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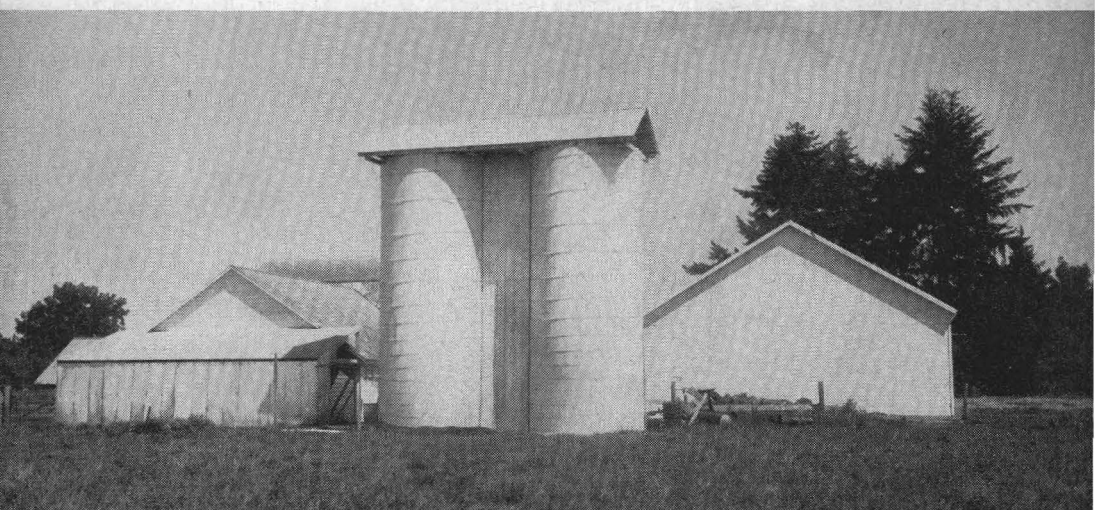

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A Homemade WOOD STAVE SILO

M. G. Huber and W. L. Griebeler*

THE INCREASED use of grass silage in Oregon has revived an interest in silos and their construction. Consideration of a few of the advantages afforded the farmer who owns a silo further demonstrates the economy and practicability of such a storehouse.

Advantages of silo

- More feed, whether corn or grass silage, can be stored in a silo than in any other building utilizing the same space.
- A silo provides the lowest cost roughage storage.
- A silo increases the livestock-carrying capacity of the farm.
- Soil-conserving crops, which help maintain soil fertility, can be grown and ensiled.
- A silo provides a way to save roughage that might otherwise be lost because of weather conditions. High-quality hay cannot be made in adverse weather.
- Ensilage will not burn spontaneously.

How grass silage can be used

Grass silage can be used in the rations of all classes of livestock, including dairy and beef cattle, sheep, horses, swine, and even poultry. To determine the true value of grass silage in a farm feeding program and the extent to which it can be used profitably, the following points should be considered:

- To what extent can hay be replaced in the ration?
- To what extent can pasture be supplemented during dry periods?
- To what extent can part of high-cost grain or protein concentrates be replaced?

Cattle fattening requires about 40 to 50 pounds per 1,000 pounds of live weight. Sheep take about one-eighth as much as per cow. Laying hens can be fed 4 to 6 pounds of silage per day for each 100 birds. Mature turkeys can be fed 6 to 10 pounds per 100 birds per day.

Most feeding experts agree that best results are obtained when some dry roughage is fed along with the grass silage. As a rule about one quarter of the roughage on a dry weight basis is fed as

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hay. Silage is about three times as heavy as hay. Thus a cow normally eating 20 pounds of hay per day would consume 45 pounds of silage and 5 pounds of hay when changed to a grass silage program. Table 1 lists the amount of hay for various feeding rates of hay with grass silage. This can be used as a guide to determine the amount of stored hay required per season.

Table 1. HAY AND SILAGE REQUIREMENTS PER COW WHEN FED AT DIFFERENT RATES PER DAY FOR DIFFERENT FEEDING PERIODS.

Amount fed daily	Total feed used per cow for given period			
	3 months	4 months	5 months	6 months
Hay	*Pounds*	*Pounds*	*Pounds*	*Pounds*
3 pounds	270	360	450	540
4 pounds	360	480	600	720
5 pounds	450	600	750	900
6 pounds	540	720	900	1,080
7 pounds	630	840	1,050	1,260
8 pounds	720	960	1,200	1,440
Silage	*Tons*	*Tons*	*Tons*	*Tons*
30 pounds	1.35	1.80	2.25	2.70
40 pounds	1.80	2.40	3.00	3.60
50 pounds	2.25	3.00	3.75	4.50
60 pounds	2.80	3.60	4.50	5.40
70 pounds	3.15	4.20	5.25	6.30
80 pounds	3.60	4.80	6.00	7.20

Choosing a Silo

This bulletin explains the construction of a homemade wood stave silo. This silo is easily erected, without staging, with the tools usually found around the farm. Metal (both aluminum and steel) and concrete stave silos are available from commercial silo firms. These silos are good and should be investigated before building a silo to make certain that the type selected is most suitable for individual requirements.

The life of silos varies with the care. Wood stave silos may depreciate more rapidly than concrete or steel, but at least 20 years use is assured, and in most cases more.

Practical Types of Silos

There are two types of permanent silos. The most common is the upright silo, which should be cylindrical for economy, strength, and airtightness.

Table 2. CAPACITY OF SILOS WITH DIFFERENT DIAMETERS AND DEPTHS OF SILAGE*

Depth of silage	Capacity with an inside diameter of—										
	8 feet	10 feet	11 feet	12 feet	13 feet	14 feet	15 feet	16 feet	17 feet	18 feet	20 feet
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
20 feet	18	27									
22 feet	19	30	37								
24 feet	21	34	41	49							
26 feet	24	38	46	55	65						
28 feet	27	43	52	61	72	84					
30 feet	30	47	57	68	80	92	106	121			
32 feet	32	51	62	74	87	100	115	131	148		
34 feet		56	67	80	94	109	125	142	161	180	
36 feet		61	73	86	101	117	135	153	173	194	
38 feet			79	93	109	126	145	165	186	209	258
40 feet				100	117	135	155	177	200	224	276
42 feet				108	124	144	165	188	212	237	293
44 feet					132	153	174	198	224	251	310
46 feet							184	209	236	265	327
48 feet								220	248	279	344
50 feet									261	293	361

* From FB 1870, "Silos—Types and Construction."

The underground trench and pit are flexible containers and are of miscellaneous dimensions. The important fact about them is that they must be provided with good drainage.

Emergency silos can be either a temporary trench, or a circular construction of snow fence, or woven wire lined with a good quality kraft paper.

Surfaces exposed to the air will have spoiled silage to a depth of 6 to 8 inches or more. Care should be given to pack or seal the surface.

Essential Features in Construction

Some features are essential to the construction of all silos, without which silage does not keep in perfect condition:

- The walls should be as nearly airtight as possible.
- The walls should be smooth and plumb, allowing free settling of the silage.
- The silo must be as deep as is practical to construct so that the pressure of the silage will force the air out. The minimum height should be at least twice the diameter.
- A round silo is considered the least expensive to build and is the most rigid.
- Sharp corners will trap air that results in spoilage.
- A good foundation is essential.

The silo should be located for convenience in setting the blower or cutter, driving in with loaded wagons when it is being filled, and for convenience in feeding.

Size to Build

In order to preserve the silage on top, at least 3 inches should be fed daily. In warm weather this is important to prevent heating and spoilage. The size to build will, therefore, be determined by the number of cows to be fed, the number of days that silage will be fed, and the amount to be fed each day.

Table 3 shows the proper diameter and height of the silo for herds of different sizes to be fed different quantities when 3 inches are removed daily.

Many farmers are finding that it is a good practice to build silos no larger than 14 feet in diameter because of the work in unloading larger diameters. A 12-foot silo can be unloaded without much carrying of each fork full, but rather throwing it into the chute. Larger diameter silos require considerable carrying toward the chute.

Table 3. Relation of Size of Herd to Diameter of Silo for Feeding on the Basis of 40 Pounds of Silage per Cubic Foot and the Removal of a Minimum of 3 Inches of Silage Daily to Avoid Spoilage.

Number of cows fed and daily rate				60-day period			90-day period			120-day period		
40 pounds	50 pounds	60 pounds	70 pounds	Feed required	Silo diameter	Silo height	Feed required	Silo diameter	Silo height	Feed required	Silo diameter	Silo height
				Tons	*Feet*	*Feet*	*Tons*	*Feet*	*Feet*	*Tons*	*Feet*	*Feet*
12	10	8	7	15	8	18	23	8	26	30	8	30
14	11	9	8	17	8	20	26	8	28	34	10	24
16	13	11	9	20	8	24	30	8	30	40	10	28
18	14	12	10	22	8	26	33	10	24	44	10	30
20	16	13	11	24	8	26	36	10	26	48	10	32
22	17	15	12	27	10	20	41	10	28	54	10	34
24	19	16	14	30	10	22	45	10	30	59	11	32
26	21	17	15	32	10	24	47	10	32	63	11	34
28	22	19	16	34	10	26	51	11	28	68	12	32
30	24	20	17	36	10	26	54	12	26	72	12	32
32	26	21	18	39	10	28	59	12	28	78	12	34
34	27	23	19	42	10	28	62	12	30	83	13	32
36	29	24	20	44	10	30	65	12	30	87	13	34
38	30	25	22	46	10	30	68	12	32	91	14	30
40	32	27	23	49	11	28	73	12	32	97	14	32

How to Figure Required Size

To use Table 3 to figure the proper size of silo, you must know (1) the size of herd, (2) the amount of silage to be fed daily per animal, (3) the length of the feeding period.

