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## Pit and Trench Silos

R. L. Patty

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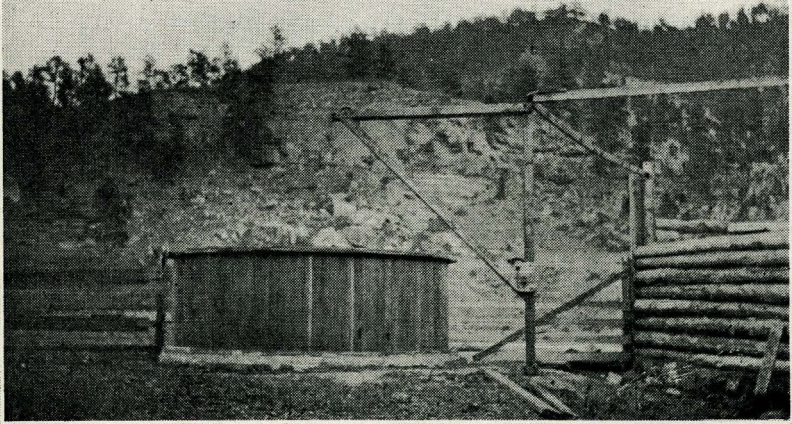
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# PIT and TRENCH SILOS ~



EXTENSION SERVICE  
SOUTH DAKOTA STATE COLLEGE OF  
AGRICULTURE AND MECHANIC ARTS  
BROOKINGS, S. DAK.



### **To Build a Pit Silo**

1. Bore test hole with one-inch extension soil auger to full depth of silo. If the soil contains clay and no water or deep sand veins are struck a pit silo will be satisfactory.
2. Strike off the circles for forming the concrete collar.
3. Dig a smooth trench, 3 feet deep and pour the collar to the surface of the ground, leaving it grooved (see Figure 5).
4. Spade the dirt out inside the collar and move it with slip scrapers to grade up around farm buildings. (A new sharp spade will pay for itself.)
5. Set up the reamer and dig 5 feet below the bottom of the collar. (See Figure 4).
6. Wet the wall down and plaster two coats.
7. Set up equipment for hoisting dirt.
8. Dig another 5 feet and plaster. Continue to the bottom.
9. Set up forms for 30-inch to 36-inch collar above ground.
10. Thoroughly clean and wet down top of collar that was left grooved. Sprinkle lightly with plain cement and pour the collar.

### **To Build A Trench Silo**

1. Choose a location carefully, one that will be least in the way of work around the buildings.
2. Lay out the trench by measurement.
3. Plow the strip of ground, keeping the sides straight.
4. Slip the dirt out with fresno or slip scrapers. Pile this first layer along the edges of the silo to be used for banking up later.
5. Finish excavation, slipping dirt out at the ends of the trench and pile close by so that it may be used later for refilling the hole.
6. Trim the sides smooth and true with spades.
7. Set posts along sides to hold planks at top and put up the planks along the sides.
8. Bank the dirt left for the purpose up against these planks.

# Pit and Trench Silos

R. L. Patty

Pit and trench silos are often confused, in name. The pit silo is cylindrical in form, and deep. It is the same shape as the above-ground silo and extends below the ground. There are several good reasons for making pit silos in this shape. They have the greatest capacity for the amount of side-wall required, they are easier to build, the silage settles in them better, and the wall (plastered or other) is stronger. Pit silos have been used for many years and have given excellent satisfaction. They are used for storing the most valuable silage crops and can be relied upon to preserve the silage as well, if not better, than the superstructure, when they are properly built. Feed can be stored in them from one season to the next just the same as in the above-ground silo and they have an advantage as far as the freezing of the silage in winter is concerned. These advantages are listed below.

## Advantages of the Pit Silo

1. A pit silo is very economical to build when the wall can be plastered.
2. The most valuable of feeds can be stored in it with a minimum of spoilage.
3. Feeds can be stored in the pit silo from one season to the next as a reserve supply.
4. Practically no trouble is experienced from the freezing of the ensilage in the pit silo.
5. Owing to its depth and shape, the pit silo has a large capacity for its size.
6. Less power is required for filling the pit silo.
7. The smooth plastered walls of the pit silo allow the silage to settle uniformly and retains the juices.
8. The maintenance for a well built pit silo is practically nothing.

## Disadvantages of the Pit Silo

1. No doubt the greatest disadvantage of the pit silo is the inconvenience in taking out the feed. Men who have them, however, insist that this factor should not deter anyone from building a pit silo, as it is not at all serious.
2. The pit silo does not enhance the value of the farm as much as does the above-ground silo.
3. It is tedious to build and requires a considerable amount of labor.

