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Self-feeding bunker silos

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Self-Feeding Bunker Silos

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Introduction

Competitive markets for both dairy and beef products, together vith a shortage of farm labor, have resulted in the farmer's seekng better and more economical means of feeding livestock. These economic factors have been responsible for the mass movement of outhern stock farmers to better grassland farming. In the South, ertain grasses and legumes can be grown in abundance in early pring when the frequency of rains and damp ground makes field uring of hay practically impossible. In such cases the feed can be aved as silage. Properly prepared and stored, silage has always een recognized as an excellent food, but by and large, the southern tock farm has failed to take advantage of feeding silage because f the investment involved and the labor required for feeding it. This particularly applies to beef cattle farmers.

Experiments were conducted to seek a suitable low cost method f storing and feeding silage in the South where the land is practically flat and rather poorly drained. The above-ground bunker silo s a result of these tests. Many of the early experiments resulted in igh dry matter losses as compared to losses with the conventional pright silo long in use by the more progressive dairy farmers. However, as better filling and packing methods were introduced, as vell as improved silo construction, these losses from bunker silos vere reduced until they compared favorably with losses from other ccepted methods of storing silage.

The above-ground bunker type silo appealed to the stock farmer ecause of its low cost construction, large capacity, adaptability o feeding and field locations, handling methods and self-feeding. Bunker silos are well adapted for use in the flat coastal areas where igh water tables make trench silos impracticable. They can be onveniently located in the areas where the feeding is done. The lecision to build a bunker silo should be based on these factors ut should also take into consideration that very high spoilage losses an be expected with poor handling and management practices.

Locating the Silo

The bunker silo should be placed on a spot that is as well lrained as possible in the area where it is to be located. The site hould be easily accessible both to the fields where the ensilage is grown and to the pastures where the cattle will be fed. Many farr-ers have located large-capacity silos that are to be self-fed across fence line dividing two pastures so that they can self-feed each e of the silo from a different pasture. Drainage at the site is ve

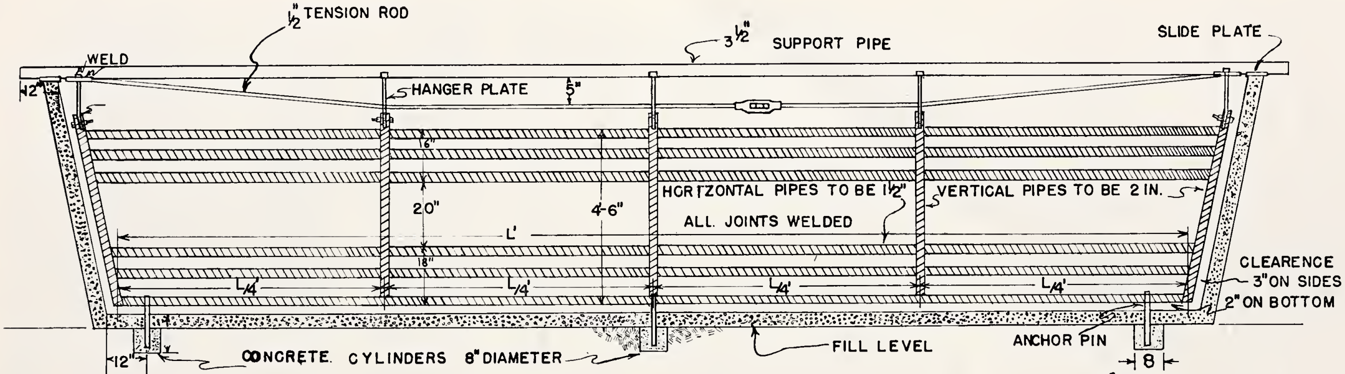
Fig. 1.—Floor slab poured for a bunker silo on a slight ridge in normal flat land.

important since seepage from the silo, as well as rain water, mu be drained away. Rain water should not enter the silo, and a drai-age or diversion ditch should be made on both ends and sides of t silo.

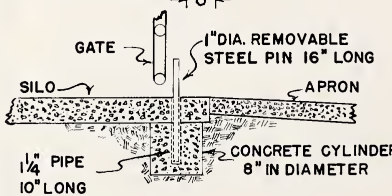
Do not place the bunker silo with either end next to a buildin, row of trees, or a ditch, since ample room must be allowed to turn leaving or entering the silo. Figure 1 shows a floor slab poure for a bunker type silo on a slight crown of the land in an area th is normally flat.

Size and Capacity

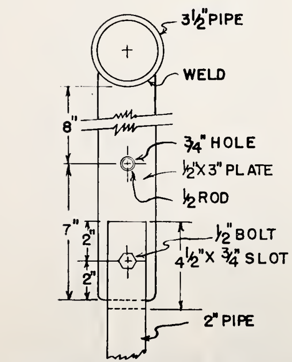
The over-all size of a bunker silo to build will be governed by t size of the herd to be fed. If the silage is to be self-fed, the wid of the silo would depend on the size of the herd in that pastu where the silo is located. In many instances one silo will be use to feed cattle from two pastures by feeding from both ends of t silo. Other factors determining the required size of the silo are t amount of silage fed daily and the length of the feeding period.