Find the column on the left of the table that gives the amount you want to feed each animal daily. Run down this column until you find the number of cows you will want to feed. Move to the right on this line until you are under the 60-, 90-, or 120-day feeding period. Each length feeding period gives the total tons of silage required, the diameter and height required to hold that amount of feed and the correct diameter to feed a minimum of 3 inches per day out of the silo to prevent spoilage.

A 180-day silage feeding program will require two silos of the proper size to feed your herd for 90 days.

Staves

Douglas-fir, pine, spruce, and hemlock are used for staves, the preference in the order listed. The most satisfactory wood silo stave is a 2 x 6, tongue-and-groove, slightly beveled, and as long as the height of the silo. If the staves are not beveled, there will be a slight crack at each joint on the outside of the silo. This will not affect the keeping qualities of the silo, since the inside edges will fit tight. Two by six, S4S, may also be used as staves, but there is some danger of the staves collapsing or buckling in strong winds unless the hoops are well stapled.

Table 4. NUMBER OF STAVES, STAPLES, AND LENGTH OF HOOPS REQUIRED.

Inside diameter of silo	Number of staves required[1]	Number of staples required[2]	Length of each half-hoop[3]
		Gross	
8′ 0″	53	2	12′ 9″
9′ 0″	61	2½	14′ 5″
10′ 0″	69	3	16′ 1″
11′ 0″	76	3½	17′ 8″
12′ 0″	83	4	19′ 1″
12′ 6″	87	4½	20′ 0″
13′ 0″	91	4½	20′ 9″
14′ 0″	98	5	22′ 3″
16′ 0″	112	6	25′ 4″

[1]Standard silo staves, with 5¼″ inside face.
[2]Staples should be ⅝″ in diameter, 2½″ long.
[3]See Table 5 for the number of hoops required and diameter of hoops.

The size and number of hoops required may be determined from Table 5. Soft steel rods are preferred to iron. The table is based on steel rods and spacing is indicated from the *top* down.

Sometimes it is not possible to get full length staves for a tall silo. If short staves are used, they should be of two different lengths so the end splice points will be staggered. With tongue-and-groove staves, a butt joint splice in the upper 20 feet of a silo is sufficiently strong but may leak a little air if the joint is not perfectly square. S4S staves should be spliced together on any end splice. Splices for either type stave may be made of galvanized sheet iron inserted in a saw cut one inch deep in the end of each stave. A better splice is a piece of $\frac{1}{4}$-inch exterior type plywood, if tools are available to make a wider cut required in the end of each stave.

Hoops and Hoop Spacing

The length of hoops is determined from Table 4. Both ends of each hoop should be threaded at least 6 inches, and the tie rods $1\frac{1}{2}$ inches.

The number and size of staples required for various diameter silos are listed in the same table.

Washers

Large malleable or cast iron washers, commonly known as bridge washers, are used on hoops and tie rods for heights up to 24 feet. Beyond this height special washers should be made from

Table 5. Spacing of Hoops for Silos Not Exceeding 16 Feet in Diameter.

Diameter of rod	*Distance from top of silo*
$\frac{1}{2}$"	1′ 6″
$\frac{1}{2}$"	5′ 0″
$\frac{1}{2}$"	8′ 6″
"	11′ 6″
"	14′ 0″
"	16′ 6″
"	18′ 6″
"	20′ 6″
"	22′ 0″
"	23′ 6″
"	25′ 0″
"	26′ 6″
"	28′ 0″
"	29′ 6″
"	30′ 6″
"	31′ 6″

3-inch steel bands, making square washers $\frac{1}{4}$ inch thick and 3 inches square. The drilled hole should be 11/16 inch for a $\frac{5}{8}$-inch hoop. The square washers should be placed under the malleable washers on every hoop and tie rod more than 24 feet down from the top of the silo, to prevent the washers on every hoop from pulling into the door frame and binding post. The taller a silo is, the greater the bursting pressure near the bottom when the silo is filled.

Foundation

The foundation design shown in Figures 1 and 2 is for average conditions encountered in western Oregon; where the frost line is shallow and solid, undisturbed earth can be found as little as 12

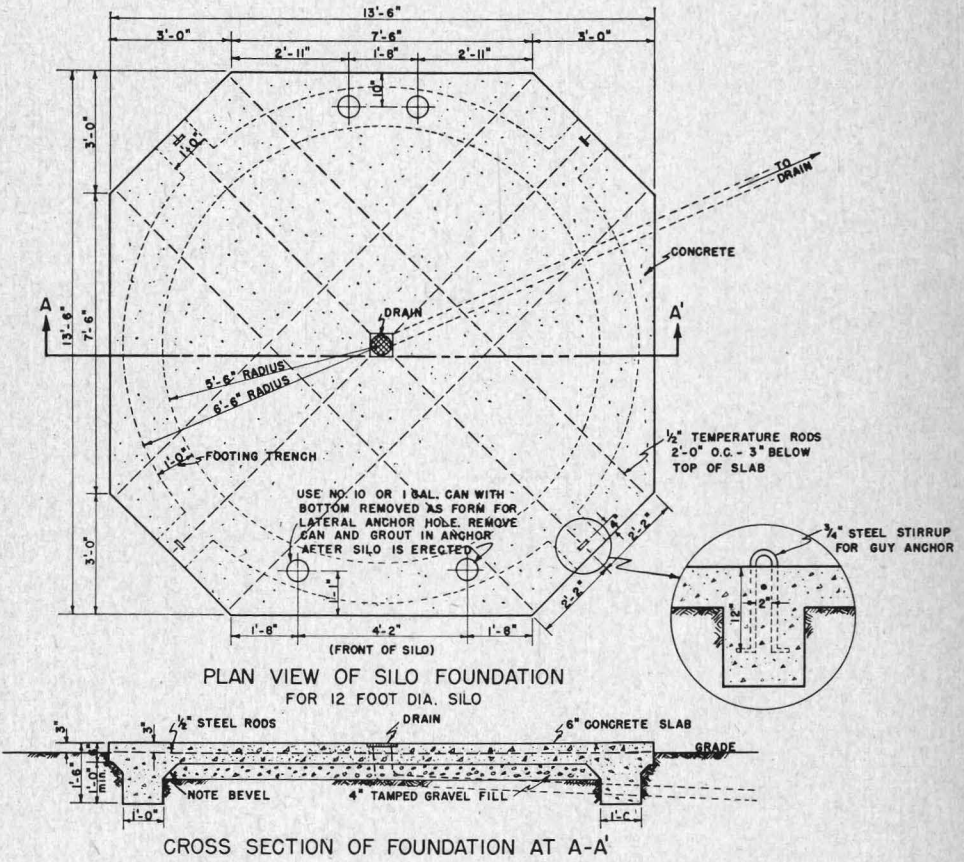
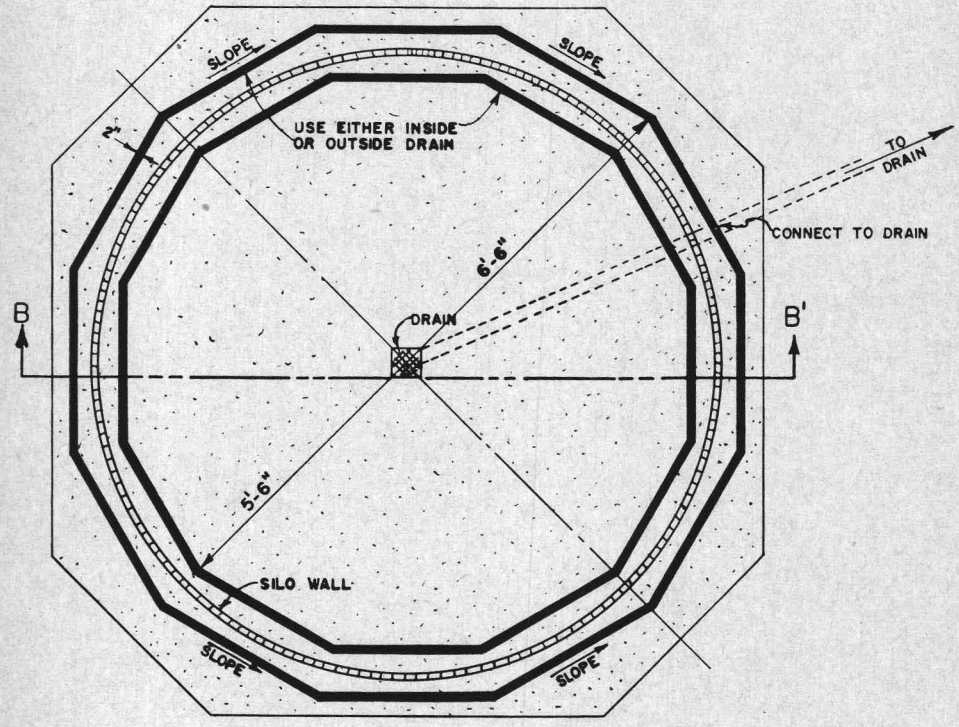
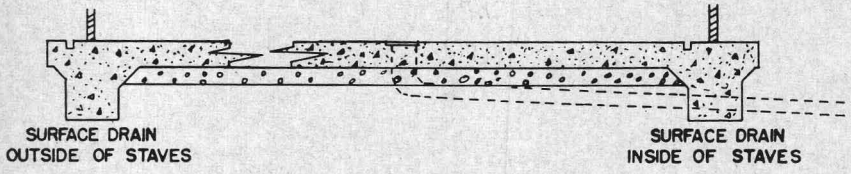