## Economical if Plastered

The pit silo is a very economical silo to build in favorable soil for a man who is willing to do his own work in excavating it. If the soil is not favorable for a pit silo, it is not advisable to try to build one. In favorable soil the walls of a pit silo can be plastered right onto the dirt. This makes a very inexpensive silo. If the wall cannot be plastered, it is not desirable to build a pit silo because it will cost just about the same to build a masonry wall for it as it would to build an above-ground silo. Since the above-ground silo enhances the value of the farm a great deal more than an underground silo, it does not pay to put as much money into it.

### Test the Soil Before Digging

It is not at all difficult to test the location for a pit silo with a soil auger and find out whether it will be satisfactory or not. The most desirable characteristic in the soil is to have it uniform in texture. A considerable amount of clay is desirable, but it does not need to be all clay. In fact, it is better to have a little sand in it. Veins of pure sand, however, are very bad when encountered in the pit silo. A very thin vein can be plastered over safely, but the deep ones will give trouble. If ground water is struck in any amount, the pit silo should be abandoned. Probably the trench silo would be advisable.

In testing this location, a one-inch extension soil-auger can be used. (See Fig. 1.) It is not a difficult matter to bore down to a depth of 20 to 25 feet with one of these augers. This will solve the question of both the type of soil and of the ground water at the same time.



Fig. 1.—TESTING THE LOCATION FOR A PIT SILO

An important piece of equipment in pit silo construction is a one-inch extension soil auger. A test hole can be bored the full depth of the silo with this little auger to insure against soil water and sand veins.



### How to Build the Pit Silo

After the location has been tested with the soil auger, a stake should be driven for the center of the silo. A spike is then driven into the top of the stake and the marker shown in Fig. 3 is set up for marking the two circles eight inches apart. One is for the inside of the collar, and one for the outside. If the ground is very uneven, the carpenter's level should be used, while marking, to keep the 2-by-4 level.

The trench for the collar is next dug. It is to be poured to the top of the ground only, at first, or perhaps a few inches above. A groove is left in it so that the above-ground section will bond to it when it is poured, after the slab is finished.

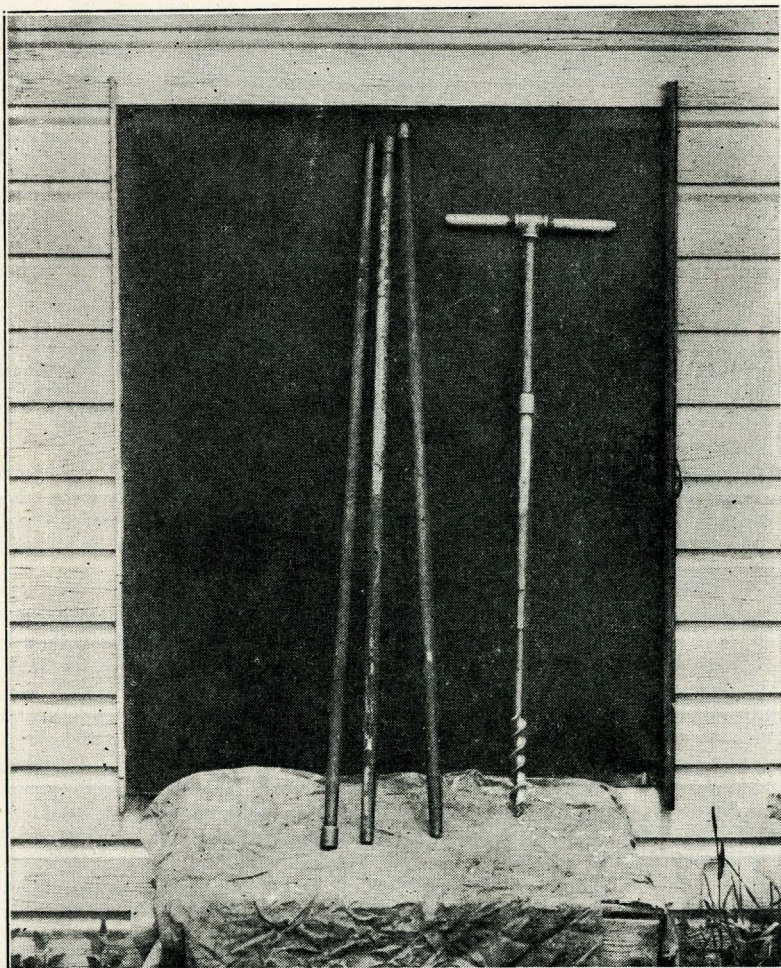


Fig. 2.—SOIL AUGER AND EXTENSION PIECES

As the test hole is bored deeper, extension pieces are coupled on to the auger. Three extension pieces are shown in the picture.

