (3) unloading, and (4) leveling and packing. There are many combinations of machines and procedures that provide satisfactory filling.

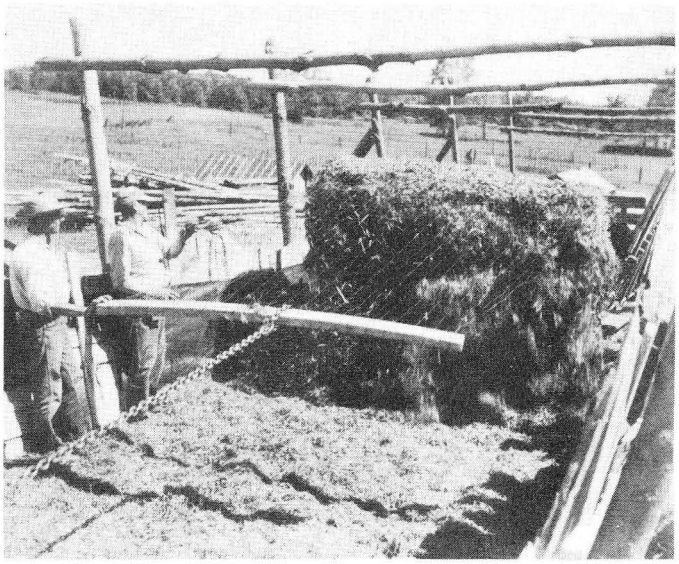


Fig. 15. An effective homemade unloader.