Figure 1.

inches below the ground surface. In cases where the building site is poorly drained and there are soft soil conditions, the foundation size must be increased and additional reinforcement will be required. The plan shown is for a 12-foot inside diameter silo. For other silos, the over-all width of the foundation slab should be the inside diameter plus 1½ feet. The footing should be centered under the silo wall.



ALTERNATE PLAN VIEW OF SILO FOUNDATION SHOWING OPTIONAL SURFACE DRAINS & LOCATIONS



CROSS SECTION OF FOUNDATION AT B-B'

Figure 2.

Figure 3 shows a method for laying out the foundation and concrete form work. After the building site is cleared off and leveled, drive a stake into the ground at the center of the foundation and pivot a 2 x 2 or 2 x 4 scantling on top of the stake with a single spike. With two pointed members tacked onto this piece the proper distance from the stake and 1 foot apart, the footing trench can be marked out on the ground by swinging the scantling around. The outer forms of 2 x 6 are set across the corners of the foundation square to conserve concrete.

Dig the footing trench to a depth at least 15 inches below the surface of the ground and cut the bottom and sides smooth. The circle within the footing trench should be leveled off about 8 inches below ground level to permit a 4-inch, tamped, gravel fill under the floor slab. Notice that the footing trench is also dug out toward the four corners of the forms to provide a thick section of concrete where the anchor stirrups for the guys are placed.

Experiments show that most of the silage juice moves down along this wall and can be collected by providing a surface drain just inside the wall. In wood stave silos, the juice can pass under the staves to the outside and may be intercepted by a surface drain just outside the wall and carried away from the silo.

The surface drain may be formed by pressing a 2 x 4 on edge into the green concrete after it has been poured. The drain should slope uniformly around the silo to a collection point.

Figure 2 shows the optional locations for this drain.

A drain at the center of the silo floor also is desirable and should be installed before concrete pouring is begun. A drain line of 4-inch tile with a 6-inch floor drain is usually adequate. The floor drain can be propped up in place with a small amount of hand-mixed

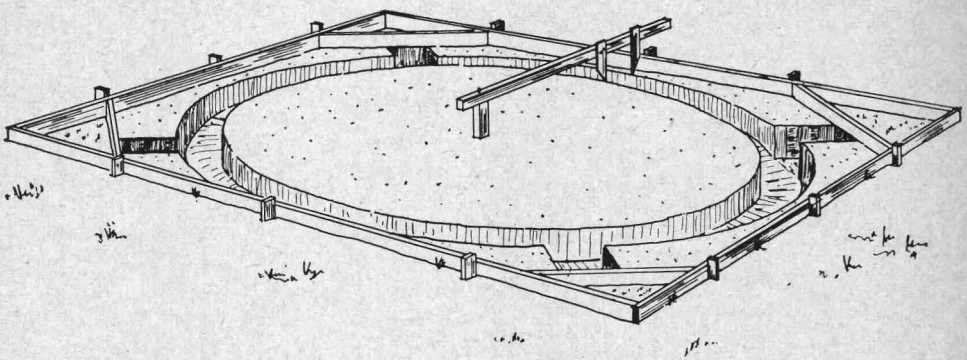


Figure 3. Method of laying out silo foundation.

concrete before the main foundation is poured; then the floor drain can be used as a guide point for sloping the floor during the finishing operation.

The foundation was designed to permit pouring concrete in one operation. The plans indicate ½-inch steel reinforcing rods imbedded in the floor slab. These are intended to distribute changes in temperature that may cause cracks and will give some reinforcement to the floor.

One of the problems is anchoring the bottom of the silo to prevent lateral movement on the foundation. It is difficult to align a silo perfectly over small anchors set in the concrete. To make this job easier, the foundation plan shows the location of four No. 10 (or 1-gallon) cans placed when concrete is being poured. Cut out the bottoms of the cans before they are used and then pour around them. When the concrete has set, the cans can be pried out of the concrete by collapsing them. After the silo is put up, the silo walls should fall someplace over these holes in the foundation. Anchors, as shown by Figure 7, can be bolted to the silo staves with the end of the anchors in the holes left by the cans. Fill the holes with a rich cement grout and the anchors are properly aligned without delaying erection.

Concrete for a silo foundation *must* be of good quality. Use standard portland cement; clean, coarse sand; clean, coarse gravel graded from ½" to 1½", and water that is clean enough to drink. The usual mixture for this type of foundation is 1 part cement, 2½ parts sand, and 4 parts of gravel mixed with 4 to 5 gallons of water for each sack of cement used in a batch. If ready-mix concrete is used, specify that it be what is known as a "6-sack mix."

More complete information on mixing and placing concrete is given in Farmers' Bulletin 1772, "Use of Concrete on the Farm," and in booklets obtainable from cement dealers.

The Door Frame

The door frame is built as a unit on the ground before erection, and is continuous from the bottom to the top of the silo. The frame is made of two full length 4 x 6 door posts spaced 3 feet apart, outside to outside. The drawings in Figure 4 show the location of part of the holes for the hoops and tie rods for a 30-foot silo. All spacings are shown on Figure 7. Dimensions for hoop locations of other height silos are obtained from Table 5.

To build the door frame, lay the 4 x 6 door posts up on several sawhorses and mark the hoop and tie rod locations on both door posts

at the same time. Notice that the dimensions are given in progression from the top of the silo down. A long, flexible tape will make this marking job easy and will avoid errors in location. After marking for the holes, spike on the 2 x 4 door stop, as shown in the drawings, being careful not to nail where holes are to be bored.

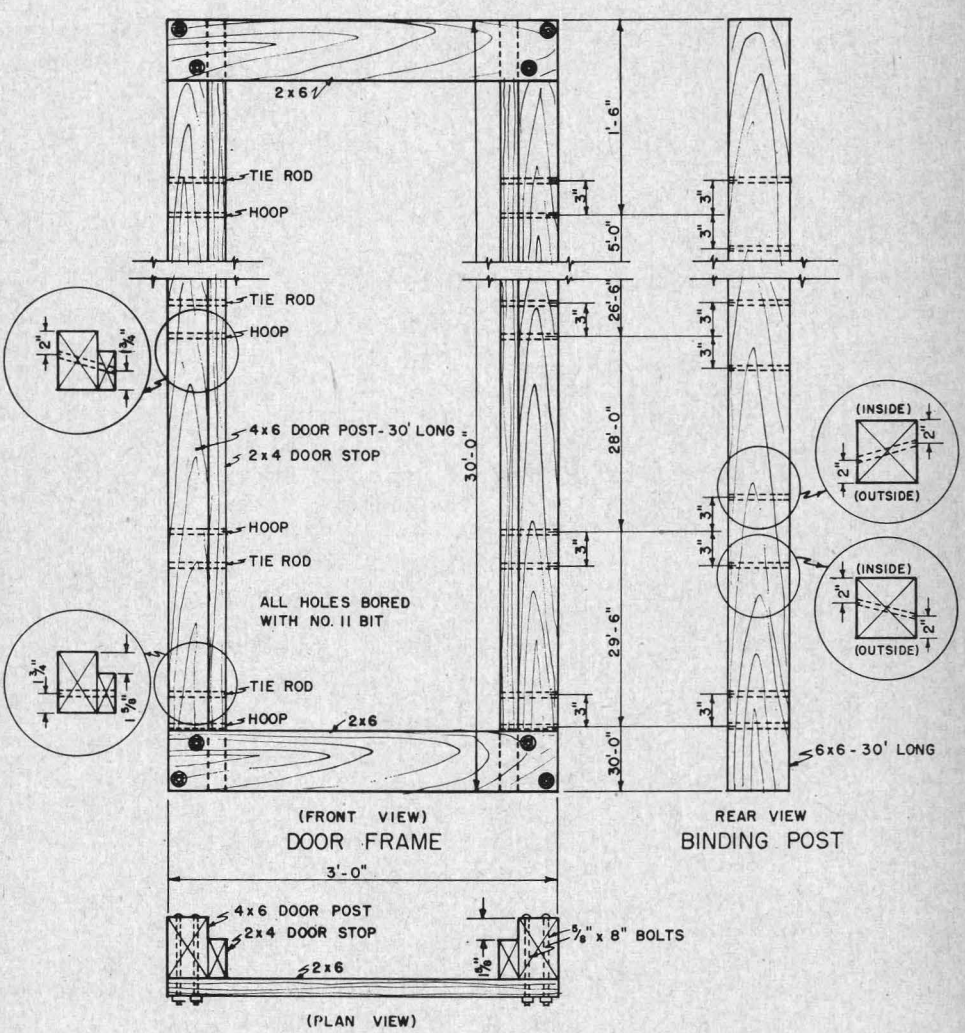


Figure 4.