### Digging the Trench for Collar

A sharp narrow tile spade should be used for digging the trench for the collar. The trench should not be dug much over six inches wide in taking out the first spading. It should then be trimmed carefully to exactly 8 inches before the "crumbs" or loose dirt is thrown out. The second spading should be made in the same way. This careful trimming will save a great deal of concrete. Many silo foundations are three or

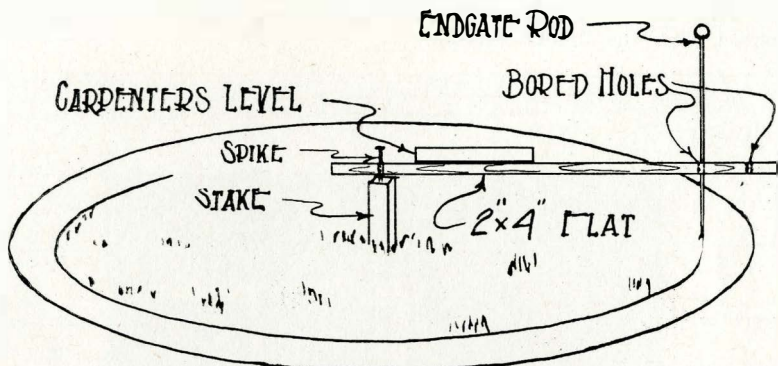


Fig. 3.—MARKING OUT THE TRENCH FOR THE COLLAR

This is a simple and quick way of marking out the trench for the collar of a pit silo. (Could also be used for the foundation of an above-ground silo.) The 2 by 4 inch sweep swings around on the spike in the stake, making a perfect circle. The holes for the end-gate rod are large enough so the rod will slip up and down for uneven ground while the sweep is kept level. The holes should be as far apart as the wall is thick.

four inches wider than intended, before they are finished. The bottom of the trench should spread to the outside as shown in Fig. 5 to give more bearing surface. When the inside of the trench has been given a final smoothing up, it is wet down and then the concrete may be poured.

### Pouring the Collar

The sand and pebbles in the gravel used should be clean and hard. The sand should not be too fine and no pebble larger than two inches in diameter should be used. The ordinary equipment for concrete work should be at hand and if a small concrete mixer is available, it will save quite a bit of time and labor. If the collar is widened at the bottom about as shown in Fig. 5, it will take just three cubic yards of concrete to pour the lower section. It is best to screen the sand from the pebbles and mix them back together with the cement by reasonably careful measurement. The proportion should be one part of cement, two and one-half parts of sand, and four parts of pebbles or crushed rock (1-2½-4). This is equivalent to a pit-run mixture of 1 to 3½. The concrete should be tamped in the trench as it is poured, with a little "spading" on the inside of the trench to make the wall smooth as possible. Wooden blocks can be imbedded at the top of this lower section of the collar so that a groove will be left when the blocks are knocked out. Some reinforcing rods could also be imbedded in this section if desired, and left sticking up in order to bond the two sections together when the top section is poured.



