HOW TO BUILD A GURLER SILO

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This circular is mainly a reprint of circular number 48, by H. E. McNatt, published in July, 1911. The popularity of the plastered or Gurler silo and its special adaptation to those parts of Missouri where there is still a local supply of native lumber indicates the need of a more detailed publication on this subject. The additions which appear in this circular are mainly suggested by questions asked during the past two years by prospective builders of Gurler silos.

The Gurler silo is built much like a frame house except that it is round in form with a lining of boards running lengthwise around it somewhat like the hoops of a barrel. This lining gives it strength to withstand the outward pressure of the silage. It is the reinforcement of the silo and corresponds to the hoops on a stave silo and to the woven wire or other reinforcement placed in the center of the wall of a concrete silo.

The lining is lathed and then covered with cement plaster. This plaster protects the wood framework from decay and makes an air-tight wall. A silo to be successful must have a

Fig. 1.—Gurler silo complete except siding. Has been filled five times. Size 16x32. Cost of materials $125.
wall strong enough to withstand the outward pressure of the silage. The wall must be smooth on the inner surface and air-tight.

Some of the strong points in favor of this type of silo are:

1. Can be built entirely from ordinary lumber.
2. Requires no highly skilled labor for its construction.
3. Preserves the silage as well as any type of silo in use.
4. Is strong and durable when properly made.

Size of Silo.—The number of animals ordinarily fed should determine the size of the silo. It is a common mistake to build silos with too great a diameter. Generally speaking it is not advisable to build any silo more than sixteen feet in diameter. It is better to have two small silos than one silo which is too large for the herd. In order to insure proper settling of the silage the height of a silo should be at least twice the diameter. A table is shown on page 296 of Bulletin 103, Missouri Experiment Station, which gives the size of silo to build for herds of different size.

Laying out Foundation.—A short stake is driven firmly into the ground at the point selected for the center of the silo. To the top of this is secured, with a single nail a horizontal piece of light, stiff lumber, bearing upon one end an arm sharpened so as to scratch a circle on the ground when moved around the center post (Fig. 2). This circle marks the outside limit of the silo foundation. Care should be taken to get the measurements correct.

![Fig. 2.—Arrangement for marking out the circle on the ground; (a), center stake; (b), arm; (c), scratching piece.](image)

Digging the Pit.—With the circle as a guide a pit is dug to a depth of from 2 to 3 feet. The wall of dirt must be cut plumb and the floor leveled.

Building the Foundation.—The foundation is reinforced concrete. Figure 3 shows in cross-sections the construction of one of the frames, which hold the form boards in place. These frames, which are made of 1x4 plank, should be placed 30 inches apart around the
pit to hold the inside and outside form boards in place. These boards are \( \frac{3}{4} \)-inch lumber of 4-inch width, so as to be readily bent to conform to the wall of the pit. The distance between the inside form boards and the pit wall should be 1 foot. The concrete foundation should extend about 1 foot above ground on the outside. Figure 3 also shows how the upper corners of the concrete wall are beveled after the concrete has become sufficiently stiff to permit this being done. The 2x4 sill with a large spike or bolt for an anchor is also shown imbedded in the top of the wall.

The concrete should be made from gravel or crushed rock, sand, and Portland cement. The materials should be clean and the mixing must be thoroughly done. They should be mixed in the following proportions, cement 1 part, sand \( 2 \frac{1}{2} \) parts, gravel 5 parts. Enough water is added during the mixing to make a mixture that is thin enough to settle to the form with light tamping. However, it should not be so thin as to leak out through the cracks in the forms.

![Fig. 3.—Cross-section of one of frames that hold the form boards in place. (a), concrete foundation wall; (b), edge of inside form boards; (c), arm holding outer form boards; (d), sill, showing one of the anchor spikes.](image)

The foundation is reinforced with a piece of 3-foot woven wire fencing placed in the center of the form before filling with the concrete mixture.
After the wall has set sufficiently to stand alone, the forms may be removed and the floor laid to a depth of 4 inches. It is advisable, but not absolutely necessary, to pack about 4 inches of wet gravel or cinders in the bottom of the pit before laying the floor. Before the wall and floor have hardened, a finishing coat of sand and cement mixed 3-to-1 should be put on with a plasterer's trowel.

Figure 4 shows a view of the top of the foundation wall with the sill in place. The sill is made of 2x4 lumber cut into 2-foot lengths. Each piece is put in place while the concrete is soft and anchored by three heavy spike nails with turned points, or thin bolts with nuts and washers on their ends. This anchoring is necessary, and ties the woodwork of the silo firmly to the concrete.

The studding may be anchored to the foundation in ways other than indicated above. Sometimes pieces of ¾-inch by 2-inch strapiron, cut 2½ feet long are used. Each piece is bent at right angles about three inches from one end. This end is buried in the concrete foundation, the angle of the iron firmly anchoring it. These pieces of strapiron are set in the foundation at regular intervals at a depth of 1½ feet. This leaves 1 foot protruding above the top of the finished foundation. Holes of ½ inch diameter are bored in this part of
the strapiron and the studding are simply set on the top of the foundation, each one being bolted to one piece of strapiron with ½-inch bolts.