Bore the holes for the hoops and tie rods with a No. 11 bit. The holes will be a little large, which will permit easier assembly of the hoops to the frame. Notice that the tie-rod holes are bored straight through the door frame. The hoop holes are bored at an angle to center the washer and nut location on the 2 x 4 door stop. A method of getting this angle bored correctly is as follows: Lay the door post on the sawhorses with the 2 x 4 door stop down. On both ends of the 4 x 6 door post, carefully mark off the correct location and angle of the hoop holes. Nail a short piece of 1 x 2 on each end of the 4 x 6 carefully following the lines marked, with one end of the 1 x 2 sticking up in the air. While one man is boring the hoop holes,

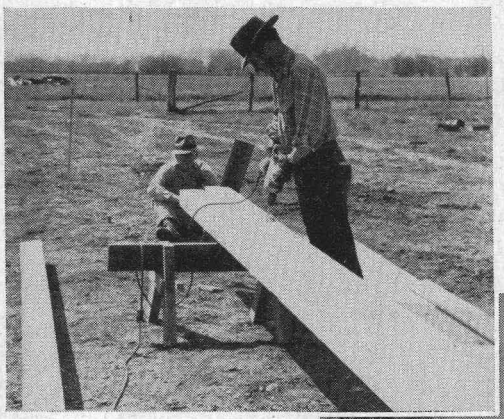
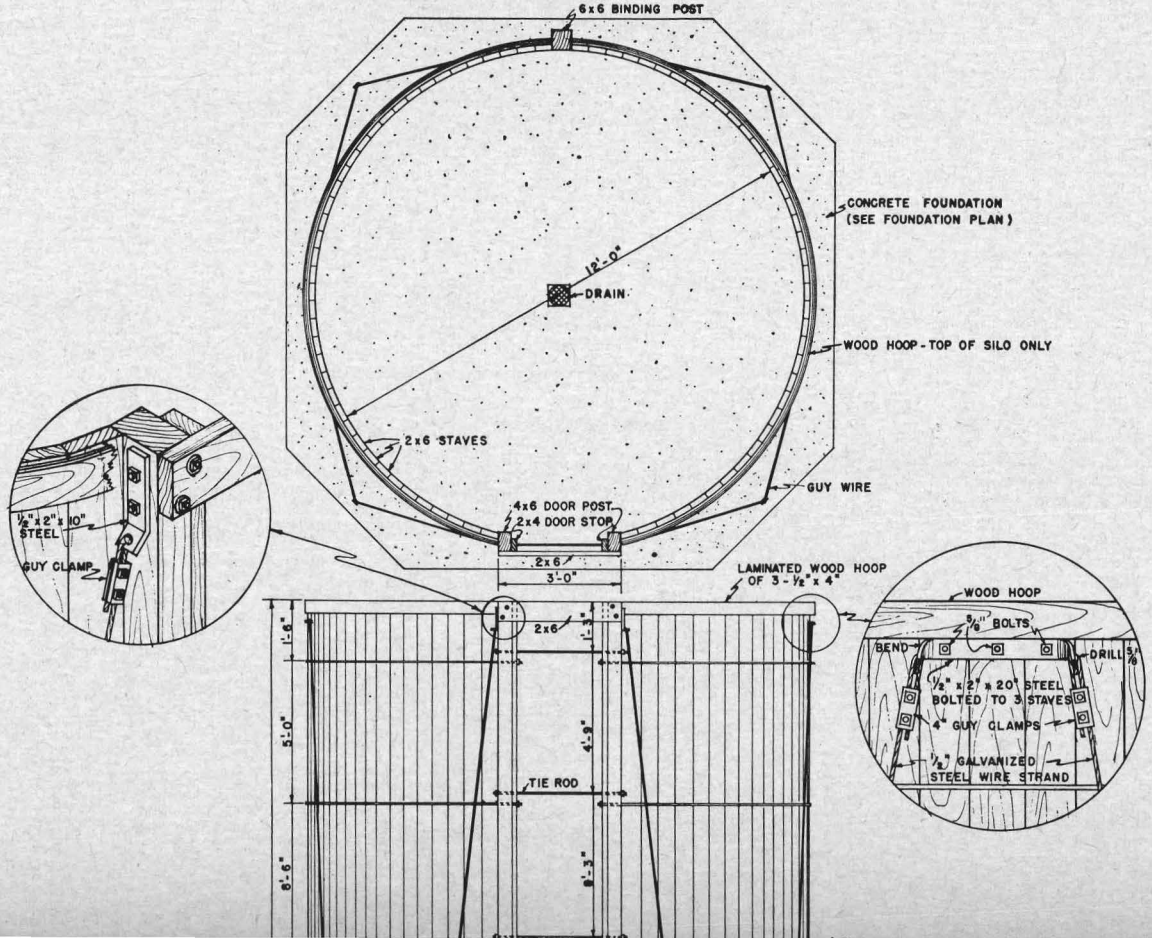
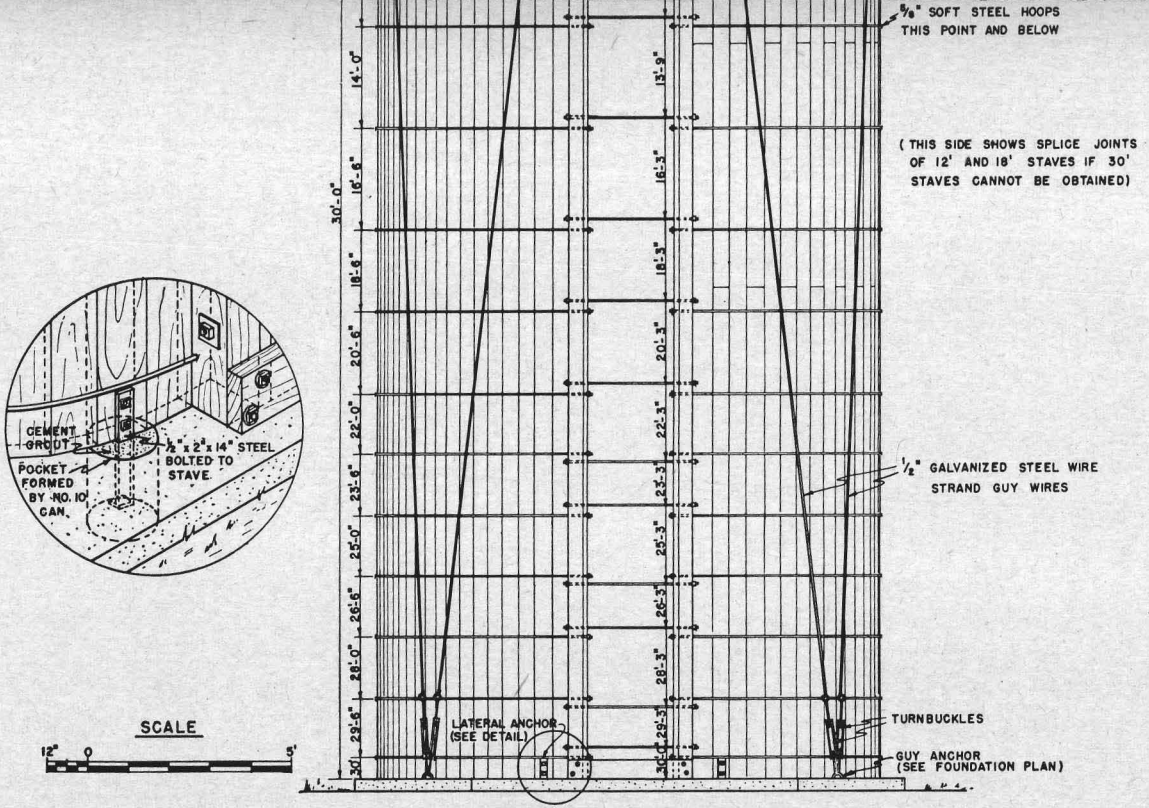


Figure 5. Boring holes for hoops in door frame timbers. Note straight edge nailed at the angle required for the holes.