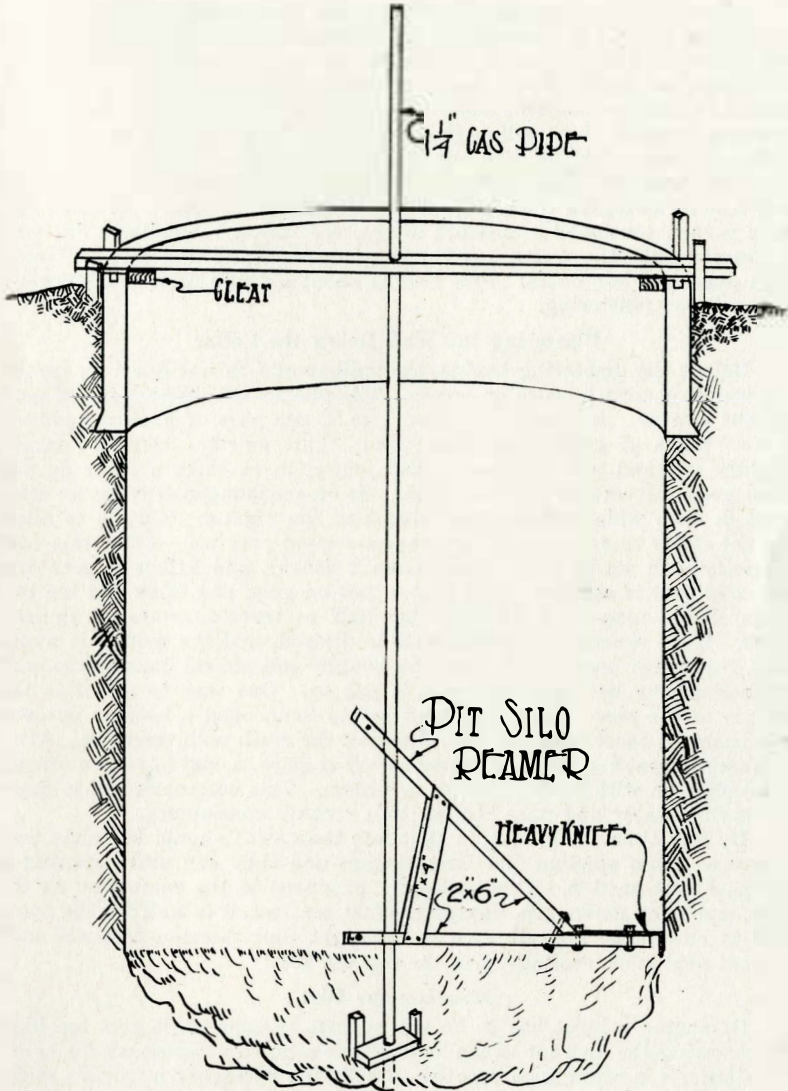


Fig. 4.—REAMER FOR SMOOTHING AND TRUEING THE WALLS

This simple piece of equipment will save its cost several times over in building a single silo. It would be a good idea to see if your County Agent does not have one to loan before making one. This reamer swings around the gas pipe and trims the wall as true as a die. An uneven wall takes twice as much cement plaster and is never as good.



### **Digging the Hole**

After the collar has set-up safely, the excavating can begin. The first thing to do is to sharpen the spades and shovels. The dirt is spaded out inside the collar first. It is thrown out over the collar (lower section only) and far enough away that it can be picked up in a slip-scraper and hauled to nearby locations that need grading. After the bottom of the collar is reached, the spading should continue to a depth of two or three feet and care should be used not to spade too far out at the sides. The reamer is then set up as shown in Fig. 4 and the sides cut down straight and true by swinging the sweep and knife around the gas pipe. The digging is then continued to a depth of five feet below the collar. The wall is dressed with the reamer as the digging continues and this section is then plastered two coats. Five feet is about as high as it is convenient to reach for plastering.

### **Plastering the Wall Below the Collar**

Before the plastering begins, the wall should be wet down by throwing water on with a brush or broom. The plaster should be made of pure cement mortar. It should be mixed 1 to 2, one part of Portland cement to two parts of good hard clean sand. This mortar should be mixed slightly dry and put on with a steel trowel in as thick a layer as will stick good. It should be left rough. Some recommend leaving an open joint  $\frac{3}{4}$  inch wide between the collar and the plaster. This is to allow for the collar to settle and seems to be a good practice. After this coat is pretty well set-up (not sooner than 2 hours), and before it gets dry, a second coat is applied. This coat is put on good and thick and the two coats should make a layer from one-half to three-quarters of an inch thick. If an especially durable wall is desired, and the money is available, fine mesh poultry wire may be bought and pinned back to the wall for reinforcing before the plaster is put on. One way to pin it to the wall is to cut pieces of wire, 6 to 8 inches long, bend a hook in one end and push the other into the wall, catching the mesh with the hook. After this second coat sets-up, and better before it dries, a coat of cement cream is brushed on with a heavy brush or broom. This cement cream is made by mixing water and pure cement to a creamy consistency.

By this time the operators (not less than two) should be fairly well recovered from spading the first section and they can start spading a second 5-foot section. This section is plastered in the same way as the first, and so on down. In digging the last ten feet, it is well for the operator to encourage himself with the thought that this ten feet will hold a great deal more ensilage than the top ten feet!

### **Hoisting the Dirt**

Of course a hoist has to be set up just as soon as it gets too high for throwing the dirt out of the hole. Since a hoist is necessary for hoisting silage, it is often good practice to have the necessary materials ready and build the permanent hoist while waiting for the plaster to set-up. It can then be used for hoisting the dirt. Two dirt buckets should be used while excavating, one on each end of the rope, so that as a full bucket is raised by the hoist, an empty bucket is let down. Many different kinds of hoists have been used. A common type is shown in Fig. 6. For hoisting the dirt while digging the silo, a horse should be used if possible.

