

UNIVERSITY OF MISSOURI

COLLEGE OF AGRICULTURE

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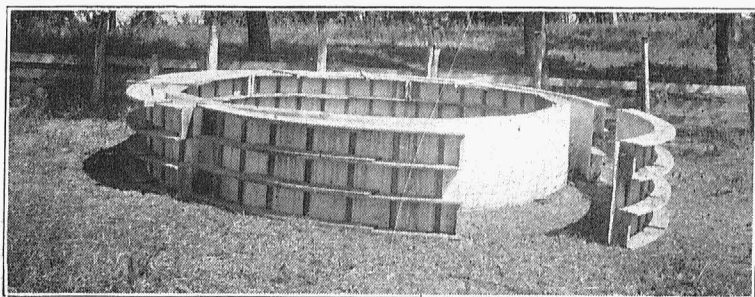
CIRCULAR NO. 49

## THE REINFORCED CONCRETE SILO.

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Silage is coming into more general use every year and the concrete silo as a means of preserving green feed has become very popular. The popularity of this silo is well founded since it is durable, efficient, fire and vermin proof, and the cost is not excessive.

**Size of Silo**—The size of the silo which is practical to build will depend upon the number of animals to be fed and the length



First section of solid concrete silo completed, showing forms loosened and ready to be raised.

of the feeding period. It is necessary to feed two inches or more of silage daily from the top after feeding has begun in order that it may not spoil. This being true, careful attention to size is essential in order to save feed after it has once been secured. The diameter of the silo should depend upon the number of animals to be fed while the height will depend upon the length of the feeding season. The latter will of course vary with the locality.

The following table will aid in determining the size to build both in diameter and height:

**TABLE NUMBER 1.**  
SHOWING SIZE AND CAPACITY OF SILO FOR HERDS OF VARIOUS SIZES.

No. of Cows	FEED FOR 180 DAYS		CAPACITY—TONS
	DIAMETER	HEIGHT	
7-10	10 feet	25 feet	36
10-12	10 feet	28 feet	42
12-15	11 feet	29 feet	60
15-20	12 feet	32 feet	73
20-25	13 feet	33 feet	83
25-30	14 feet	34 feet	115
30-35	15 feet	34 feet	131
35-40	16 feet	35 feet	158
40-45	20 feet	35 feet	258

**Making the Forms.**—After having decided upon the size of silo needed the next thing is to secure forms for the construction of the walls. If the forms of correct size can be hired in the neighborhood or from a distance it will be advisable to secure them rather than to go to the trouble of making them. If not, the cost of making is not excessive. They are fairly simple and can always be hired out or sold for enough to repay the cost of construction.

The forms can be most easily made in six sections each. To mark out patterns observe the following: Clean off a large space on a barn floor, then select a long piece of straight stripping at least 20 feet in length. Nail to the floor at any convenient place and from the center of the nail measure out on the strip the exact distance of the radius of the silo to be built. Drive a nail through the stripping here so that the point will scratch. If the wall is to be six inches thick measure from the center of this nail six inches farther and drive another nail so that it will scratch. Strike a long arc with the two nails. Now take a fine wire, tie a pencil or piece of chalk to one end and measure it the exact length of the inside radius of the silo. Select any point on the inside curve, mark it with chalk, then strike a point on this same curve as far as the string will reach from the point selected. (See Fig. 1.) This will mark off a part of the circle equal to 1-6 of the circumference of the silo. The enclosed segment of the circle so described may be divided exactly in half by laying a straight board from the two points designated, measuring exactly half the distance and projecting the line from the center of the circle through the middle point of the board described. From these two points which are marked X in the diagram measure back toward the center four inches inside the first circle and eight inches beyond the outer

circle. Now take a plank ten feet by eight inches and one inch thick, saw exactly in the middle and lay them as indicated in the diagram. Nail lightly to the floor and with the scratching nails, scratch out the curves as shown. This will make one pattern each for the inner and outer forms. Since the patterns are only half large enough for a full section, two of them must be nailed together in order to make the full length. The strips to be used in holding the two parts of the section together should be at least four feet long and cut on the same circle as the form. A glance at the photograph of the forms will show this.