Figure 6. Assembling the door frame. Insert top and bottom tie rods and two rods spaced at third points along frame with the 2 x 4 spacers. Screw nuts snug and check bottom ends of frame posts. They should be squared.

TOP VIEW OF SILO





FRONT ELEVATION OF SILO
(WITHOUT DOORS OR ROOF SHOWN)

Figure 7.

another can be sighting across the angled 1 x 2 and give corrections to him. This method has given good results of practical accuracy in a number of silo buildings.

When the boring is completed, the door frame may be assembled by bolting on the 2 x 6 pieces top and bottom. At frequent intervals, scraps of 2 x 4 should be set across inside the frame to hold the door posts parallel during assembly and erection. Slip the tie rods into the proper holes and across the door frame. Put on the washers and nuts, tightening the nuts enough so the rods are not loose, and the 2 x 4 scraps are held firmly in place. On the tie rods and hoops below 24 feet (measured from the top down) extra washers 3 inches square and made of $\frac{1}{4}$-inch plate should be placed under the regular round washers. There is considerable pressure near the bottom of a tall silo and these larger plate washers will guard against the pressure pulling the smaller round washers into the wood.

The Binding Post

The binding post is a full length 6 x 6 timber located on the opposite side of the silo from the door frame when the silo is erected. Figure 4 shows the location of the holes bored in this member to take the ends of the silo hoops. Notice that the holes are located 3 inches above and 3 inches below the hoop holes as bored on the door frame. This staggers the hoop ends on the back side of a silo for easier fastening of the hoops. Notice also that the holes are all bored at an angle, alternate in direction, in order to leave room to put the washers on the hoops and clear the staves.

To insure accuracy in hoop hole location, you should lay the binding post alongside of the door frame, with the ends even, and mark the location of the hoop holes 3 inches above and 3 inches below hoop holes on the door frame. See boring directions, page 15.

Doors

The doors fit across the door frame and inside of the 2 x 4 door stops. There are several types of doors that may be used satisfactorily. They may be made simply by cutting lengths of 2 x 6 tongue-and-groove stock about $\frac{1}{8}$ inch shorter than the distance between the door posts and setting them across the frame as filling progresses. This type of door has the advantage of keeping the height to a minimum over which a man must pitch the ensilage, as a board can be taken out every time 5 inches of ensilage is removed. When placing doors at the time of filling, alternate doors should be

placed tight against the opposite door posts to stagger the air pockets at the end of each door board. This eliminates air circulation along door ends up the length of the silo and reduces danger of spoilage.

If you prefer to line the inside of the door with paper during filling, the paper should be kraft-type or a good grade of roofing paper. This paper should run lengthwise up the silo and be held on each side of the door with lath battens placed vertically. If this system is not followed, the paper usually will buckle as the silage settles and form air pockets, a source of spoilage.

Larger doors may be made by cleating several staves together, with the cleats vertical and facing the outside of the silo.

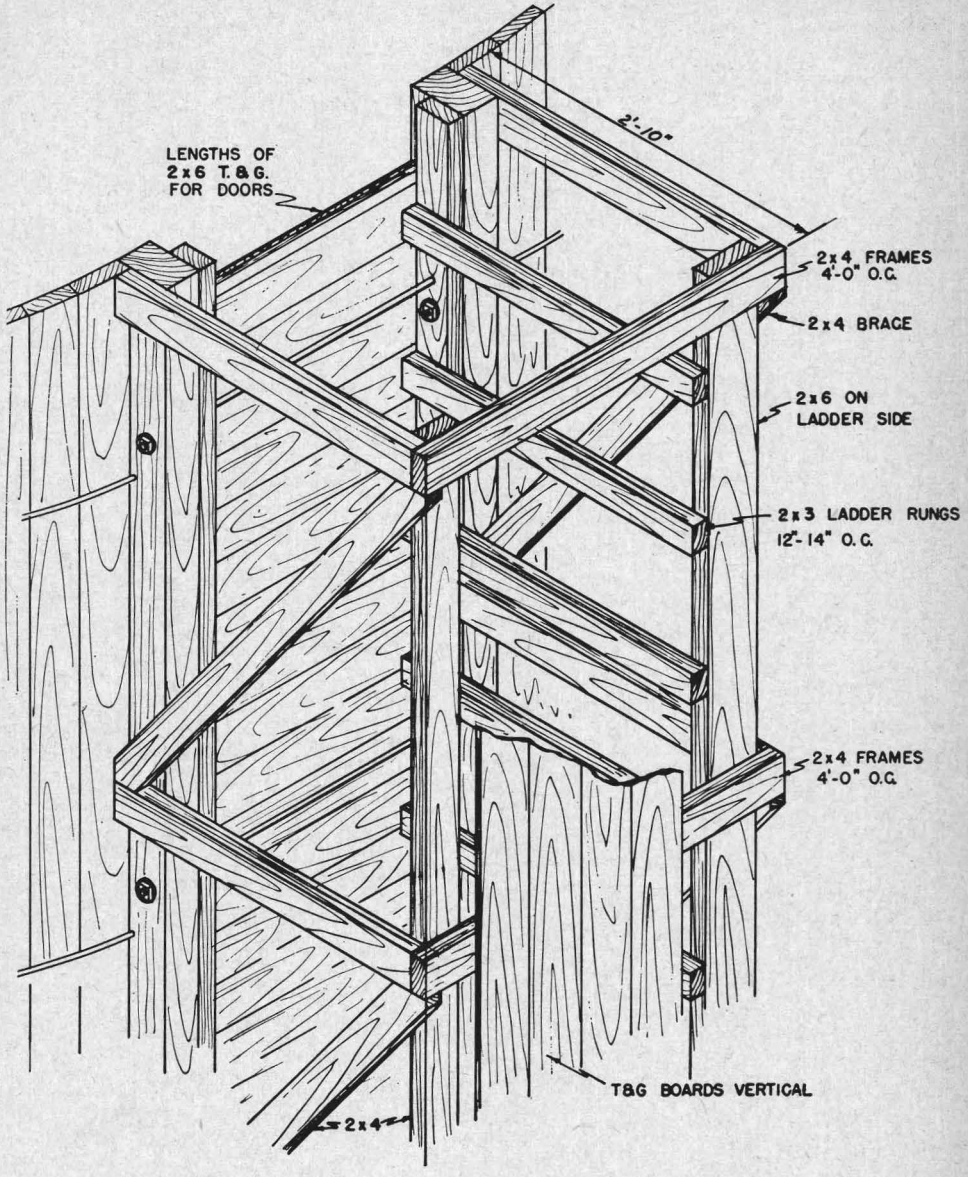
Another type of door is a double-layer panel of 1-inch boards laid in opposite directions and nailed together. These may be tongue-and-groove boards or plain boards with building paper between the layers for airtightness. The boards on the inside should be vertical.

Still another type of door is made of exterior grade plywood. Below a depth of 26 feet from the top, the plywood should be $\frac{3}{4}$ inch thick, and above that point $\frac{1}{2}$ inch will be rigid enough to prevent excessive bowing from silage pressures. To get the most doors from a 4′ x 8′ sheet, the doors should be cut the proper width to fit the door frame and 2 feet high. Be sure to use *exterior grade* plywood.

Anchors

It is poor economy and workmanship to erect a silo and then permit it to lean and twist until it is blown down. One of the most common faults in building homemade silos has been improper anchoring or no anchoring at all. The discussion on the foundation mentions placement of guy anchor stirrups in the concrete at the time of pouring, and also the placing of lateral anchors to prevent the base of the silo from shifting. After the silo is erected, guy wires should be strung from the guy anchor stirrups in the foundation to the top of the silo. Figure 7 shows the placement of the guy wires and details of the fasteners bolted near the top of the silo. Guy wires are best made of $\frac{1}{2}$-inch galvanized steel wire strand which does not stretch as much as ordinary wire rope. Turnbuckles on each wire at the foundation will make it easy to tighten up the guy wires and keep them tight.

The guy wires are shown in Figure 7 as being fastened near the top. It is often more convenient to do this when erecting the silo and while a long ladder is still in place inside of the silo. Anchoring the tops of the guy wires two-thirds of the way to the top of the silo is as effective and affords a saving of material, if a good ladder the proper length is available for the work.



TYPICAL CHUTE CONSTRUCTION

Figure 8.

Chute

A chute over the silo doors will save ensilage by preventing wind from scattering it when it is pitched down. The chute also affords a place to build a safe ladder to get in and out of the silo. Figure 8 shows a typical chute construction that was designed for ease in building. The framework is on the inside of the chute to permit application of vertical siding and prevent rain water damage to the supporting frames. Tongue-and-groove lumber is the best siding for this job. Plain boards, however, with battens over the joints, are satisfactory. Notice that the chute frame is wide enough to nail directly on the outside of the door posts. The chute should not extend lower than 8 feet from the ground to avoid damage from vehicles passing under it. It may be roofed separate from the silo roof or the silo roof may be extended down to cover the chute opening.

Cleats can be nailed to the chute frame on the opposite side from the ladder to form a place to store silo doors. From a safety standpoint, these doors should be held in place so there is no danger of their falling on someone working below.