Another method of anchoring the studding is to set them at their proper intervals in the foundation forms before any concrete is put in. The concrete is poured and tamped in around them thus firmly anchoring the studding in the foundation. It is not known how well the ends of the studding will last when buried in the concrete in this manner.

Figure 5, shows a vertical-section of the foundation wall and floor as it appears when complete with the sill embedded in the wall.

**Erecting the Studding.**—The studs are made of two lengths of 2x4 lumber spiked together at the middle and are erected 2 feet apart. If the diameter of the silo is more than 16 feet and the height more than 32 feet, it is advisable to either use 2x6 lumber or set the studding only 18 inches apart. Two pieces of 2x4 lumber spiked together to make a 4x4 is used as a center pole to tie the studding in place while they are being set up. Each separate stud is toenailed to the center of a section of the sill if the sill arrangement is used in anchoring the studding. Only the lower half of the studding is put up first, the second piece being spiked on after the lower half of the silo is nearly complete and needs no bracing. The studding is plumbed with a carpenter’s level and tied in position temporarily with small scraps of old lumber.

**Putting on the Sheeting.**—When the lower half of the studding has been tied in position the sheeting which is ½-inch lumber is nailed horizontally on the inside of the studding, the joints of the same being broken. The sheeting should be nailed on from the foundation to within about a yard of the top of the studding, and then the lath put on.

If native lumber is used for the sheeting the ½-inch boards required can generally be obtained with little trouble. Where yard
lumber is used \( \frac{3}{4} \)-inch cypress panel stock is the best material for the sheeting. If the \( \frac{3}{4} \)-inch stock is not available 1-inch stock can be ripped to \( \frac{3}{4} \)-inch thickness. In this case the rough surface should be on the inside, as the cement plaster does not easily adhere to the finished surface of the boards. When this material is used for sheeting, it is generally necessary to wet it before bending around the studding.

The Lath.—Although somewhat expensive expanded steel lathing found on the market is the best for the purpose. But ordinarily the same material as the sheeting ripped into 1 and \( \frac{3}{4} \)-inch widths and beveled on the edges is used. These are nailed on the sheeting so as to break joints covering cracks whenever possible, and leaving a space from \( \frac{3}{4} \)-inch to an inch for clinching the mortar.

After the mortar is once on this wall, it will not come off easily because of its being the lining of a cylinder rather than the surface of a plane wall.

The Upper Half.—When the sheeting and lath have been put on to within about a yard of the top of the first length of studding, a temporary platform or scaffold may be built to enable the workmen

Fig. 6.—Cross-section of silo as shown on front page, showing arrangement of studding and three inner layers. (a), stud; (b), sheeting, (c), lath; (d), plastering.
to erect the second half in the same manner as the first was put up. It is well to leave the center pole resting on the concrete floor and extend it by adding another piece.

The second half of the studding should be spiked to the first with a lap of about 2 feet. After plumbing and tying the studding in place, the sheeting and lath are put on and finally after removing the temporary platform, the middle, left open because of the scaffold being nailed to it, is completed by putting on the sheathing and lath. Care must be taken that no wide cracks are left.

**Plastering.**—The wall of the silo is plastered with a rich, well-mixed mortar made from 3 parts of sharp, clean, coarse sand and 1 part of good Portland cement. This mortar should be about as thick as that ordinarily used in plastering a house and put on to a depth of about 1 inch between the lath and about $3\frac{1}{2}$ inch over the lath.

Between the lath the mortar will stick to the sheathing. The sheathing and lath should be thoroughly wet before putting on the plaster. This makes it easier for the plaster to stick and prevents it drying out before becoming set.

Figure 6 shows in diagram a cross-section of the silo as it has been described thus far. 3 inside layers are seen. The innermost is the plastering, the next is the lath and the one lying against the inside edges of the studding is the sheathing.

![Figure 6: Cross-section of the silo](image)

Fig. 7.—Part of Figure 6 on larger scale showing more of the detail; (a), stud; (b), sheathing; (c), lath; (d), plastering.

Figure 7 shows a small part of the same cross-section more in detail.

Figure 8 shows a longitudinal section taken down the side of one of the studs, showing the cement plaster, the lath and the lining.

**The Doors.**—Four doors are sufficient for a 30-foot silo, and five are enough for a 36-foot silo. Ordinarily the bottom of the first door will come about 2 and $3\frac{1}{2}$ feet above the sill. The doors are 2 and $3\frac{1}{2}$ feet high and 3 feet are allowed between doors.