FACE VIEW OF GATE
SCALE: 1/2" = 1'-0"



ANCHOR PIN DETAIL
SCALE: 1" = 1'-0"



HANGER PLATE DETAIL
SCALE: 1/4" = 1"

SLIDE PLATE DETAIL
SCALE: 1/4" = 1"

The self-feeding gate shown in Fig. 2 is designed to allow two cows to feed from this gate for each foot of silo width where they have free access to the silo at all times. To prevent the width from becoming overly large for big herds, it is recommended to feed from both ends of the silo. A silo narrower than 10 feet is not recommended. For self-feeding, the side walls of the silo should not be taller than 6 feet and the silage should have a crown of 2 to 2½ feet in the middle after packing. This will give a center height of approximately 8 feet, which is as high as an animal can reach while feeding. Silos with side walls of 8 to 10 feet are satisfactory where the silage is to be hauled from the silo and not self-fed.

In arriving at the over-all size of a self-feeding silo for a given herd, assume that the average animal will consume approximately 60 pounds of silage per day and that the silage weighs 40 pounds per cubic foot. The number of days that the cattle will be fed from

Table I.—Approximate Capacities of Silos of Various Widths and Lengths

FEEDING PERIOD		120 DAYS	160 DAYS	200 DAYS	Capacity
Herd Size	Width of Silo	Length of Silo 60 Ft.	80 Ft.	100 Ft.	for Each 4 Feet of Length
24 head	12 ft.	86 tons	115 tons	144 tons	5.7 tons
28 head	14 ft.	100 tons	134 tons	168 tons	6.7 tons
32 head	16 ft.	115 tons	153 tons	192 tons	7.7 tons
40 head	20 ft.	144 tons	192 tons	240 tons	9.6 tons
48 head	24 ft.	172 tons	230 tons	288 tons	11.5 tons
60 head	30 ft.	216 tons	288 tons	360 tons	14.4 tons

1. Capacity is based on silage weight of 40 lbs. per cubic foot and settled depth of 6 feet, except at ends.

2. Width of silo is based on herd size and on an average consumption of 60 lbs. of silage per animal per day.

3. Length of silo based on 6" daily rate of use for warm weather conditions. Length may be varied in units of 4 feet.

the silo will govern the desired length of the silo. The beef cattle farmer along the coastal area usually plans on having to feed from silos from 100 to 120 days during the winter months. With this as a basis, the size of the silo can be determined. For example, a silo 20 feet wide should feed 40 cows from one end, and they will consume 60 pounds of feed per cow per day for a period of 120 days. The silage required would be 40 x 60 x 120 = 288,000 lbs., or 144 tons. A silo of this size will have an approximate capacity of 5,800 pounds per foot of length, so the length will have to be about 50 feet. If the silo is to feed 40 cows from each end, then the length will have to be 100 feet. The approximate capacities of silos of various widths and lengths are given in Table I.

Construction

The above-ground bunker type silo must be built rigid and strong to withstand the heavy packing loads required for preserving good silage. Materials used should be capable of withstanding weather and silage juices.

Floor

The bunker silo floor must be made of some material that will not soften from wet weather and silage juices. The floors of a self-feeding silo must also withstand the constant wear and tear from cattle hoofs. A silo without a hard floor cannot be self-fed from, nor hauled out of, because it will be a mud puddle as soon as it is opened for use. Concrete or asphalt makes the best floors, although treated timber can be used. Concrete is usually easier than asphalt for the farmer to use since it requires no special machinery. Figure 1 shows a concrete floor just after pouring. Concrete floors should be from 4 to 5 inches thick and a No. 9-6 x 6 wire mesh reinforcement is advisable. For asphalt floors a thickness of 4 inches laid over a well packed and rolled soil subbase 6 inches thick is advisable. The floor must be sloped to the open end of the silo in order to drain rain water, silage juices and manure away from the silage. If both ends are to be self-feeding, then the floor must be sloped from the center of the silo to each open end. The slope should be from 3/8 to 1/2 inch per foot of silo length. If the silo is located on the crest of a slight ridge, then the slope to the open ends can usually be obtained without filling. The silo floor shown in Fig. 1 is located across the crest of a ridge and will be self-feeding from both ends. Some designs show the floor sloping from the center to the sides in addition to sloping to the ends. If the proper slope to the open ends is maintained the side slope can be eliminated. If the silage is to be fed out by hand or mechanically, then a slope of 1/4 inch per foot is satisfactory.

An apron on each end of the silo made of the same material as the floor and extending out from 16 to 18 feet is highly recommended. This is to prevent the cattle from creating a muddy condition at the entrance of the silo and also serves as a place for turning the packing tractor while loading the silo.