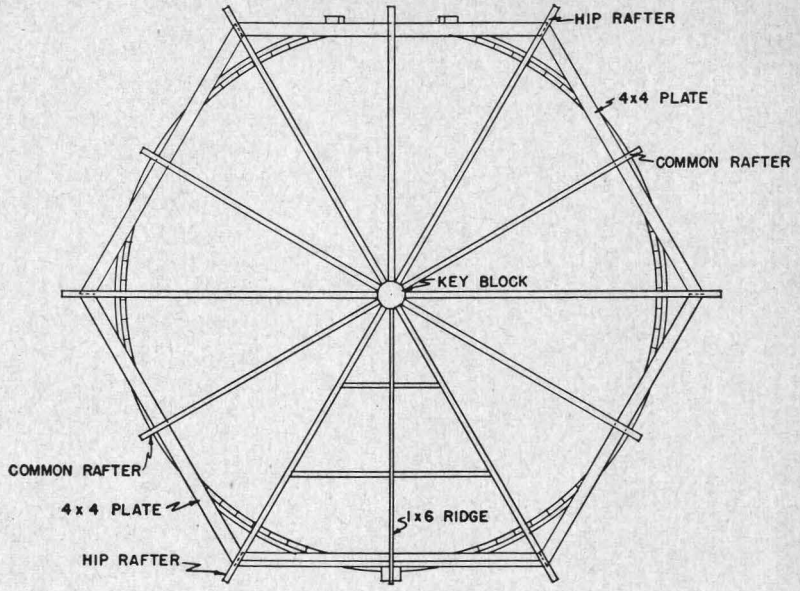
Roof

A roof is an absolute necessity in Oregon; it has many advantages that make it worth the cost and effort. It will prevent rain and snow from falling on the silage, strengthen the silo, and add to its appearance.

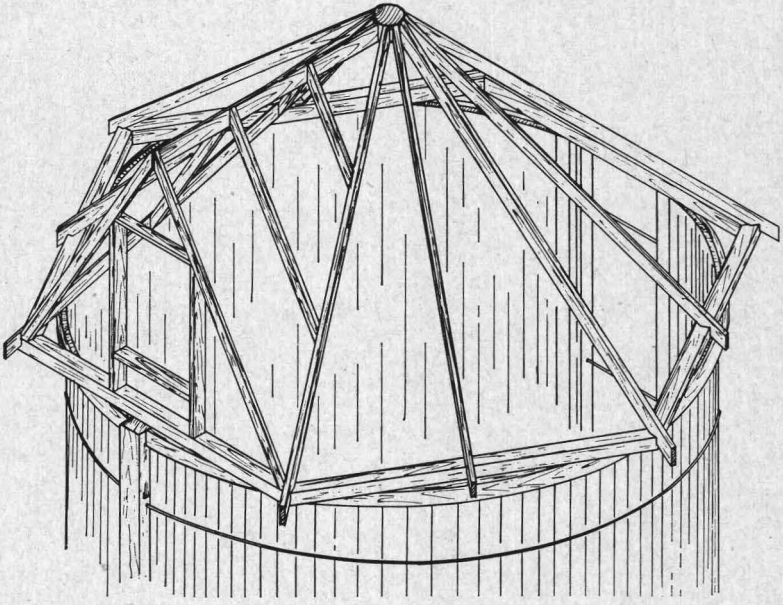
There are several types of roofs that can be built on a round silo: cone shaped, gable, gambrel, flat, and hexagonal. A flat roof would be the simplest type to build, but has the disadvantage of preventing a man from getting in the silo during the last of the filling operation. A gable roof is another easier type to build and probably fits two silos built with a chute between them better than a single silo.

Figure 9 illustrates the method of framing a hexagonal roof with all of the layout dimensions given in Figure 10. By following the dimensions listed in the table for a certain size silo, all cutting can be done on the ground and the roof assembled after the silo is filled so that the silage itself forms the platform for the roofing work.

The 4 x 4 rafter plate that rests on the top of the silo should be tied to the silo staves by means of metal straps that can be looped over the plate and carried down the staves at the two points where each plate crosses the silo. The key block that the rafters butt



PLAN VIEW OF ROOF FRAMING

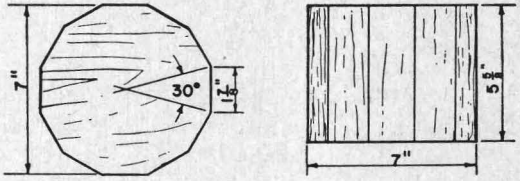


PICTORIAL VIEW OF ROOF FRAMING

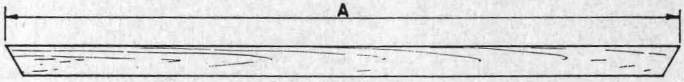
Figure 9.

against can be cut out of a short piece of 6 x 8 timber. This could be a round piece, 7 inches in diameter. The rafters will not seat quite as squarely, however, as if the block is cut 12-sided as shown in the plan.

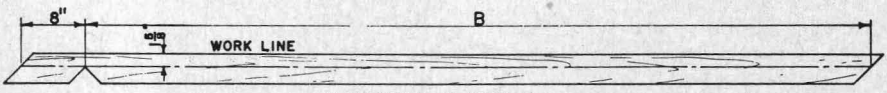
The roof framing may be covered with 1-inch boards for sheathing and a choice of shingles, composition or metal sheets for roofing.



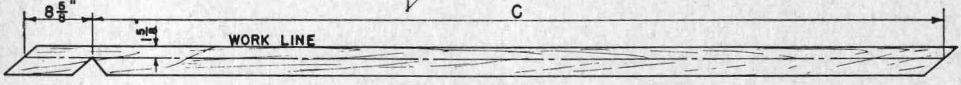
12-SIDE KEY BLOCK
(CUT FROM 6x8)



4X4 RAFTER PLATE
(USE $6\frac{15}{16}$ 12 ON END CUTS)



COMMON RAFTER
(USE 12 / 12 ON ALL CUTS).



HIP RAFTER
(USE $10\frac{5}{16}$ 12 ON ALL CUTS)

INSIDE SILO DIAMETER	4x4 PLATE DIMENSION A	COMMON RAFTER DIMENSION B	HIP RAFTER DIMENSION C	RAFTER SIZE
10'-0"	6'-0"	$6'-11\frac{1}{4}"$	$7'-6\frac{3}{8}"$	2x4
12'-0"	7'-0"	$8'-1\frac{5}{8}"$	$8'-10\frac{1}{16}"$	2x4
12'-6"	7'-4"	$8'-7\frac{1}{8}"$	$9'-3\frac{3}{8}"$	2x4
14'-0"	8'-3"	$9'-8\frac{3}{8}"$	10'-6"	2x6

Figure 10.

How to Erect the Homemade Wood Stave Silo

Equipment needed

- √ Brace and No. 11 bit or electric drill and bit.
- √ Hand saws.
- √ Claw hammers.
- √ Sledge hammer.
- √ Small jack that can be operated in a horizontal position.
- √ Single pulley with clevis or hook.
- √ Sufficient rope for three guy lines and a hoist line for pulling up staves.
- √ Rope and pulley to erect door frame and binding post.
- √ 1 ladder to reach top of staves—if staves are spliced, another ladder to reach splices.
- √ Wrenches to fit hoop nuts.
- √ Tractor or truck to pull up door frame and binding post.
- √ Hay rake or rake wheel separate.

Materials needed in addition to silo material

- √ Miscellaneous lengths of lumber or small poles for bracing.
- √ Spikes and nails for bracing.
- √ One 2 x 4 about 4 feet longer than silo diameter for top bracing from binding post to door frame.

Procedure

The order of work in preparation of erecting the silo should be:

1. Pour the concrete foundation;
2. Build the door frame;
3. Bore hoop holes in the binding post.

These operations have been previously described. Next in order is bending the hoops to the proper shapes. The hoops can be bent on a hay rake wheel or any wheel with a reasonably wide, concave rim. Such a wheel should be at least 4 feet or larger in diameter.

Wrap a length of wire or chain to form a loop around a point on the rim of the wheel. Put one end of a hoop length under this loop and bend the hoop into the concave rim by turning the wheel. This job will require two men, one to turn the wheel and one to bend the hoop. If the wheel used is off the rake, lay it horizontally on saw horses or the door frame. With one man holding the wheel, another

Figure 11. Binding the hoops. The wheel may be left on the rake if supported off the ground. Horizontal position is better for convenience.