### Finishing

When the bottom is reached, the dirt floor is left as it is. The question is often asked if a concrete floor is necessary. It is not.

The top section of the collar can next be put on. It was left off to save a great deal of work and inconvenience in digging the silo. It has an important purpose and may be built several feet higher if arrangements are made for the hoist. The collar keeps children and stock from falling into the silo. It keeps surface water from running into the silo,

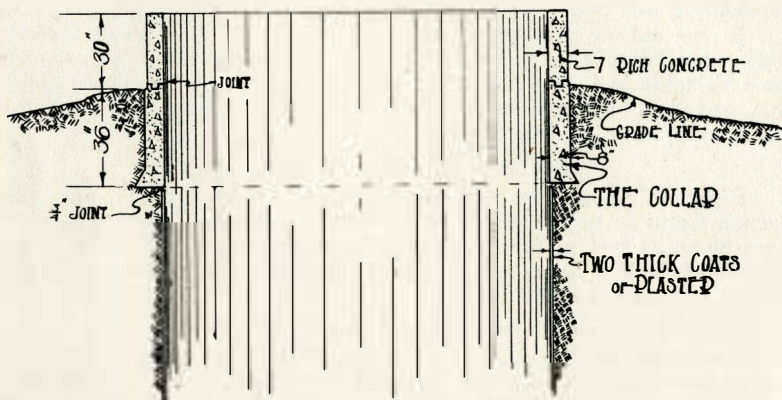


Fig.5.—A CONCRETE COLLAR FOR THE PIT SILO

A good collar around the top of the pit silo is important to its service and durability. It should be from 3 to 3½ feet below the ground after the grading-up to the silo is finished. It is spread at the bottom to give more bearing surface. A three-fourths inch space is left between the collar and the plastered wall to allow for the collar to settle.

and allows the silage to be piled up higher for settling. If built of concrete, which would no doubt be slightly advantageous, forms both inside and outside are necessary. These should be rented from a neighbor, or built co-operatively and passed along. If special forms must be built for concrete, it would be well to get prices on clay silo tile for this above-ground section. Heavy wire reinforcing is imbedded in the mortar-joints between courses of these tile and they make a most excellent silo wall.

Regardless of the material in the collar, it is a good practice to prepare for the future by embedding a few bolts in this collar. They may be used for bolting down a room, or for adding on to the above-ground part of the silo later on. Bolts should also be imbedded for holding the planks in place that bridge the top shown in Fig. 6.

### Making the Reamer

As already indicated, it is important to use a reamer in digging the pit silo. It is easily made, as shown in Fig. 4. The sweep is made of 2 by 6 lumber. The holes are bored with a large bit or an extension-bit for the gas pipe, and the knife is well bolted to the sweep. The knife may be made of an old wagon tire. A piece of tire 12 to 14 inches long is used. About 2 inches at one end is bent over at a right angle and hammered to a cutting edge on one side. It is then bolted onto the sweep.



### **Shall the Pit Silo Have a Roof?**

This was a question asked by the writer of several pit-silo owners some years ago. They did not agree as to its necessity, but the majority of them thought it very desirable. More than half of them had no roof over their silo at the time, however, and several of them warned against making the roof so tight as to make it, too dark in the silo. The most common reason given for needing a roof was to keep the snow from blowing into the silo. It would seem that a location that is protected from the snow, with a roof at a height of seven or eight feet above the ground and well open on one side, would furnish the best conditions.

In the survey mentioned above, 16 men in western South Dakota were interviewed who have used pit silos for years. Their judgment is most valuable in regard to certain important questions in silo construction, and it is therefore offered here for those interested in building a pit silo who have had less experience with them.

### **How Deep Should a Pit Silo Be?**

Eight of the sixteen men say 25 feet is the best depth, providing ground water is not struck in that depth. Most of the others advised from 20 to 24 feet in depth. One of them says: "I would much rather have a silo 25 feet deep and 12 feet in diameter than to have one 14 or 16 feet in diameter and shallower."

### **What Diameter Should the Pit Silo Have?**

Three men answered 10 feet. Three others said 10 to 12 feet, and six recommended 12 feet. One man had an 8-foot silo, but recommended 12 feet. When asked why he did not consider more than 12 feet for the diameter of a pit silo, one man answered: "It is a big job to dig a silo more than 12 feet wide. There is so much dirt to take out and besides it is not so easy to dig, because the dirt-hoist in the center is too far away while digging." He also said that the silage was fresher in the smaller silo and that if he needed more capacity than his 12-foot silo, he would dig two silos. Another important factor in this connection is the curvature of the walls. The plastered wall will stand better on a 12-foot silo than on the 14-foot, because the curvature is greater.