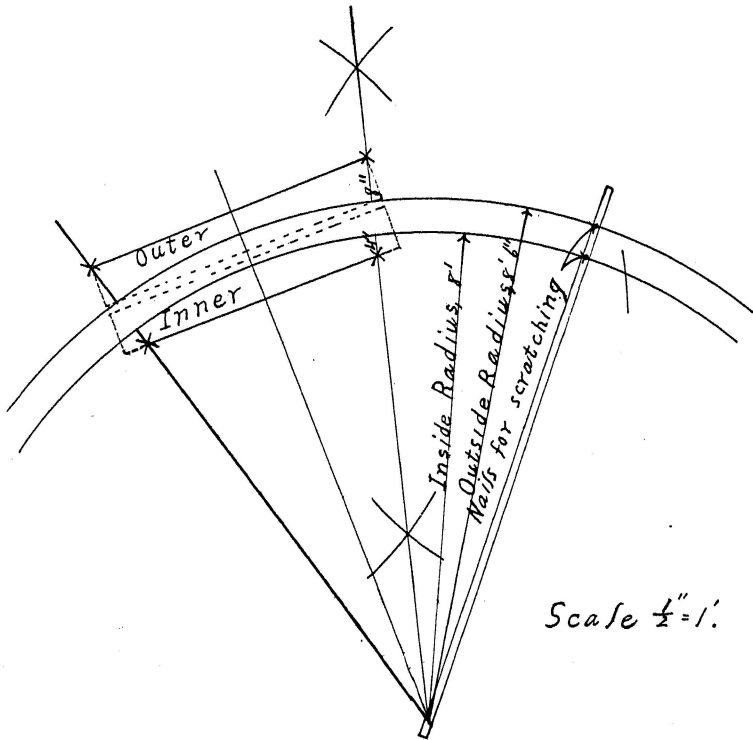


Fig. 1—Diagram showing method of making patterns for forms of a concrete silo 16 feet in diameter. For different sizes changes in measurements may be made in proportion.

The forms should be at least three feet high so that it will take six pieces from the pattern to build each section of the form. This will mean thirty-six of the inner and thirty-six of the outer patterns. When cleated together three will be used to make each section. In order to make the skeleton of the form a strip of heavy wood at least one inch thick and two inches wide and three feet long should be

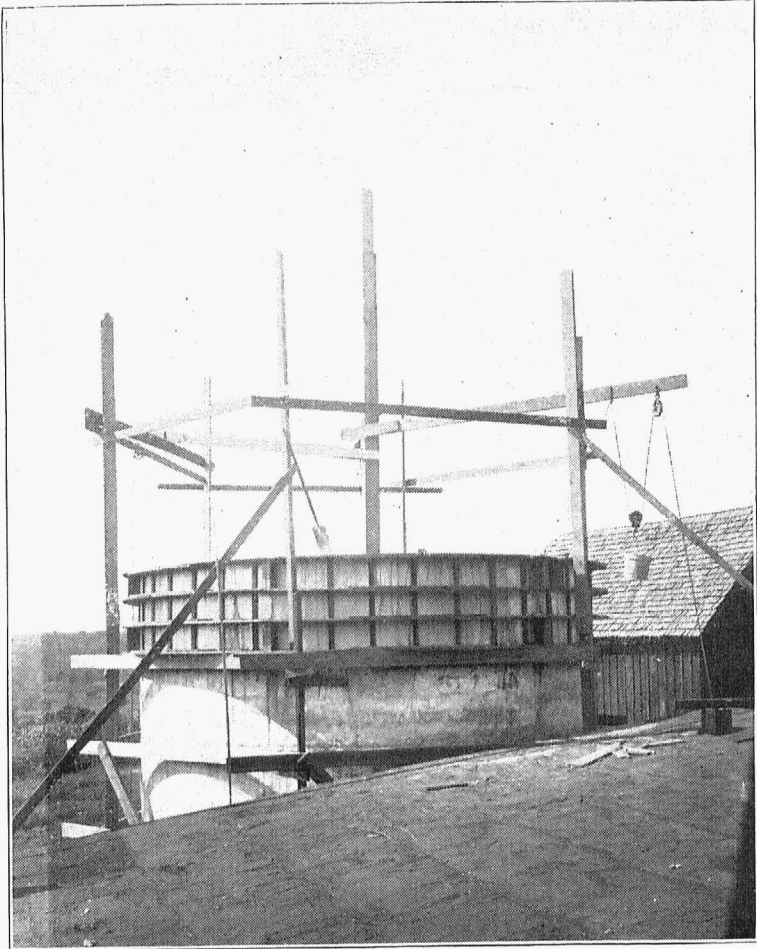
mortised into the three patterns every fifteen inches apart. The outer stick on each end of each form should be of 2x4 material. Cover each section with a heavy strip of sheet iron or with matched lumber running up and down. Any other bracing may be put between the patterns that is found necessary. As indicated by the diagram the patterns are all sawed in the radial line leading to the center so that they will fit in a circle.