Walls

There are many materials that can be used for the silo side walls. The type used will be governed somewhat by the cost and availability of the materials in each locality. The wall construction must be strong enough to withstand the loads imposed upon it by the silage, plus the packing tractor and silage wagons while filling. Research work conducted by Esmay (1) and Poole (2) indicates that the greatest stress on the side walls occurs while the silage is

Fig. 3.—A test silo to determine the suitability of side wall materials.

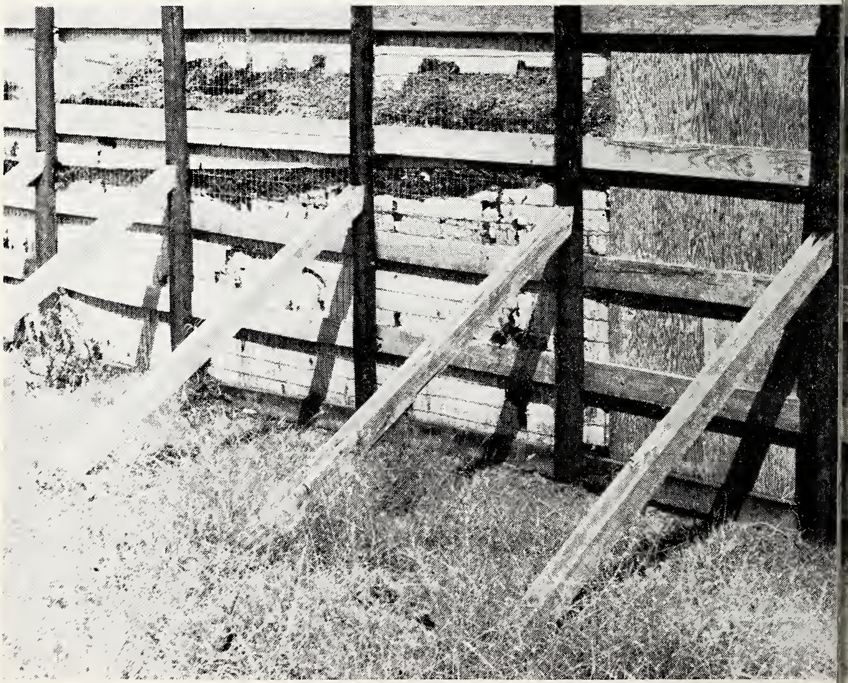


Fig. 4.—Side wall materials for silo. Right: exterior plywood. Left: weld wire with waterproof paper covering.

being packed. This side wall pressure ranges from 150 to 220 pounds per square foot as the packing tractor packs the silage next to the side walls. After packing, this side wall pressure is reduced to approximately 100 pounds per square foot. Pressure on the side walls will increase for a given vertical pressure as the angle or slope of the side wall increases. Therefore, the slope of the side walls should not be greater than necessary to assure good uniform packing along the side walls. A side wall slope of 12 inches for an 8-foot side or 9 inches for a 6-foot side is recommended.

The walls may be made of earth, concrete, treated lumber, exterior plywood, or perhaps other materials that may be economically available and which will withstand the pressures and weathering. Figure 3 shows a test silo at Louisiana State University that was constructed and used to determine the suitability of the various side wall materials. Materials tested under actual operating conditions on this silo were exterior fir plywood, welded wire and waterproof paper, corrugated asbestos roofing, treated timber and concrete staves. Of all the materials tested only the welded wire with waterproof paper proved inadequate, as shown in Figure 4.

The correct height for the side walls of the silos has been a controversial question. Some farmers want to get the greatest capacity for a given floor area and make the side walls 8 feet high. This is considered to be too high for self-feeding, requiring more attention since the cattle cannot reach the top. For the best results of self-feeding, it is felt that 6-foot walls are more desirable.

Materials for side walls for bunker type silos are described as follows.

Earth Bank—Many of these have been built with farm tractors. A bulldozer is frequently used and sometimes a dragline. The

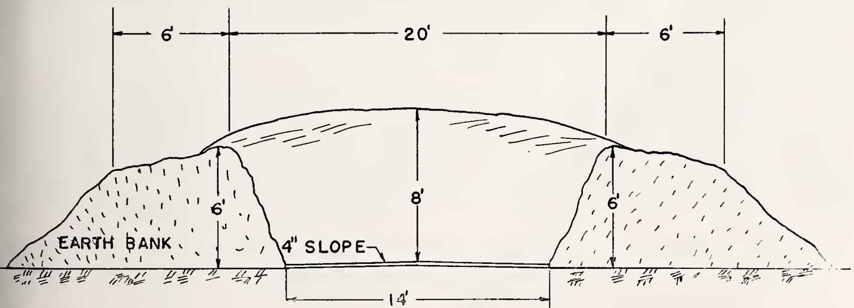


Fig. 5.—Cross section of a typical earth bank bunker silo.

shape and size of the earth banks are important as they must be sufficiently broad at the base to permit building the bank to a packed settled depth of 6 feet. Allowances must be made for settling even though packing is done while the bank is being built, by building it higher than the desired settled height. The slope of th earth banks should be 2 feet up for each 1 foot over. The top of th bank should be fairly wide so that a tractor can partly run on while finishing packing the silo. This bank should slope slightly to ward the outside to enable rain water to drain away from the si age. A cross section detail of the earth bank silo is shown in Fig.