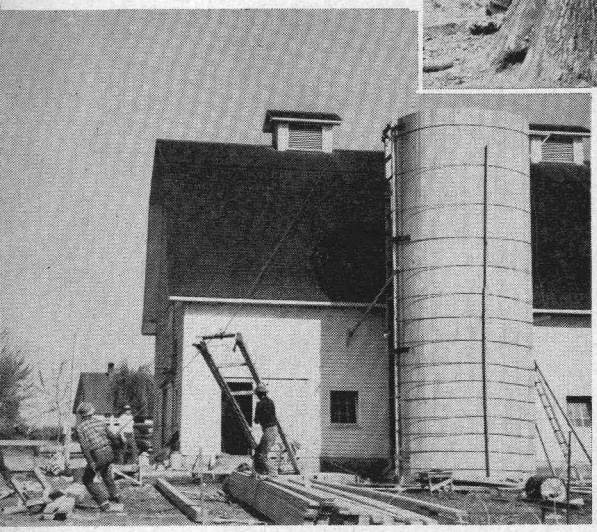


Figure 12. Raising the door frame. Notice the hauling rope rigged over the barn ridge in this case. Guy ropes steady frame as it is hoisted.

can walk around the wheel bending the hoop into shape. After the hoop is bent to the wheel shape, one man on each end of the hoop can pull the hoop ends back out to approximately the diameter of the silo.

Hoops also may be bent by laying out a template on a flat surface. The supporting block must be faced with a smooth surface such as a strip of plywood or thin board or kinks will result in the hoops.

If the wheel circumference is smaller than the length of the hoop, keep sliding the hoop through the loop on the rim while bending to keep the bend uniform and prevent sharp kinks.

To begin the actual erection of the silo, mark off with crayon on the foundation the location of the door frame and binding post. Set up the door frame by means of block and tackle. Three guy ropes should be used in addition to the lifting line to hold the frame

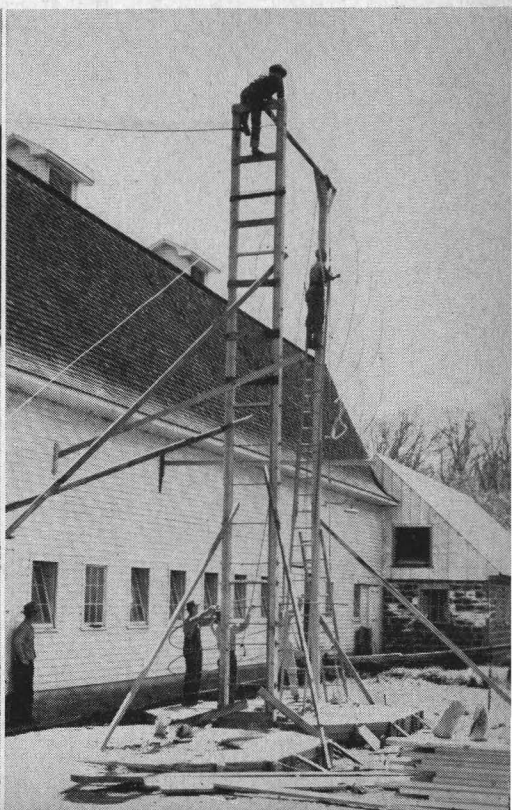
steady. Brace the door frame to adjacent buildings, if possible, or to ground anchors, making sure that it is set plumb. All braces must be fastened so as not to interfere with putting in hoops or setting in staves.

Secure to the top of the binding post, a length of 2 x 4 that will reach across to the top of the door frame when the post is upright in its proper position. This 2 x 4 should be well braced to the binding post by braces to the inside and outside surface of the post. Mark on the 2 x 4 the exact dimension for the diameter of the silo and start a spike in it that can later be driven in the top of the door frame. Fasten the three top hoops to the binding post and also secure the three guy ropes used on the door frame to the top of the post. Raise the binding post with one man on top of the door frame to position and nail the 2 x 4 crosspiece from the binding post. With the bottom of the post in position, tighten the guys, and leave them up as anchors until the silo is completed.

Place the hoops in position on one side of the silo only, beginning at the bottom and working up. Hoops in the binding post can be placed from the top down. To keep the hoops from sagging, place

Figure 13. The 2x4 extender from door frame to binding post should be nailed to post now. Guys are secured outside the working area.

Figure 14. The binding post and door frame in position. Bracing is necessary as a safety measure and will help hold job in plumb.



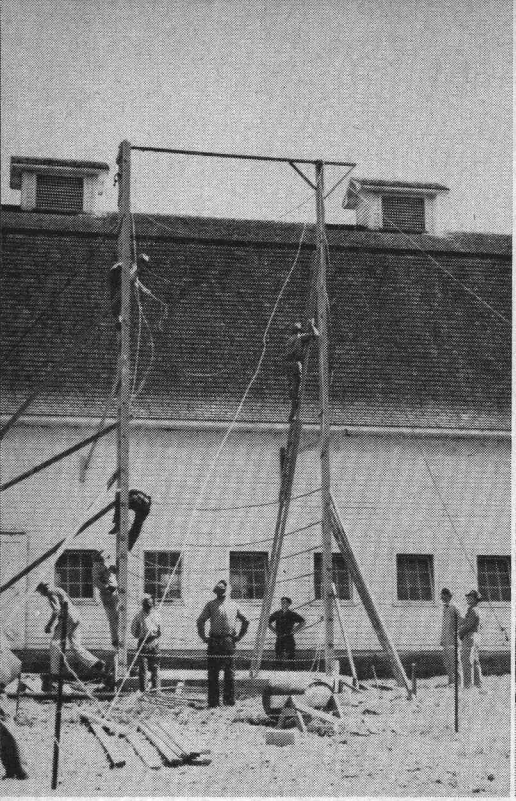


Figure 15. Hoops being placed on one side of silo. The three top hoops usually are fastened to the binding post before it is raised.

Figure 16. Ladders the height of a silo frequently cannot be found. This is one method of extending a ladder safely without marring it.

a narrow board vertically on the outside of the hoops midway between the door and binding post and drive a nail below each hoop position. Bend the nail up around the hoop. This board will not interfere with placing the staves if set on the outside and it can be removed before final tightening of the hoops.

With a man at the top of the long ladder inside the silo, start setting up the staves at the binding post, with the groove of the first stave toward the post. Staple each stave top and bottom, leaving just a little slack so the stave can move during final tightening. After four or five staves are in, drive a staple loosely in one stave and push this stave ahead of the work to hold the upper hoop in place. A pulley and rope fastened to the 2 x 4 across the top will be convenient to pull up the staves, especially full length ones.

Before the last two staves are set up, place a jack between the staves and the door frame. Jack the staves over tight and then nail several pieces of scrap board on the outside of the silo across the last stave and the door frame to hold them in place. Remove the

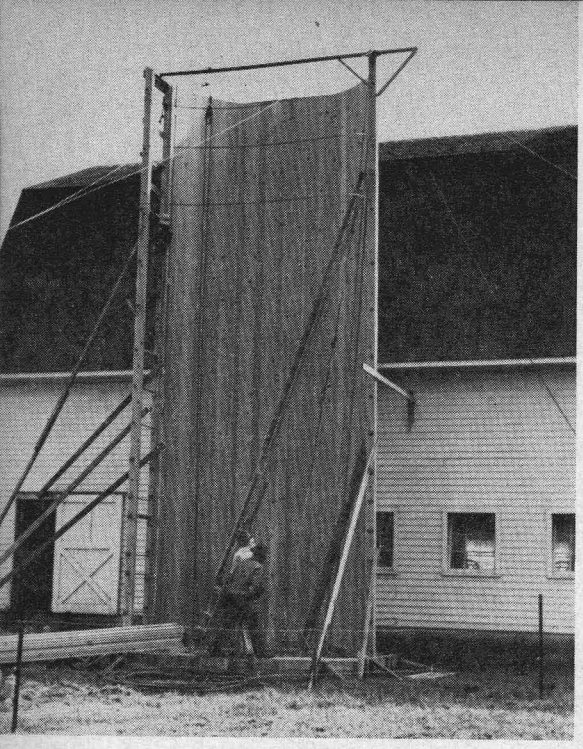


Figure 17. One side is finished before the staves are started on the other half. Three top hoops are secured to start second half.

last stave and the door frame to hold them in place. Remove the jack and put in the remaining staves. Sometimes it will be necessary to rip a stave for the last one next to the door frame. When the last stave is in place, the hoops should be straightened up and tightened evenly.

Lean the remainder of the silo staves up in the finished portion of the silo, keeping them nearly vertical so they don't push the silo out of line. Fasten the hoops in place and set the staves in the same manner the first half was built, again starting at the binding post.

Finally, tighten all hoops evenly and staple them in place. Every stave is stapled to the top and bottom hoop during erection. In addition, staple every third stave on each hoop. Stagger the staples so that each stave is stapled to every third hoop.