**Building the Foundation.**—Locate the silo at a place convenient to the barn. This will generally be within three or four feet of one end, or some door close to the mangers. Level off the ground, and with a string and nail mark out the circumference of the silo with a radius at least one foot longer than the inner radius of the silo. Excavate within the circle at least four feet, keeping the dirt around the outer edge perpendicular. The foundation wall should be at least one foot thick to properly support a concrete silo, so as soon as the excavation is finished mark off another circle the exact size of the inner diameter of the silo, using the same center as above. Drive heavy stakes so that their outer edge will be exactly on the line of this circle completely around it and about two feet apart. The tops of these stakes should extend as high as the level of the highest part of the ground around it. Brace each stake from the middle so that it can not give. Bend one half inch planks around the outside of these stakes making an improvised inner form leaving the earth for the outer.

The foundation should then be made of concrete, using crushed stone or very coarse gravel as the base of the mixture. The mixture recommended for the walls may also be used here. Care should be taken not to fill in concrete more than a foot in depth around at one time and this should be thoroughly tamped and worked with the spade until water stands on top, then allowed to set before an additional layer is added. The foundation should also be reinforced by steel rods which may be bought for the purpose or by twisting together three or four strands of number 12 cable wires and laying them a foot apart as the foundation goes up. A spirit level should be used in order to get the foundation form at the same height and level all the way around.

When the walls of the silo are complete the bottom should be laid. Put down a well-tamped layer of cinders or gravel about six inches deep and upon this put six inches of concrete. Plaster the surface about one-half inch deep with the same mixture used in smoothing down the walls.

**Erecting the Walls.**—As soon as the foundation is finished the forms should be set in place and the construction of the walls begun. The thickness of the wall should be at least six inches and the forms described have been made for this thickness. In setting up forms no specific directions can be given for the erection of



Solid concrete silo nearing completion, with staging upon which forms rest.

staging. The accompanying photograph will give some idea as to how this may be done but if the builder is uncertain as to how best to keep the forms suspended he should employ a carpenter for a day until the staging is erected. It is safer to use scaffolding both on the inside and outside to support the form. When in place the

sections are bolted together as shown in the photograph. This holds them rigid. The first section of the wall will of course be built with the forms resting on the foundation, the inner one being barely on the inner edge of the foundation so that the inside wall of the silo will be perpendicular from the bottom up. As soon as the forms are in place and leveled, fill with concrete. Tamp the concrete well and work with a flat spade, especially next to the sheet iron on both forms, until the water rises on top. As soon as level full the concrete must be left to set at least twenty-four hours. The forms may then be unbolted and raised. In building up the wall continual care must be exercised to keep it perpendicular. In order to accomplish this, do not raise the form to its full height but allow it to lap back on the solid concrete at least six inches at the bottom. Block and tackle of some description is used in raising the sections and in hoisting cement. Each time the form is raised grease the sheet iron surfaces with axle grease or soap before filling to prevent the concrete from sticking to the forms.

The walls should also be reinforced at least every foot by means of steel rods which are laid horizontally inside the form or by twisted wire as previously described. This is a good place for old barb wire.

When the forms are removed each time the inner and outer surfaces should be smoothed down with a board. This will be sufficient for the outside, but when the silo is completed the inner surface should be washed with a thin coat made by mixing one part cement and one part fine sand. This may be applied with a white-wash brush. Keep the sun out and wet the inside once or twice a day for a week. This makes a smooth and lasting inner surface.

**Mixing the Concrete.**—The mixture which is practical to use in building a concrete silo is one part cement, two parts sand, to four parts crushed rock or very coarse gravel. In mixing it is best to have a fairly accurate measure such as a wheelbarrow which will hold so many shovels or by counting the shovels of sand, gravel and cement used. The best way to thoroughly mix material is to have prepared a well-jointed mixing-board, then dump convenient quantities of sand on the board. Put on the right amount of cement and thoroughly mix with hoe or shovel. Put enough water on to make this sloppy, then dump on the gravel or crushed stone and turn at least twice with the shovel. The mixture is then ready to use.