Fig. 6—Earth bank silo where silage is hand loaded into wagons.

To self feed from an earth bank silo, timbers must be placed alon the top of the bank on which the beam will rest for holding the sel feeding gate. A fence must also be installed along the top of th earth bank to prevent cattle from walking on top of the silag Figure 6 shows an earth bank silo where the silage is being haule from the silo.

Tilt-up Concrete Wall—Concrete walls are usually of the tilt-u panel type. The wall panels are 8 feet long and 6 or 8 feet tall an are poured on the silo floor and lifted into place, using a farı tractor and a gin pole of some type. Figure 7-A shows the concret panels being poured on the floor of the silo, and Fig. 7-B show the panels in place. This type of construction is very durable wit little or no upkeep costs. Details for this type of construction ar shown in Fig. 8.

Fig. 7. (A)—Preparing forms for pouring concrete wall panels. (B)—Concrete wall panels in place.

Timber Wall Construction—Pressure treated lumber such as 2" x 8", 2" x 10", etc., preferably T & G, is suitable for side wall material. Figure 9-A shows the details for constructing a timber side wall silo. The cantilever post construction is based on the use of structural grade timbers. It should be noted that the posts are anchored to the slab and the slab is thickened at each post for ad-

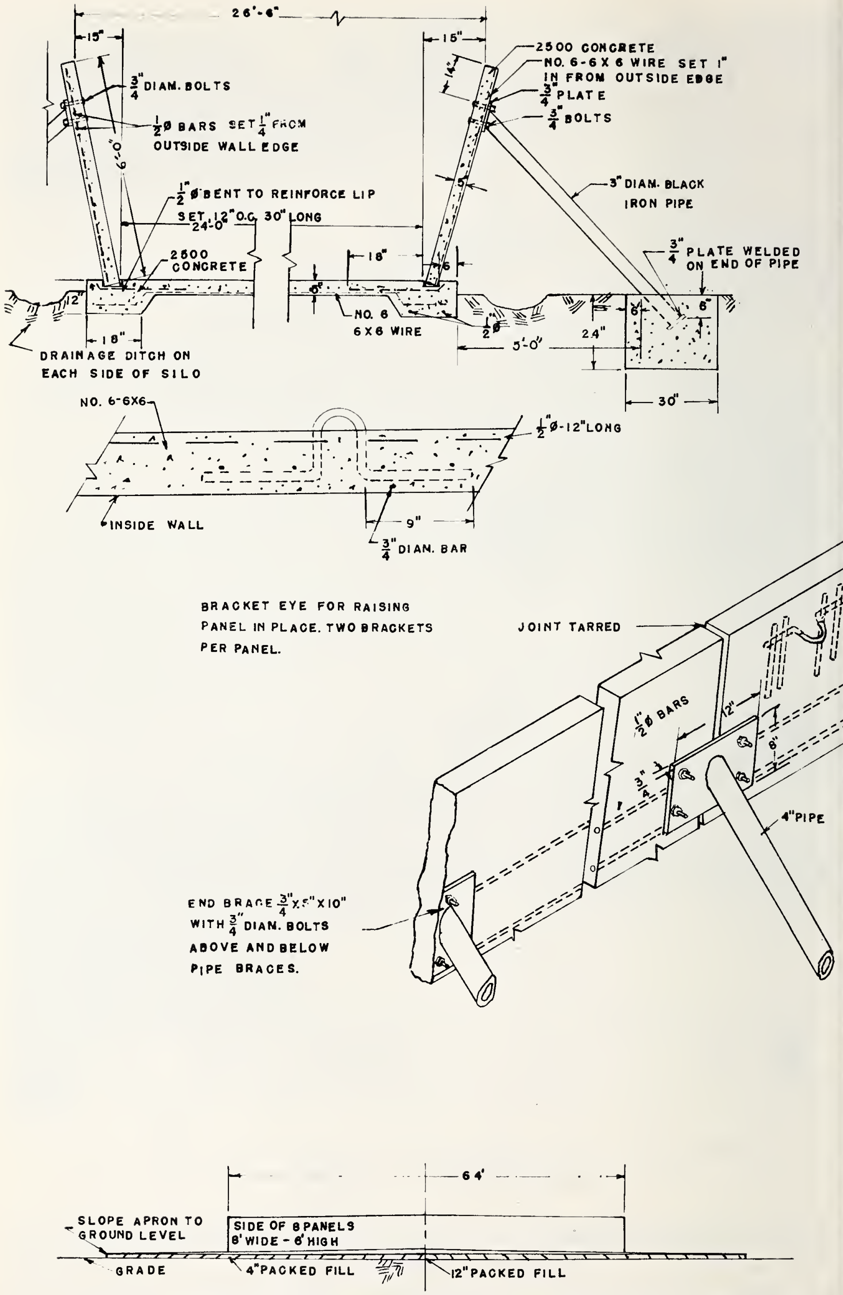
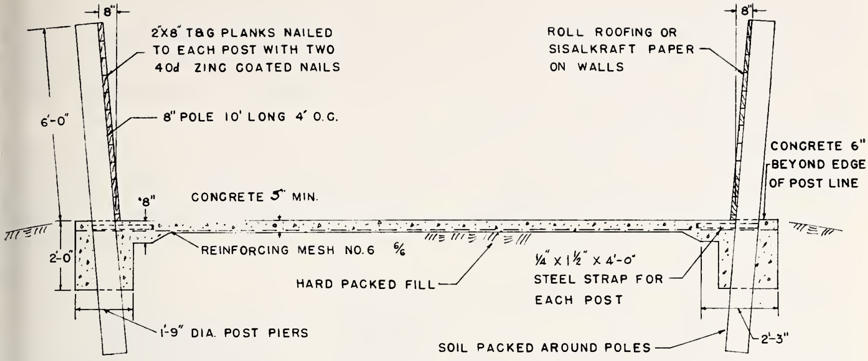
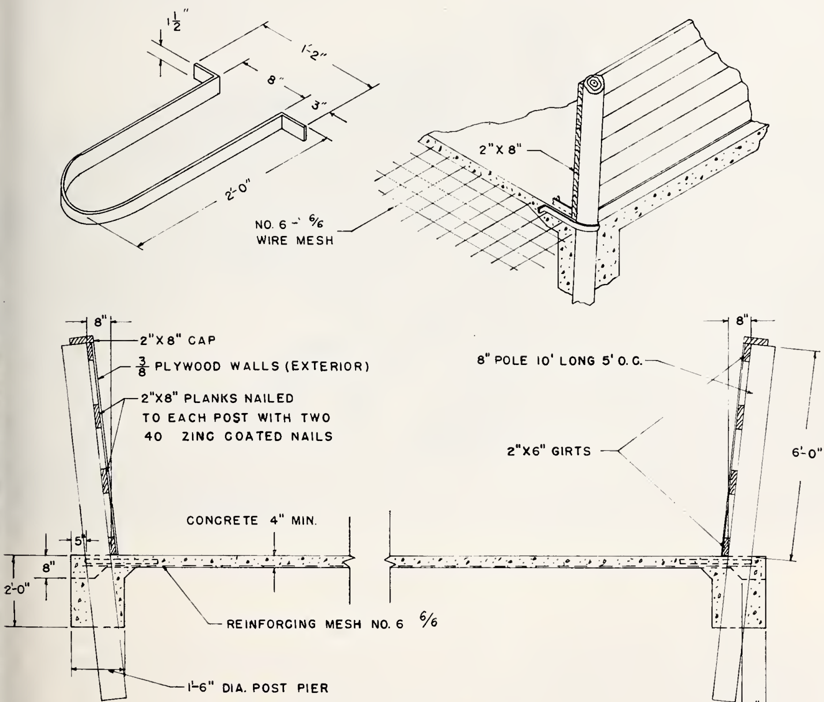