The studding between which the doors are to come, when being spliced, should not be lapped as are the others. They should be placed
end to end and tied by spiking on the side opposite the door opening a 6-foot piece of 2x4. Headers are then placed between the studding at the proper intervals, one for the top and one for the bottom of each door. The door jambs are made by spiking or bolting pieces of 2x4's on the inside of the door openings, the jambs being offset to the outside, leaving a shoulder on the inside of the door frame for the door to rest against. Figure 9 shows this region in cross section, including the door in place.

The doors themselves are made from flooring boards nailed and screwed together at right angles, with a sheet or two of tar paper between. This construction is illustrated in Figure 9.

In fitting the doors before filling the silo, a layer of tar paper or heavy building paper should be put between the jambs and the doors. The doors are held in place by heavy bolts, fitted with large nuts and washers, passing through them and through pieces of 2x6's laid across the opening on the outside of the silo. Two cross-pieces are needed; one near the bottom, the other near the top of the door.

When this point in the construction of the silo is reached, although not completed, it may be filled if it is necessary to do so. Figure 1 on first page shows such a silo which has been filled and emptied 5 times. Its general appearance, strength, and resistance to weathering, may be improved, however, by putting on some weatherboarding or siding.

**Siding.**—Although somewhat expensive, galvanized sheet metal makes a good siding. Probably the most practical plan, however, is to put on some hoops and nail ordinary box siding to them. The hoops are made of 3 thicknesses of the sheeting lumber put around

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Fig. 8.—Vertical section down side of one of the studs showing (a), stud; (b), sheathing; (c), lath; (d), plastering.
the outside of the silo every 4 feet, being careful not to cross doors. One thickness is put on at a time. The joints must break to insure strength. The siding is put on vertically and nailed to the hoops. The cracks are covered with ordinary weather strip.

Another plan sometimes followed in siding the silo is to lath and then plaster it with the same kind of mortar used on the inside wall. Expanded metal lath can be used for lathing, although this increases the expense of the silo. Ordinary house lath can be successfully used. If this is done it is best to nail the lath on with shingle nails. When this is contemplated the studding should be spaced so that there will be but little waste of lath. The plastering should be put on the outside on cool or cloudy days so that it will not dry out too rapidly and crack. Figure 10 shows a silo that has been finished in this manner.

The Roof.—A plate similar to the lower sill is put around the top of the silo on top of the studding. The roof is usually made in the same manner as the roof of a house except the rafters are put up in conical form, and no joists are put in. The roof boards are put on in short lengths, and shingles or some other good roofing material put on top. A properly made door must be left in the roof through which to fill the silo.

Ventilating the Walls.—When the silo is covered on the outside in any way other than with hoops and vertical boxing, it is necessary to bore a large auger hole between each stud on the outside at the bottom and on the inside at the top so as to allow the air to circulate.

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**Fig. 9.—Detail of door and jamb.** (a), door complete; (a'), cross-section of door in place; (b), showing jamb bolted to stud; (c), first layer of hoop; (d), second layer of hoop; (e), third layer of hoop; (f), plastering on interior of silo; (g), lath and sheeting.
through the wall and keep down decay of the woodwork. All holes should be covered with fine mesh woven wire to keep rats and mice out.

When hoops and vertical boxing are used, a few large sawed holes about 4x6 inches in size, at the bottom and top will serve, since the air can readily pass between the boxing and the studding.

**Bracing.**—While this type of silo does not dry out and collapse when empty, it is necessary to anchor it firmly with three or four strong guy wires or cables of short length. These will prevent it from blowing over during windstorms. They are attached to sleepers buried several feet in the ground about 10 feet out from the base of the silo, and attached to a point on the studding about three quarters of the way to the top of the silo.

**Bill of Materials.**—The following is an estimate of the bill of materials required to build a Gurler silo 14 feet in diameter by 32 feet in height which will have a capacity of about 100 tons. It is assumed that 3 feet of the height of this silo will be below the top of the foundation. This estimate does not include roofing material or nails. It is probable that enough scraps will be left over from which to construct the frame work of the roof.

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity/Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 studding</td>
<td>2''x4''x16'</td>
</tr>
<tr>
<td>4000 lineal feet sheeting</td>
<td>1/2''x4''</td>
</tr>
<tr>
<td>7000 lineal feet strips for lathing, or</td>
<td>1/4''x1 1/2''</td>
</tr>
<tr>
<td>2500 house lath,</td>
<td>1''x12''x16'</td>
</tr>
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<td>47 pieces siding,</td>
<td>1''x12''x14'</td>
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<tr>
<td>47 pieces siding,</td>
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</tr>
<tr>
<td>48 battens,</td>
<td>16 feet long</td>
</tr>
<tr>
<td>48 battens,</td>
<td>gravel or crushed rock.</td>
</tr>
<tr>
<td>3 cu. yds.</td>
<td>sand</td>
</tr>
<tr>
<td>4 cu. yds.</td>
<td>cement</td>
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Fig. 10.—Gurler silo plastered on the outside.