### **What About the Collar Around the Top?**

The collar at the top of the pit silo corresponds to the foundation of the above-ground silo. Practically every man mentioned the importance of building the collar up high enough so stock could not get into the silo and also grading up around the collar so all surface water would drain away from the mouth of it. The average height for the collar recommended was 3½ feet above the ground. After grading-up well to it, it should be at least 30 inches above the ground. The collar should extend well below the ground to get away from the danger of heaving through freezing and thawing of the ground at the point where the plastered wall begins, just below the collar. The collar is usually made of concrete and it is poured first. The sides of the trench are used for the forms for the collar. If care is used, this trench can be dug three feet deep with a tile spade and still be kept narrow enough so as not to waste much concrete. Three feet is none too deep for the collar, and then after the dirt is graded up around the outside it will make the plastered wall 3 feet to 3½ feet below the grade. While the frost often gets that deep, it seems to do little damage.

### How Is Ensilage Hoisted from the Pit Silo?

Nine of the sixteen men used a windlass for hoisting the silage in good sized loads. The others used a simple pulley for hoisting and raised only small amounts at a time. One of the sixteen had a power hoist. All of them laughed at the idea that it was difficult to feed from a pit silo. One man said: "It doesn't worry us any to get the silage out of our silo

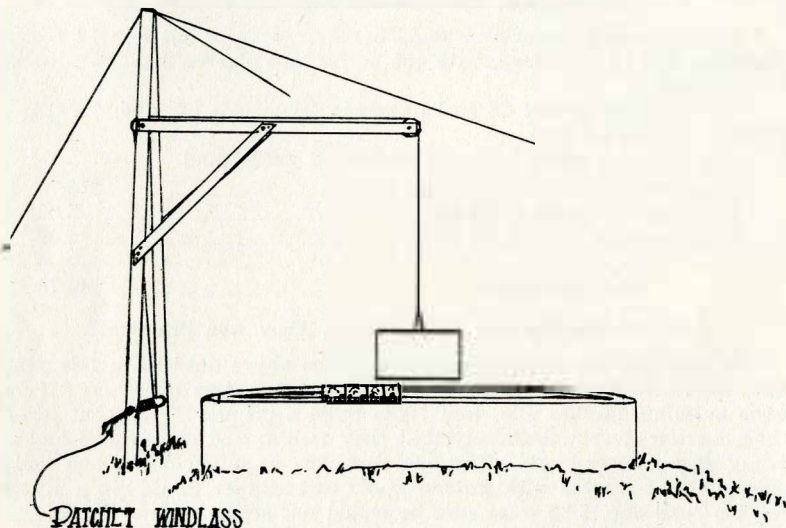


Fig. 6.—ONE COMMON WAY OF HOISTING SILAGE FROM THE PIT SILO

This is one of the least expensive ways of hoisting silage in good sized boxes by hand. If only small amounts are to be hoisted, a simple tripod and pulley can be used satisfactorily. One pit silo user having this kind of hoist has two small boys. One goes down into the silo and fills and hoists a small basket of silage while the other takes it away and feeds the stock.

if we can just get it in there." Mr. Coats, of Edgemont, says: "I have no special outfit. I have two boys who just enjoy getting out the silage. They have a simple tripod over the silo with a pulley. One fills and hoists one 'feed' at a time (hoists from the bottom of the silo) and the other takes it away and feeds it."

### Pit Silo and Seepage Water Will Not Mix

Nearly every one of the pit silo owners mentioned the importance of keeping the pit silo away from the ground water. The ground water will not only spoil the silage below the seepage point, but will spoil the plastered wall. The only trouble or difficulty had with pit silos was with ground water. Three of the men had had some trouble with ground water. They live in Fall River county and close to the Hills. One of them had to dig his silo in another place. The test auger should be used beforehand to test for ground water as well as for the kind of soil.

### Danger from Gases in Pit Silo

The danger from gases in a pit silo is not grave, but certain precautions must be taken in their use. It is very easy to stir the air up so



that it will not be dangerous. This can be done by dropping a light pail into the silo on a rope and jerking it up and down. About the only time trouble has been experienced with gas is when fresh silage is just being put into the silo at filling time. A test should always be made for gases before going into a silo that is being filled and after it has stood over night.

#### Estimate of Material and Cost for Pit Silo

The following material would be required for a pit silo 12 feet in diameter and 25 feet deep, with the collar and plaster as shown in Fig. 5 on page 9.

