

The Utilization of Plywood
in Farm Construction
by
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A Thesis
Presented to the Faculty
of the
School of Forestry
Oregon State College

In Partial Fulfillment
of the Requirements for the Degree
Bachelor of Science
June 1940

Approved:

Professor of Forestry

ACKNOWLEDGMENTS

I wish to express my appreciation of the cooperation given in the preparation of this thesis to members of the faculties of the Department of Agricultural Engineering and School of Forestry, and to members of the Agricultural Experiment Station. Mr. Gus N. Arneson, chief of the Research Section, Douglas Fir Plywood Association, has been of great assistance in suggesting the topic and supplying current information and data. Much of the text with its ideas and recommendations has been evolved after frequent discussions with Professor W. J. Gilmore of the Agricultural Engineering Department and Mr. Glenn Voorhies of the Wood Products Department.

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INTRODUCTION

Purpose

The purpose of this report can well be separated into two parts. First, it is to show the results of a survey involving the use of plywood on farms of the Willamette Valley, particularly those of Lane and Benton Counties, and make recommendations for future use. Second, it is to discuss the possibilities and details of construction of a circular plywood granary.

Importance of the Problem

Agricultural engineers tell us that some of the greatest weaknesses in present farm buildings are, in order of relative importance: Bracing, Anchoring, Splitting, Air Infiltration, and Weight. The superiority of plywood to other structural materials as to structural stiffness or rigidity, failure to split, tighter and fewer joints, and lightness of weight are alone factors that merit attention; and when combined with possible cost reductions to the farmer, the advisability of this and similar surveys is apparent.

Professor Henry Geise of Iowa State College, Department of Agricultural Engineering, in surveying Iowa farms¹, states that on the average farm there are potential uses for some 64,390 square feet of plywood, or about ten times as much as is presently adopted.

¹ American Builder, December 1937, page 77.

Review of Related Previous Studies

The survey conducted on Iowa farms by Professor Geise and the plans for a plywood poultry brooder house developed by him and his associates is apparently the only significant study made to date on this subject.

Method of Procedure and Sources of Data

In conducting the survey for present and potential uses, the Agricultural Engineering Department of the College and local county agents were first consulted and information as to the location of farms that had employed plywood in construction was obtained. For suggestions as to possible uses for plywood, farmers, retail lumbermen, and members of the Agricultural Experiment Station were questioned, in addition to those sources already mentioned. These items are taken up in detail on page 3.

The discussed plan and details of construction of the circular granary were developed from original ideas and numerous valuable suggestions from members of the Agricultural Engineering Department, Agricultural Experiment Station, and Wood Products Department.

RESULTS OF THE SURVEY

Where Plywood Is Being Used

While the results of this survey are not particularly impressive as to the present quantity of plywood being employed on local farms, never-the-less, the very fact that farmers have made these adoptions shows they are interested and should give a lead as to what type of structures would be most readily suitable for plywood.

Corn Dryer

This use was significant in that the walls were constructed of 5/8 inch, 5 ply, plywood which after three years under drying temperatures up to 200° F., and a relative humidity of 80% (drying the grain to 13% m.c.) appeared in perfect condition.

Pea Fumigator

To get gas-tight inside-walls for fumigating peas with tear gas, one farmer employed 1/4 inch rejects. The results were very satisfactory. Plans have just been completed by the Agricultural Engineering Department at Oregon State College which call for the identical use of plywood, or lining the walls of fumigating rooms with 1/4 inch plywood. .

Turkey Brooder

Here, plywood, in the form of 1/4 inch rejects, was used for the inside walls and air duct of a 1000-dollar stationary brooder house. The farmer was fairly satisfied with the results but pointed out that the failure to take

the relationship between the placing of studs and the dimensions of a plywood panel into consideration had caused construction difficulties; this should be a precaution to suggest when selling plywood to the farmer. The desire was also expressed for a bunkhouse attachment to the portable range-brooder because the farmer must sleep near the flock.