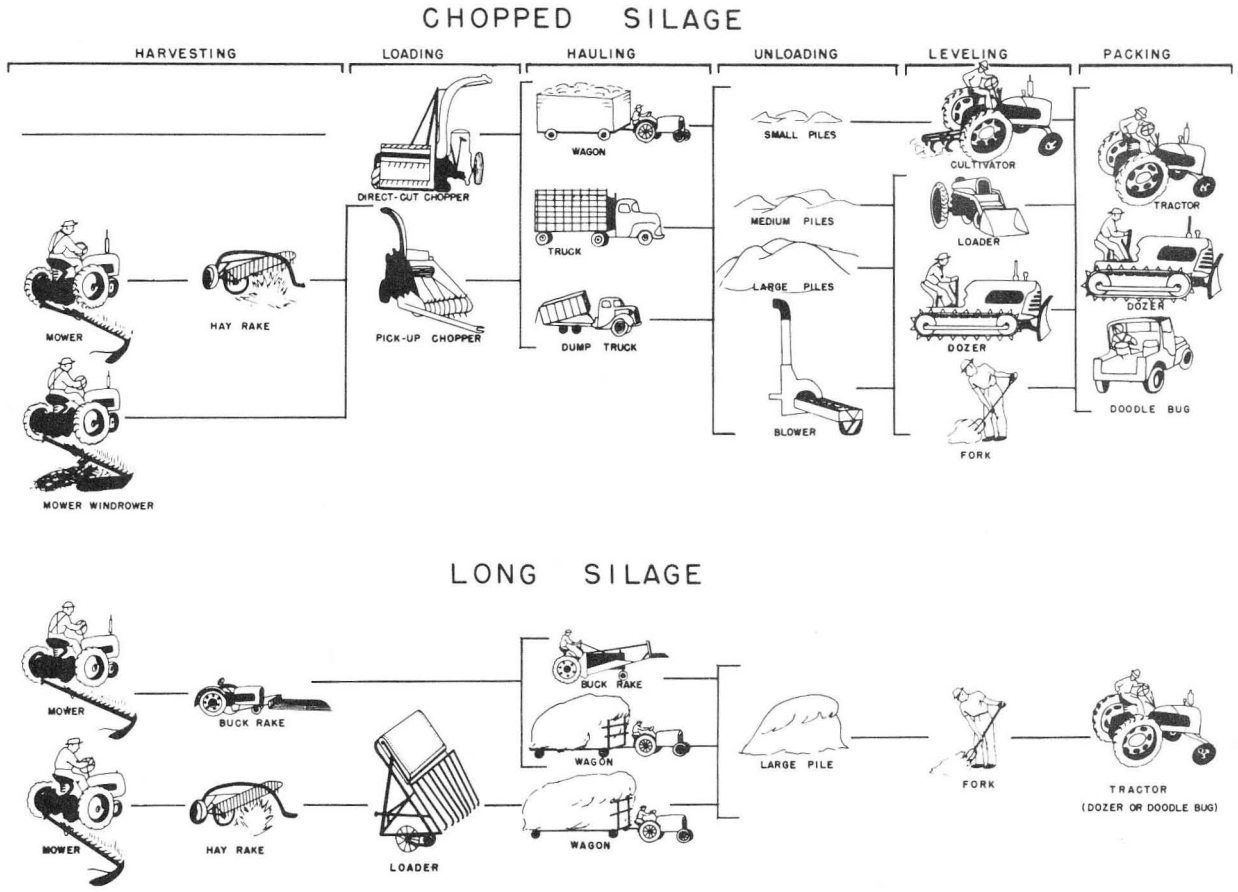


Fig. 16. Chart for selecting a filling method for horizontal silos.

Figure 16 is a pictorial aid for selecting the filling method. To select the machinery involved, move from left to right through the colunm headings (Harvesting, Hauling, etc.), selecting the combination that will best fit an individual farm situation. The process must be connected by solid lines.

For example, cut with a mower windrower, pick-up with a pick-up chopper, haul with a false endgate unloading wagon, level with a front-end-mounted manure fork, and pack with the same tractor. Other combinations can be worked out from the chart. Figure 15 shows a farm-made unloading device.

Packing

The object of packing is to remove excess air so that the silage will keep (Figs. 17 and 18). It also makes it possible to drive through the silo with succeeding loads. A good packing job next to the wall helps to prevent spoilage by keeping the silage tight to the wall and air out. When filling, the silage should be kept high near the wall so that the

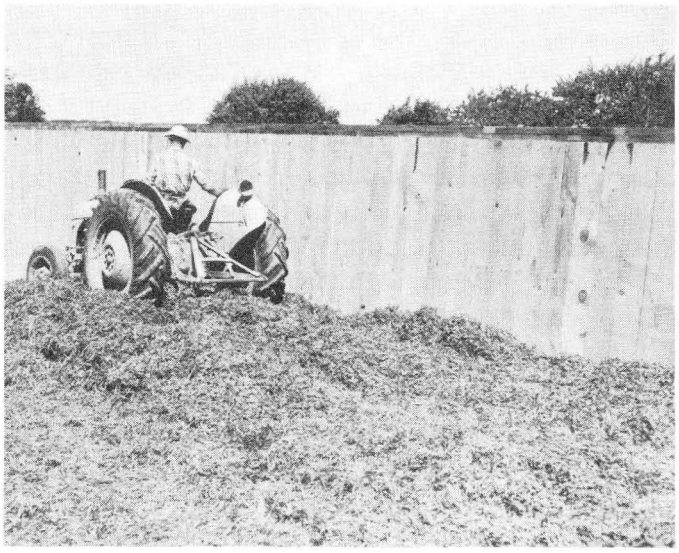


Fig. 17. Good packing of the silage is important.

tractor can pack without injury to the wall. It is difficult to overpack—many do not pack enough. A minimum of 10 minutes per load is recommended. A slow moving tractor packs more effectively than a fast one.

Packing does not end when the silo is filled. Many farmers spend at least ½ hour a day packing for a week to 10 days, after the silo is completely filled. This aids in removing pockets left by settling.

Covering

Silos left uncovered can have 6 to 8 inches of spoilage on the top surface, and this depth