For concrete collar: 28 sacks cement, 2 $\frac{3}{4}$  yards of sand, 4 yards of pebbles or crushed rock.

For  $\frac{3}{4}$ -inch plaster: 21 sacks cement, 2 yards sand.

Total cement 49 sacks @ 75c net.....	\$36.75
Total sand, 5 yards @ \$1.00.....	5.00
Total pebbles 4 yards @ \$1.00.....	4.00

Total materials.....\$45.75

#### Do Pit Silo Owners Really Think They Are Practical?

In order to get a definite answer to the above question a few years ago, we asked the sixteen men mentioned above, this question: "If you were building another silo, would you build a pit silo?" All but one of them answered very definitely that they would; and one or two had already dug a second one. The one that was at all in doubt had had a great deal of trouble with ground water and said he would dig a pit silo for a second one if he were sure he would not strike ground water.

#### THE TRENCH SILO.

Trench silos have been used to a certain extent for a number of years. Up until the last two or three years they were used only for beet-tops, sunflowers, and other rough feeds. During the past two or three years they have been used in some instances for corn in the north-west and have proven quite satisfactory. These seasons have been unusually dry, however.

There is no doubt that for an emergency silo in the hands of a man who will take care of them, they will be practical. If not taken care of and used regularly, they will develop into an unsightly mud hole in the barn lot that is not easily refilled.

#### Advantages of the Trench Silo

1. It is inexpensive to build if the hiring of labor and teams can be avoided.
2. Horses or Fords can be used to pack the silage in the trench silo.
3. The power required for filling the trench silo is considerably less than for the above-ground silo.
4. The silage will bother less from freezing than the above-ground silo—more than the pit silo, however.
5. It is well adapted to the ensiling of sunflowers, thistles, and emergency feeds.

### Disadvantages

1. When once constructed, it is not easily filled-in, when abandoned.
2. More silage will spoil in the trench silo.
3. Greater exposure while feeding from it. (Somewhat similar to feeding from an outside stack as compared to feeding hay from the loft.)
4. Mars the farmstead, especially if it is located handy to the barn.
5. The trench silo must be trimmed on the edges and cleaned up every fall.

### Cost of Construction

The cost of constructing a trench silo is very slight if the men, teams, and scrapers are available. One man built a medium sized silo for \$50.00 beside the labor. This money was largely spent for planks around the top and for the woven wire and skeleton for the roof. The labor and time required to dig a trench silo will depend a great deal upon the type of soil. For one silo 38 feet long by 14 feet wide it took about five days for the excavating. There were four men, three boys and two teams working on it. A 90-ton silo would require about 260 cubic yards of excavating.

### Size of the Silo

Experience has shown that a new trench silo should be dug 10 feet wide at the bottom, 14 feet wide at the top, and eight feet deep. This leaves the walls "battered" and as the dirt walls are dressed down each year the silo will gradually become wider. The hole need be excavated only seven feet deep, as the other foot in depth will be gained by the excavated dirt being piled up around the edges. There is no objection to making it a foot deeper than this, however.

The length of the silo should depend upon the stock to be fed. Every foot in length for the above silo would have a capacity of 96 cubic feet of silage, and in a shallow silo the silage would weigh about 25 pounds to the cubic foot. This would give a capacity of one and one-fifth tons for each foot in length. It would be good practice to figure three feet in length for each mature cow, in digging the above sized trench silo.

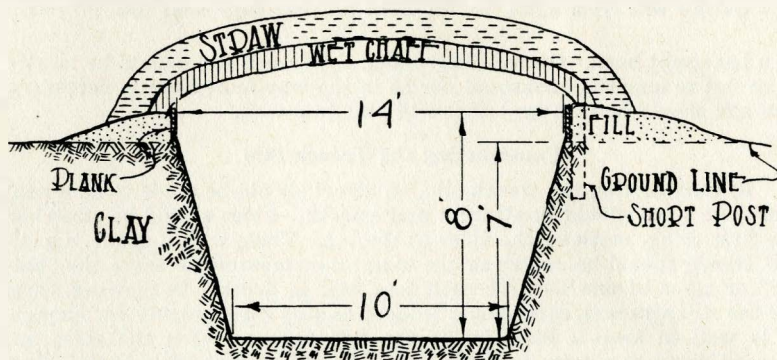


Fig.7.—CROSS SECTION OF A TRENCH SILO

A trench silo should be dug about 14 feet wide at the top and 10 feet wide at the bottom. The length would depend upon the number of cows to be fed. These silos get wider each year as the walls are trimmed. Concrete walls can be built to prevent the walls from crumbling. The materials required to wall a 90-ton silo with a 9-inch concrete wall would cost about \$283.