Fig. 8.—Details of construction of a tilt-up concrete wall silo.



A.



B.

Fig. 9. (A)—Details for constructing a timber wall bunker silo. (B)—Details for constructing a plywood wall bunker silo.

ditional support. If the side wall lumber is tight, such as T & G, th use of a liner of building felt or the like may be eliminated. How ever, if the boards are uneven and cracks exist in the side wall, i will be necessary to line the silo with some type of waterproof liner This material will last only one season.

Plywood as a side wall material has proved very satisfactory Figure 9-B shows the details for constructing such a silo. Plywood walls eliminate the necessity of using a waterproof paper or build ers felt liner. The walls should be of ⅜ inch exterior plywood interior or plyscore grades cannot be used. Surface cracking of th outer ply next to the silage can be prevented by applying a gen

Fig. 10.—Silo of discarded railroad crossties.

erous coat of Penta before filling the silo; however, after four year of use in a test silo these small surface cracks did not seem to in crease or cause the plywood to deteriorate.

Figure 10 shows a timber silo where the walls are made of dis carded railroad ties.

Other Side Wall Materials—Corrugated asbestos roofing in bot ¼- and ⅜-inch thicknesses were tested for use as a side wall ma terial. It was found to be excellent in withstanding silage aci and weather. The corrugations gave sufficient rigidity to the ma terial to withstand the lateral pressures and did not noticeabl hinder in any way the packing of the silage. The ¼-inch-thic asbestos was found to be too thin to resist the impact when struck with the unloading or packing machinery, so it is not recommended. The ⅜-inch-thick material was satisfactory. Figure 11 shows one wall of the silo which was tested.