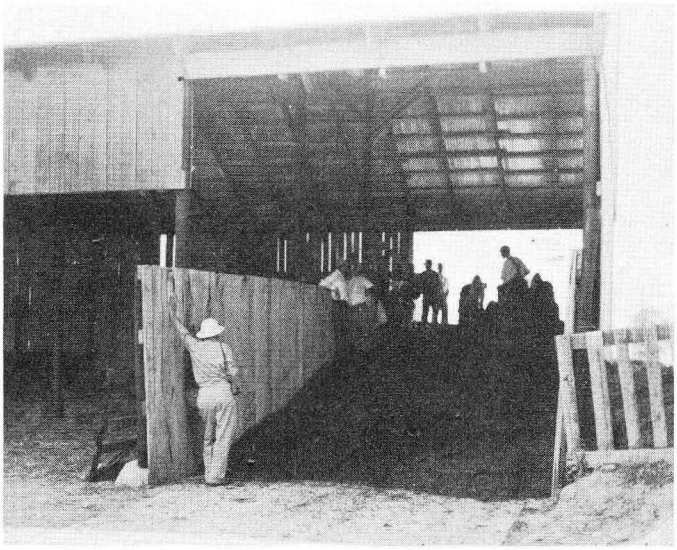


Fig. 18. Filling a horizontal silo which is part of a pole barn.

may increase as spring approaches. It, therefore, is desirable that some form of waste-covering material be used to reduce the quantity of spoilage. The cover can be a variety of materials from rotten, soggy sawdust (Fig. 19) to worthless hay or straw. It should be at least 6 inches thick.

Better results can be obtained if a vapor barrier—such as roll roofing or 15-pound felt building paper—is used over the silage and covered with some waste material. This will prevent an exchange of moisture to or from the silage. When using a paper covering, it is good practice to lay the paper across the width of the silo, lapping the joints, so that a week's feeding can be uncovered at one time, without breaking the seal elsewhere.

Fig. 19. A filled, above-ground horizontal silo with a cover of sawdust.

Feeding From Low-Cost Storages

The silage should be removed and fed at some distance from the silo in a feed bunker. A spike-tooth manure loader is a good way to remove the silage and transport it to the feeding area. In many cases, hand removal is used. Spoilage can be held to a minimum by using good management when removing the silage. Take small bites of not more than 2 to 2½ ft. in length with the loader. Hand removal should follow the same procedure.

The feed bunk pictured in Fig. 20 is a typical example of what is being used with good results. Movable bunks may be taken to the silo, filled, and then transported back to the feeding area.

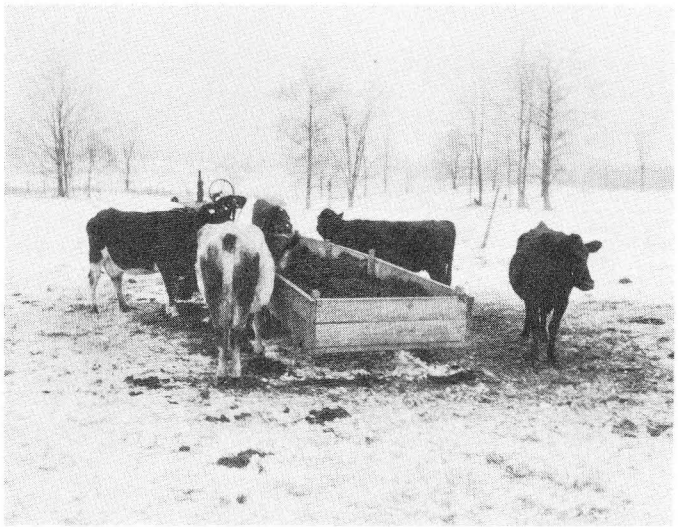
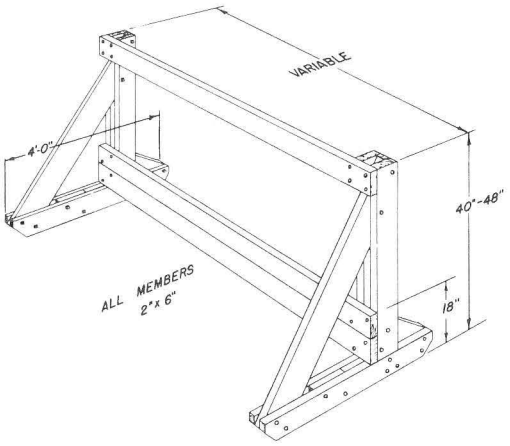


Fig. 20. A trailer feed bunk, movable by tractor to any location.