### Location

The trench silo should be placed in a comparatively high, well drained location. To be the handiest for feeding, the end of it should come right up to the barn door at the end of the feed alley. Some build a covered entry way between the barn and the end of the silo. An ideal location would be to have the end of a trench silo open into the feed alley

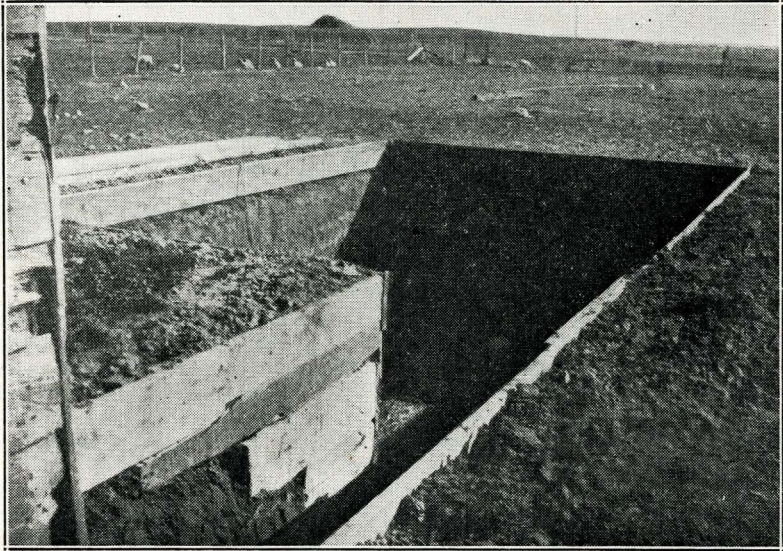


Fig. 8.—A SMALL TRENCH SILO

This is a small trench silo showing the entrance at the end next to the barn. Note three-inch plank around the top for holding the dirt that is graded up. This arrangement not only adds depth to the silo, but drains the flood water away from the trench.

of a basement barn. On the other hand, the trench silo should be located so as not to mar the farmstead nor be in the way more than is necessary. The soil should be of a type that will stand up well.

### Constructing the Trench Silo

In constructing the trench silo, an effort should be made to do a neat job. The sides should be straight and smooth. Lines should be stretched the first thing, marking the sides at the top. Then, with a spade, a shallow trench should be cut along the sides, remembering to leave the "batter" or slope of one foot for each four feet in depth. In plowing, then, for the slip scrapers, care should be used to stay inside plenty far enough. It is well to keep a little inside the line because when the sides are dressed down to a true line, the silo walls will be cut back some. Usually the dirt is plowed loose and slipped out with a scraper, where it is dumped along the sides so as to give extra depth to the silo and to drain the surface water away from the silo. The end of the silo next to the barn is usually left sloping so that a team and wagon can be backed

into the trench after it is finished. The other end is usually made with the same steep slope as the sides. A long chain-hitch to the scraper near the end of the excavating is often used to good advantage while excavating. Explosives have been used to some extent in the excavating where extremely hard soil was encountered. Twelve-inch planks are sometimes set on edge around the top of the trench to hold back the loose dirt that is banked up around it.

### The Roof

In some instances no roof is provided for the trench silo. The silage is piled up high in the center and a foot or more of wet straw or green hay used on top. (See Fig. 7). The practice of dragging loose dirt on top of the straw has been tried and reported satisfactory. It is some trouble to remove this dirt when frozen, but the weight of the dirt is good for weighting down the straw and preserving the ensilage. A layer of three or four inches of wet chaff or cut straw tramped on top of the silage is very good before this top is put on. It seals the silage from the air. A skeleton roof of poles or dimension lumber covered with woven wire and with straw or hay on top is often used. This gives more protection for taking the silage out for feeding in cold weather and keeps the snow out better.

### Filling the Trench Silo

In filling the trench silo, no blower is necessary. It is advisable to use the ensilage cutter, however, and cut the fodder rather fine. As the silage is filled in, it should be tramped very thoroughly. A boy riding one horse and leading another can do this work nicely. Ford cars have been used for this purpose. The silage should be well tramped at the edge, as there is apt to be heavy spoilage. The "battered" sides of the silo make it convenient to tramp the silage close to the edges. Water should be added to the silage when filling. The amount, of course, depends upon the condition of the feed being cut. One man reports having used four tanks of water (16-barrel tanks) to a 54-ton silo and found it about right. He was filling with corn under average conditions.

#### Extension Service

South Dakota State College of Agriculture and Mechanic Arts

Brookings, South Dakota

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