TABLE NUMBER II

MATERIAL NECESSARY FOR CONCRETE.

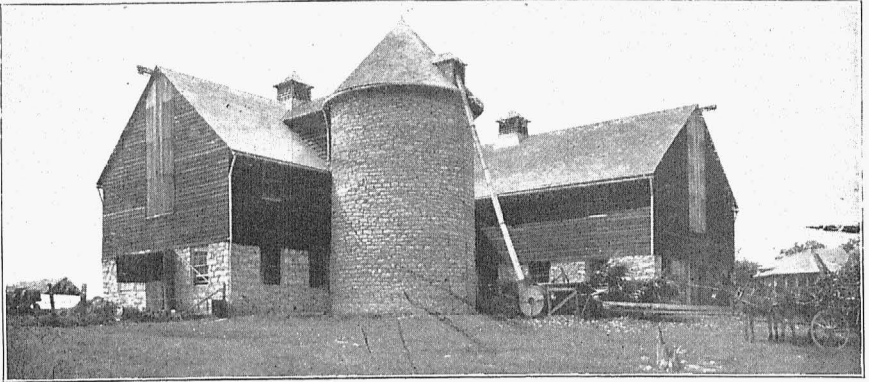
Ht. Silo Feet	Inside Diam. Feet	Thickness Wall—Inches	Cement— Bags	Sand— Cubic Yards	Gravel or Stone —Cubic Yards
20	8	6	34	2 $\frac{3}{4}$	5 $\frac{3}{8}$
20	12	6	55	4 $\frac{1}{4}$	8 $\frac{1}{2}$
20	15	6	73	5 $\frac{1}{2}$	11
25	10	6	54	4	8 $\frac{1}{4}$
25	15	6	86	6 $\frac{1}{2}$	13
25	20	6	122	9 $\frac{1}{4}$	18 $\frac{1}{2}$
30	10	7	73	5 $\frac{1}{2}$	11 $\frac{1}{4}$
30	15	7	115	8 $\frac{1}{2}$	17 $\frac{1}{4}$
30	20	7	154	11 $\frac{3}{4}$	23 $\frac{1}{2}$
40	15	8	159	12	24 $\frac{1}{4}$
40	20	8	220	16 $\frac{1}{2}$	33 $\frac{1}{4}$
40	25	8	283	21 $\frac{1}{2}$	44

**Doors and Openings.**—Openings must be left on the side of the silo next the barn. They should be placed no more than four feet apart, a convenient size being 2 x 2 $\frac{1}{2}$  feet inside measurements, the longer way up and down. The form is constructed so as to leave a shoulder on the inner edge of the opening which is two inches deep with a one inch jam. Reinforce each doorway with twisted wire completely around the opening to prevent splitting.

The doors to fit into these depressions should be made double of one inch matched lumber and stripped along the edges with tarred paper or felt in order to make air-tight joints. Generally the doors are set in place allowing the pressure of the silage to hold them. They may be bolted in place, however, by running a long bolt through the center of the door and a cross piece outside the opening holding to the outer edges of the silo. When in place the inner surface of the doors is flush with the inner surface of the walls.

A ladder leading up into the silo is necessary. To attach one to a concrete silo it is a good plan to set bolts a few feet apart on each side of the door openings as the wall is being built. Turn the bolts before the concrete sets completely so they may be removed and the ladder attached to them.

**A Simple Roof.**—Silos should have a roof to protect the silage after feeding has begun. It is not necessary for the preservation of the feed before. Throw up rafters to the middle making a conical roof, and shingle. Leave a trap door in the roof for the pipe when filling.



Beef Cattle Barn and Stone Silo on College Farm, Columbia, Mo.

This silo is 20 ft. in diameter, 40 ft. high and holds 240 tons of silage. It is suited only to large herds. It is reinforced with half-inch iron rods, built into the walls. Note its position in relation to the barn. A favorable location of the silo saves time and labor in feeding. In sections of the state where building stone is abundant it may be used to advantage in the construction of silos. However, its first cost is greater and it is more liable to crack than is the properly reinforced concrete structure.