Welded steel wire, 2" x 4", covered with a waterproof paper and/or builders felt was tested as a side wall material. The paper and felt damaged too easily while filling and deteriorated rather rapidly. Cattle also punctured the paper from the outside trying to get at the silage. Damage during test is shown in Fig. 4.

Fig. 11.—A bunker silo wall made of ⅜-inch-thick corrugated asbestos roofing.

One test wall was made of concrete silo staves. These staves were 30 inches long, 11 inches wide and 3 inches thick. Precast pilasters or posts were set every 30 inches to hold the staves and a 4" x 4" concrete brace post was used at each pilaster. Figure 12 shows this wall on a test silo before filling. This wall is now under trial test so results are not yet available; however, from observations this material looks promising for use as a bunker silo wall and compares favorably in cost with other more or less permanent materials. Figure 13 shows the details for constructing a concrete stave silo wall.

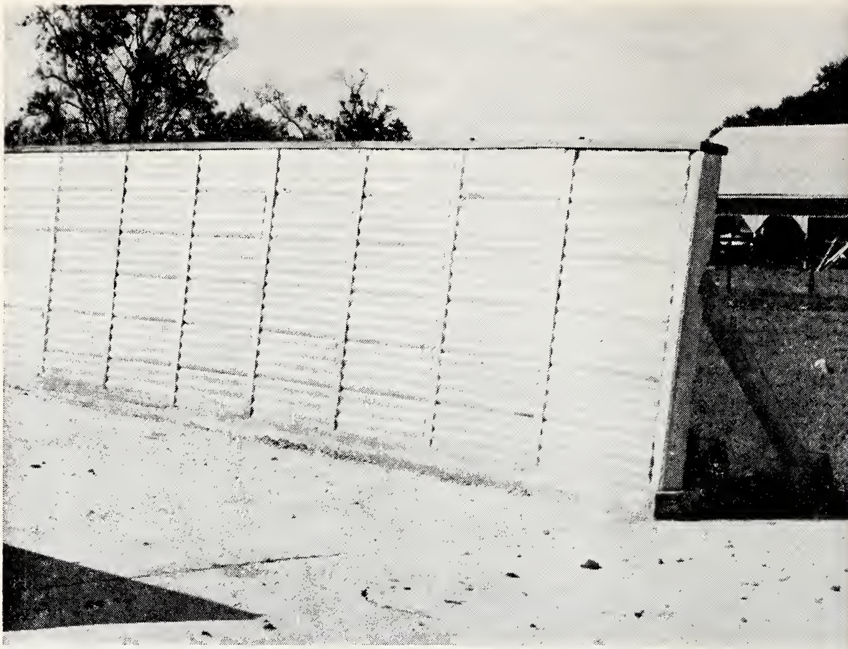
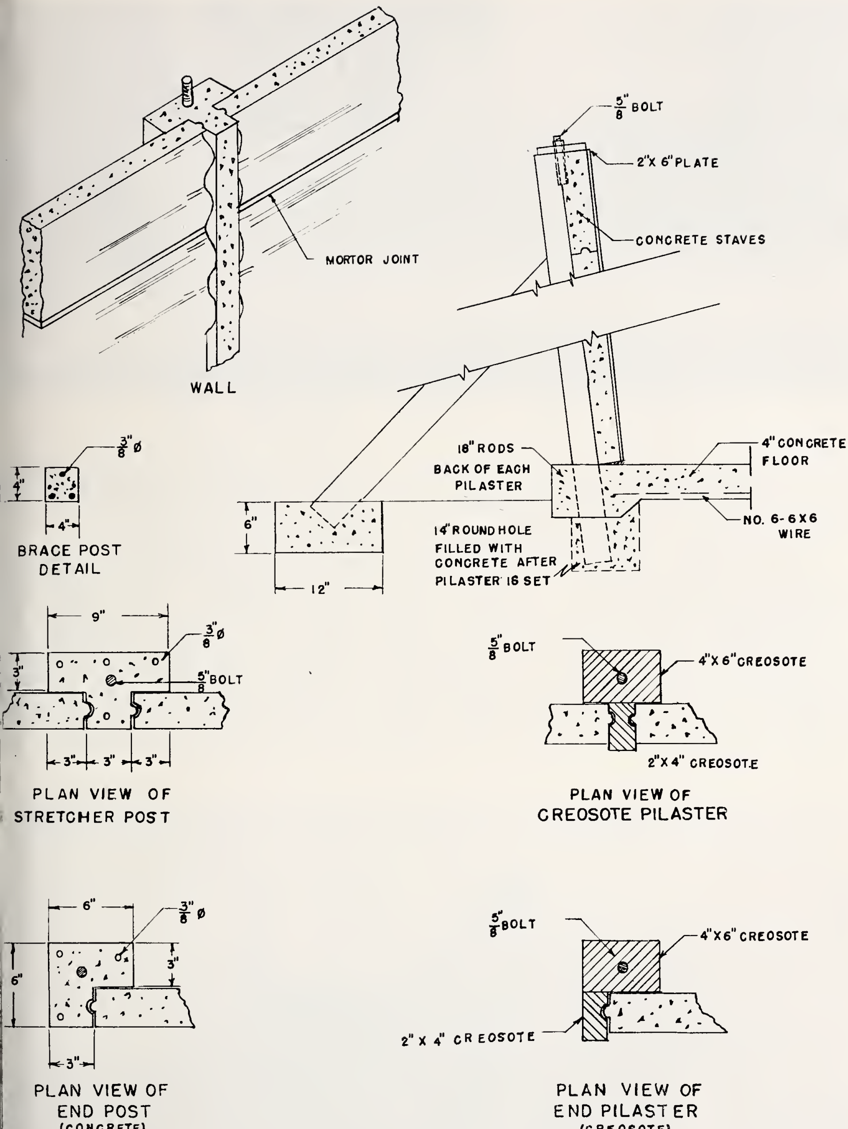