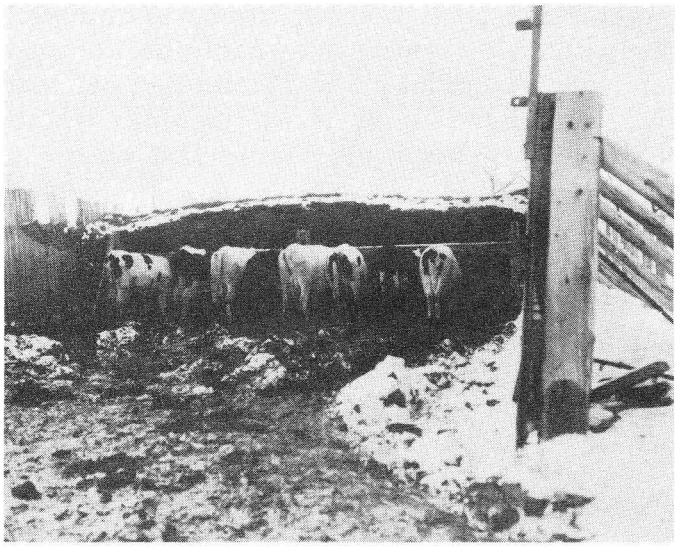


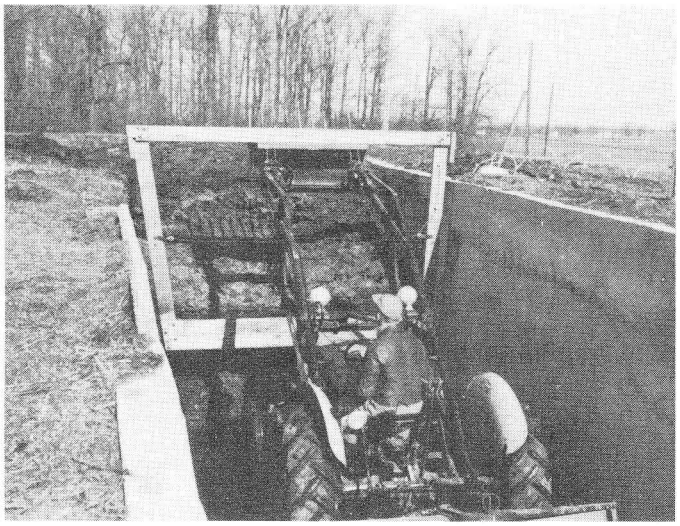
Fig. 21. A "push-back" feeding gate.

Feeding From Self-Feeding Silos

A good self-feeding system requires certain standards of the silo and of the manager. These requirements are (1) ample eating-space for the animals, (2) a well-defined set of walls, and (3) a concrete floor. The management of the self-feeding process is very important. Even though the animals are allowed free access to the silage, it is necessary that they be prevented from tramping on it. Feeding gates, like those pictured in Figs. 21 and 22, provide suitable barriers necessary for keeping the cattle off the silage. The construction is not difficult. An electric fence can make an even simpler "gate".

The management of the self-feeding system does not stop with providing the essential tools, but continues with the proper use of them. Feeding gates should be kept about 18 inches from the silage. Adjustments should be made as the animals clean up the silage. Spoiled silage and covering material should be removed as needed.

A good management program consists of the following daily steps: (1) check the silage and throw out spoilage, (2) adjust the feeding gates for proper feeding position, (3) remove the cover from the next section of silage, and (4) scrape the feeding area to provide good drainage.



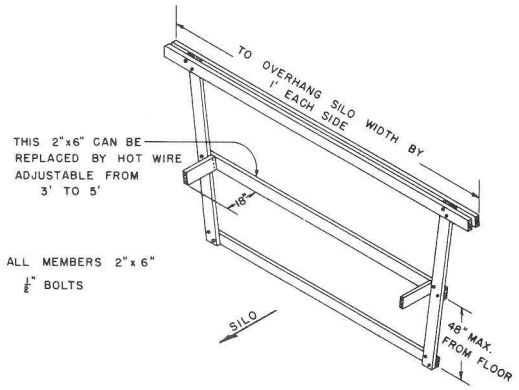


Fig. 22. A "wall-hung" feeding gate.