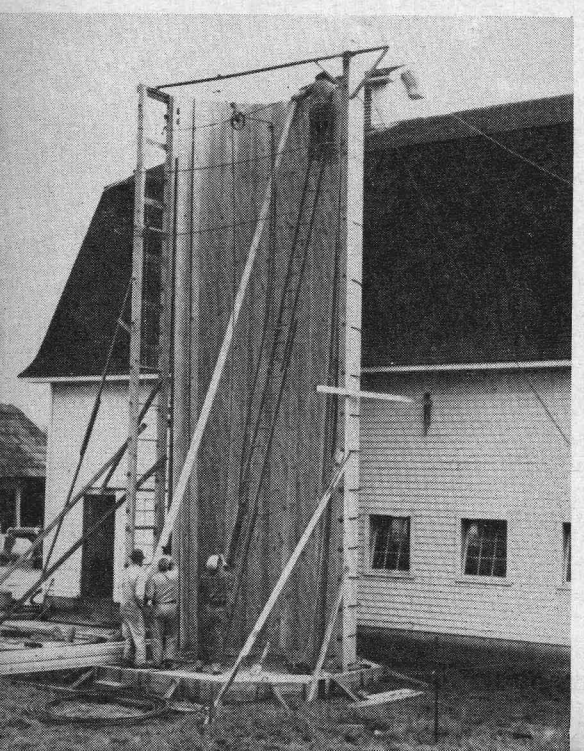


Figure 18. The staves are stood up and leaned against the finished side. The top man unties the rope when the staves are hoisted.

Preservation

It is doubtful that there is much advantage to finishing the inside of a Douglas-fir silo in any way, unless the whole stave is soaked or pressure treated. Dipping or brushing on preservatives is not very effective on Douglas-fir. The first deterioration of a wood stave silo is at the bottom of the staves. This

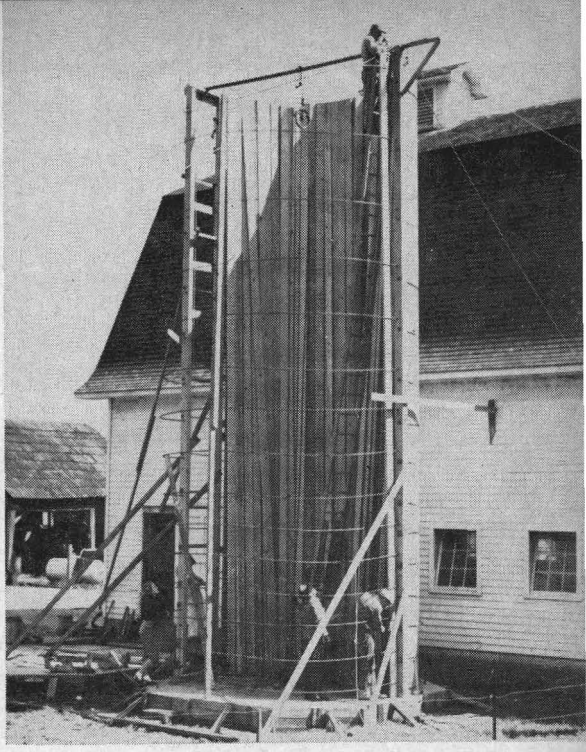


Figure 19. Placing first stave on the last half of silo. This stave is stapled loosely to top hoop and pushed out for support.

is caused by rain water being absorbed by the end grain of the wood. To prevent this decay at the bottom, a soak treatment of creosote or pentachlorophenal is necessary.

Painting

Painting the outside will add years to the life of the silo by preventing checks and cracks that will allow water to soak into the wood. Any painting, of course, should be done when the staves are dry. The best paint for a silo is one of the darker paints such as red barn paint which has iron oxide as a pigment. Black paints made with carbon black and similar pigments, and yellow, red, and brown paints made with natural earth pigments (in which the color is due principally to iron oxide) are very durable. A paint of high lead and oil percentage is also a good silo paint. The paints mentioned here are the type that will have a soft finish that will chalk with age and will not readily blister or crack. The harder paints made with lead and zinc do not give good results on a silo as they usually blister and crack as the staves absorb moisture from the silage.

The initial prime coat is the most important part of the paint system. The primer should be the type recommended by the manufacturer.

Figure 20. Jacking staves tight so last stave can be added. Before releasing jack, nail a cleat from post to the last two staves.

Figure 21. Nailing the cleat to hold staves apart after jacking. Note use of the large square washers on the staves near the bottom.

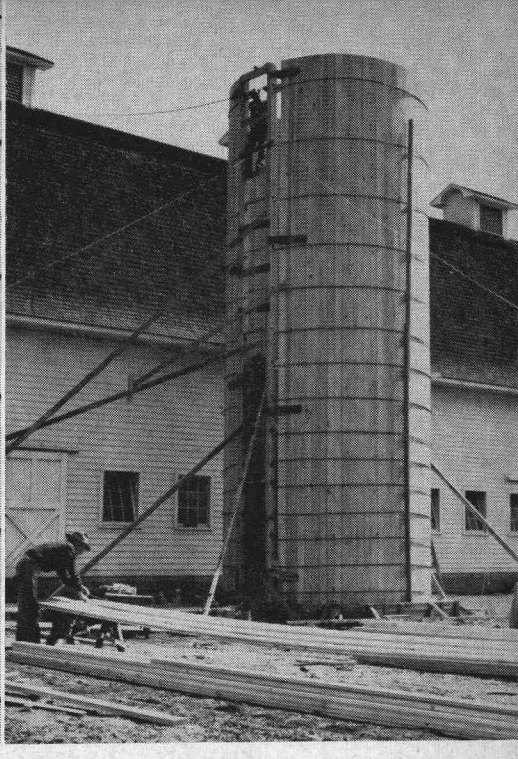
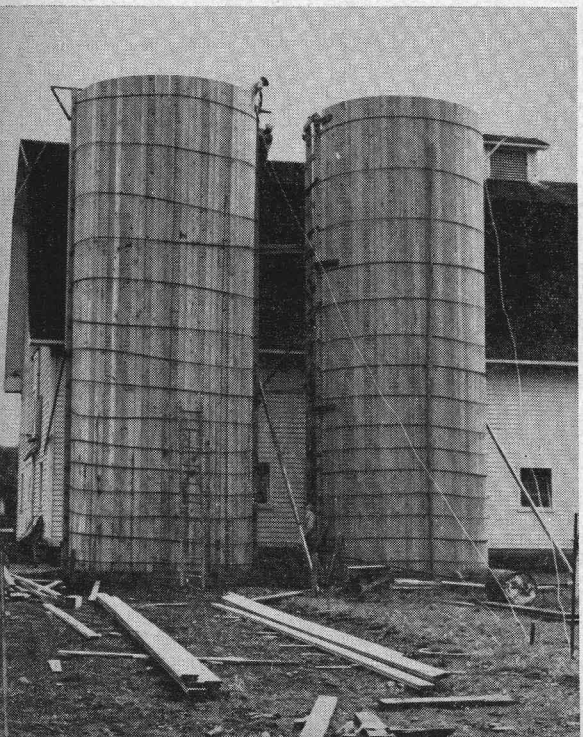


Figure 22. Support on outside is to hold up hoops during erection. This support and the cleats are to be removed when silo is finished.

Figure 23. Two silos near completion. Notice sagging hoops where hoop support was not used. These should be pushed up when stapling.



A little time spent in routine maintenance will add years to the life of a wood stave silo. If the silo is empty during dry weather, hoops should be tightened as the staves dry out to prevent the silo from twisting out of shape. Hoods should be loosened uniformly as the silo is filled with wet material. The staves will absorb moisture and expand. Loosening the hoops will prevent damage to the door and binding posts when increased pressure draws the hoop washers into the posts, crushing the wood fibers. Guy wires should be kept tight at all times.

Bill of Materials

12′ x 30′ Wood Stave Silo
(less roof or chute)

Lumber

Item	*Pieces*	*Size*	*Length*	*BM*
Silo staves (beveled)	83	2 x 6 T&G	30′	2,490
Door post	2	4 x 6	30′	120
Binding post	1	6 x 6	30′	90
Door stop		2 x 4	60 lin. ft.	40
Wood hoop	6	½″ x 4″	20′	20
Doors	14	2 x 6 T&G	12′	168

Hardware

Item	*Pieces*	*Size*	*Length*
Soft steel hoops	6	½″ dia.	19′ 1″
Soft steel hoops	22	⅝″ dia.	19′ 1″
Soft steel tie rods	14	⅝″ dia.	3′ 3″
Large malleable washers	12	½″ hole	
(or cast iron)	72	⅝″ hole	
Steel washers	24	¼″ x 3″ square with 11/16″ hole	
Nuts	12	½″	
Nuts	72	⅝″	
Staples	4 gross	⅝″ dia.	2¼″
Door frame bolts	8	⅝″	8″
Top anchor bolts	6	⅝″	3″
Top anchor bolts	8	⅝″	6½″
Steel wire strand	8	½″ dia.	32′
Turnbuckles	8	⅝″ bolt	20″
Guy clamps	16	½″	4″
Lateral anchors, steel	4	½″ x 2″	14″
Top anchors, steel	4	½″ x 2″	10″
Top anchors, steel	2	½″ x 2″	20″
Guy anchor stirrups	4	¾″ dia.	30″
Floor drain	1	6″ dia. minimum	

Concrete

Item	*Pieces*	*Size*	*Length*
Reinforcing steel	6	½″ dia.	15′
Concrete	4½ cu. yds.	1 :2½ :4 mix or 6-sack plant mix	

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