Fig. 12.—Concrete staves used as side wall material.

Self-Feeding Gates

The self-feeding gate is constructed so that the cattle ca feed themselves from the silo. Figure 2 shows in detail how to cor struct this self-feeding gate. The horizontal slot type of gate wi allow more cattle to feed for a given width than will the "V" typ It also causes less disturbance of the cattle during feeding, sinc the animal can move over instead of removing her head from th slot when disturbed by the boss cow. Figure 14 shows an all-welde metal self-feeding gate mounted on a concrete wall bunker silc This type of gate is supported on the silo side walls. Some gates hav been built to rest on a slide at each end of the gate so that the gat rests on the floor. Either method is satisfactory; however, it i easier to move the gate when it is supported from a pipe or timbe and rests on the silo walls.

In feeding from the silo it is necessary to check the silo a least once every two days and preferably each day. The gate wi have to be moved forward as the cows eat the silage. This is easil done by using an iron pipe or bar for a lever to slide the pipe o timber forward. Some types of silage may be so firmly packed tha the cows will have difficulty in pulling it from the stack. In thi case it will be necessary to cut some silage from the stack and pil it in front of the gate. This is particularly true when calves ar feeding from the silo.



'ig. 13.—Details for constructing a concrete stave wall for a bunker silo.

Filling and Packing

The silo can be filled with either long or chopped forage. Most 'armers find it requires less labor in handling when the forage is :ut and chopped in the field with a forage harvester. Chopped for- ıge is easier to pack and handle at the silo, and forage must be :hopped in order for it to be self fed from the bunker silo. The

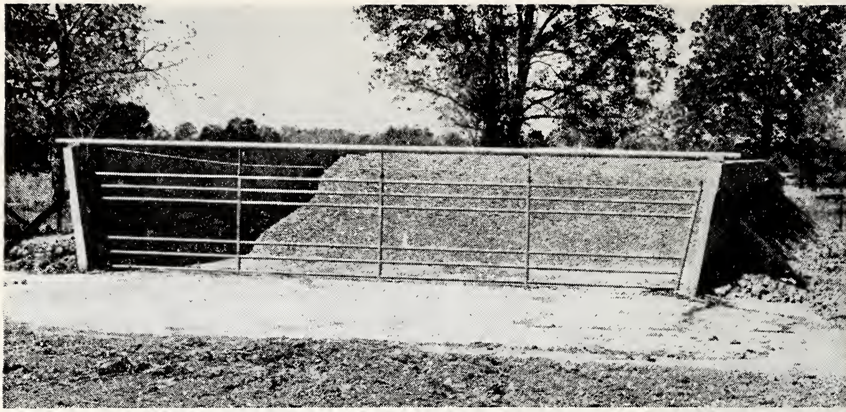


Fig. 14.—Concrete silo and self-feeding gate.

chopped silage is usually hauled to the silo in silage wagons. Thes wagons may have self-unloading features such as a movable en gate, canvas or wire roll bottom, wire sling or dump body.

The regular movable end gate or canvas roll method as used fo unloading silage into a silage blower was found to be slow an inconvenient when used at the bunker silo. It is not necessary t unload the wagon slowly, since a load dumped in one place can easil be spread by the packing tractor. The easiest, simplest and fastes method used for unloading the silage wagon was to place a wir mesh sling in the bottom of the wagon and up about three feet o

Fig. 15.—Silage wagon having a wire mesh sling being unloaded at the sil

front and back ends. This wire mesh forms the tail gate for the silage wagon body. Two 2" x 6" timbers are bolted at each end of this sling. When the wagon is ready to dump, the end forming the tail gate for the wagon body is let down and a cable extending from the packing tractor is attached to a sling fastened to the front of this wire mesh. As the packing tractor pulls, the whole load of silage is rolled out of the silage wagon. This operation requires only minutes to accomplish. Figure 15 shows a wagon being unloaded in this manner.

To fill the silo, start by dumping the first load at the entrance on the end where the wagons start into the silo and not in the middle. The reason for this is that the silage itself is used as a ramp as the height of the silage increases in the silo, and therefore it must be firmly packed to support the silage wagons. The ramp is then built up to the height of the silo walls. This height is then maintained as filling progresses and the silo is filled, starting at the entrance end. When this method is used the ramp will be well packed and the silage wagons will continuously help pack the silage previously placed in the silo. This ramp is usually fairly gradual in slope on the entrance side but can be much steeper on the exit end. If the silo is to be filled at intervals it is important to keep the gradual slope to facilitate driving through when filling is resumed. Since the thin layer of silage at the lower end of the ramp will spoil, it is advisable to cut the ramp at a 3-foot depth and add fresh forage to the ramp for the next filling.

Fig. 16.—Packing an earth bank bunker silo with a farm tractor.

Because of the packing by the hauling wagons or trucks the silage in the middle of the silo will be packed more than that on the sides, so additional effort must be made to make sure that the silage next to the wall is packed equally as well as that at the center. The surface of the silage should be kept a little low in the center during filling, but crowned at least 2 feet on top when filling is completed. This crowning of the silage is shown in Fig. 5. The importance of a good job of packing cannot be overemphasized for these open bunker silos. Largely, the spoilage found has been due to improper packing. Figure 16 shows a tractor packing silage in an earth bank silo. A tractor should be left on top of the silo to pack for several days after the silo has been filled. If too much settling occurs next to the sides it is wise to add more silage and pack.

Covering the Silage

Top spoilage can be excessive if the silage is poorly packed and no cover used. A good cover will not make up for poor packing but it will help to prevent top spoilage and leaching. Some type of suitable cover is recommended. A layer of material such as ground limestone, soil, sawdust, etc. has been used on top of the silage to seal off the surface of the silage from air. Where the silo had been adequately crowned to shed water these materials have been very effective under most conditions.

More recently plastic covers have been used very effectively. These covers require less labor to put on and, if well cared for, can be used for several years. Polyethylene plastic is the most widely used since it is more easily available and lower in cost than vinyl plastic. The black plastic is more durable than the clear and is more lasting under outdoor weather conditions. The plastic cover material should be at least a 4 mil thickness, as the lighter weight will tear too easily. The plastic cover should be carefully weighted down along the edges to keep it from flopping up and down in the wind as this will allow air to get to the silage and will also result in tearing of the plastic.

Notes on Making Good Silage

The feeding value of silage after a storage period will depend upon several factors. First, it must be a good quality silage when put into the silo and must have been cut at the proper stage. It should also be at the proper moisture content, preferably between 65 and 70 per cent. Assuming that the quality of ensilage is high it can be spoiled by improper handling at the silo.

The process of silage making consists essentially of a restricted respiration of the crop after it has been chopped, which is followed, after the death of the cell, by the action of different groups of bacteria. These bacteria do not become active until the air is exhausted in the silage. So if the fermentation process, which is the forming of lactic acid, is delayed by trapped air, high temperatures will result and consequently high dry matter loss in the silage.

Proper packing while filling the silo is one of the best ways to exclude air from the silage. However, if the ensilage is too dry it will be spongy and impossible to pack properly and exclude air, resulting in high temperatures and dry matter loss. On the other hand, if the silage is too wet, say 75 to 80 per cent moisture content, excessive pressures from packing occur and lactic acid is not formed. This results in a rancid, putrid smelling silage with less digestible protein than well-cured silage. The addition of a preservative in high moisture silage will help to produce the lactic acid so necessary for making good silage. Preservatives providing carbohydrates such as molasses, ground grain, etc. have been used to form lactic acid. Chemical additives such as sodium meta bisulphate at a usual rate of 10 pounds per ton of green material have become very popular.

Zoerb and others (3) found that more important than additives was the proper sealing of the silo by a good cover. They found that when the silage was properly packed, covering it with a suitable air tight covering produced much better silage and by far lower dry matter loss than when the same silage was treated with additives, such as sodium meta bisulphate, and left uncovered. They also found that a suitable cover over the silo had much more effect toward making good silage than did the moisture content of the ensilage when put into the silo.

Regardless of the type of silo used, careful filling and sealing methods are essential. Careless methods result in excessive spoilage and in the loss of many tons of valuable feed. In addition there is the time and cost of removing this excessive spoilage, plus the time and cost of storing the green forage which it represents. The savings resulting from the use of careful methods will be many times greater than the extra cost involved.

Literature Cited

(1) Esmay, Merle L., and Brooker, D. B. "Lateral Stresses of Silage as Packed in Horizontal Silos." Paper presented at meeting of American Society of Agricultural Engineers, Chicago, Illinois, December 8, 1954.

(2) Poole, Wiley D. Unpublished data on side wall pressures for bunker silos. La. State University Experiment Station, 1959.

(3) Zoerb, G. C., Young, H. G., DeLong, H. H., and Moe, D. L. "Storage Structures for Grass Silage." South Dakota Agr. Exp. Station, Bulletin No. 477, May 1959.

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