Recent Adoptions

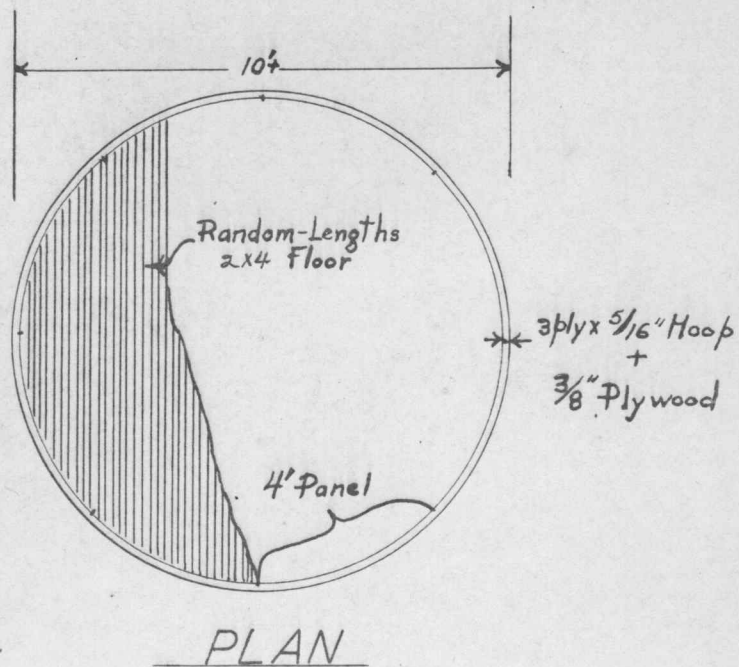
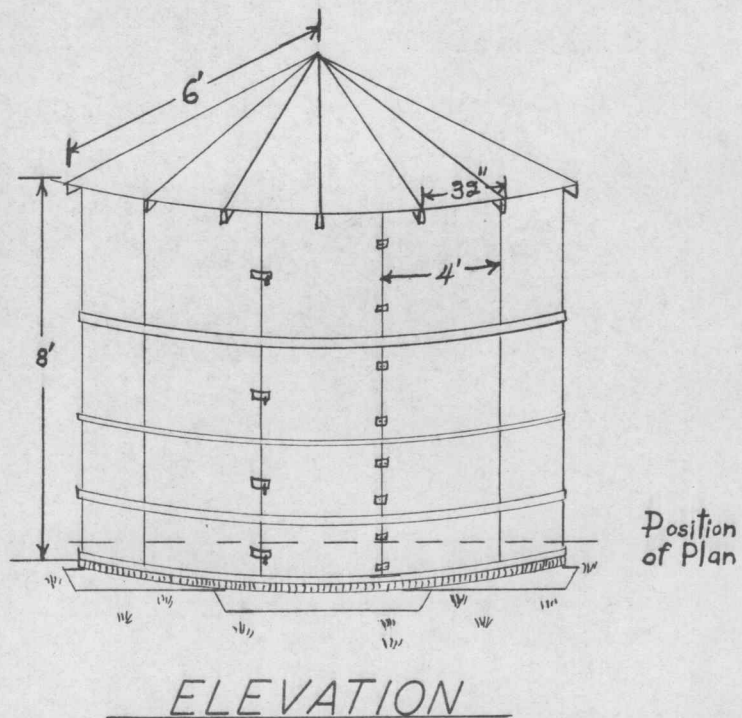
Plans, recently developed by the Ag. Eng. Dept., for a chick-brooder and a hog-brooder, include plywood as a major material in their construction; these plans can be obtained from the College.

Recommendations

The sources contacted for suggestions and recommendations have been mentioned and, we feel, give a reasonable conception of the present attitudes of agriculture toward plywood. Perhaps the most repeated remark was the urge for a "Sheathing Grade" for farm use, a cheaper "Utility Grade" adapted for farm building convenience. It should, in other words, be an economical, easily usable plywood with a title or grade name (such as "Utility Grade") that is suggestive of both price and use to the farmer. The present standard grades of plywood and their respective titles are confined chiefly to home construction, or so many persons presume.

Retail lumbermen appear ignorant of plywood's qualities and are hesitant in recommending any kind of plywood to the farmer.

Prefabrication is receiving increased attention, particularly from agricultural engineers. Their efforts are toward standardized farm buildings; the most economical sizes and shapes are stressed, such as round in place of square in the latter item. To sum up, they are more aware of the possibilities of plywood in farm construction, perhaps than the farmer, and are anxious to experiment.



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Fig. 1

A CIRCULAR GRANARY

Why a Circular Plywood Granary

Just within the last year, the government under the AAA has established a buying program calling for the purchase of some 30,000 portable granaries. To date, metal bins have held the market; but for various reasons such as buckling, overheating, and condensation because of the metal's reaction to quick changes in temperatures they are not proving satisfactory. Agricultural authorities have long praised the qualities of wood; observations made of a large number of frame structures indicate that as dry wood is relatively a good insulator no special precautions with respect to condensation are necessary for wooden bins.² This suggests that a round portable (about 500-bushel capacity) plywood granary, if possible to construct and of reasonable price, would have a ready market.

Details of Construction

Note: Since the final answer as to the practicability of this structure will come from building and testing, the ideas about to be expressed must be regarded as ideas and not as proven facts.

Brief Description

The completed structure would appear as in Figure 1. The ten-foot diameter (actually it is 10.2 feet) and eight

² Farm Bulk Storage For Small Grains, U.S.D.A. Farmers' Bulletin No. 1636, Page 24.

foot height were chosen as the dimensions because: (a) eight feet is a standard length for plywood panels; (b) the capacity of the unit would be approximately 500 bushels, which is a standard capacity for the portable bins now on the market.

The main difference of this design from present ones lies in the possible use of plywood panels and wood hoops in forming a suitable circular wall.

The Wall

The wall should consist of eight 4'x 8' panels of the Exterior Grade of plywood stood in the four foot edge and framed by five wood hoops.

Three-eighth inch, 3 ply panels were chosen with several considerations in mind. First, curving. According to Oscar Fisher³, noted architect, 3/8 inch plywood is the maximum size panel that can be bent, without any treatment whatever by securing one end and forcing it into templet shaped framing and nailing it in place as it takes the desired form, in a radius under six feet. Second, bending strength. The horizontal pressure of silage for a circular bin 14 feet in diameter is about eight pounds per square foot, per foot of depth; this is comparable to the pressure of the heaviest grain. In this case, it would amount to 65 pounds per square foot at the base rapidly decreasing until, at the top, it would be zero.

The amount of deflection of the plywood will be determined by the spacing of the hoops.

³ Pencil Points, "Construction With Plywood", Nov. 1939.

From the Deflection Chart for 1/2 inch Douglas Fir Plywood, Grain of Face Plies Parallel to Span, Simple Beam Loads published by the Douglas Fir Plywood Association, an assumption of 16 inches as the span between the bottom and next higher hoop appears reasonable. If we determine the positions of the remaining 3 hoops by the rule for a constant deflection with increasing spans and diminishing loads, we find the next span to be 20 inches, then 24 inches and the last one 36 inches.

The panels should be stood on the four foot edge because: (a) the grain of the face plies would be running parallel to the span giving maximum bending strength; and (b) the panels would bend easier, or to a smaller radius, since the direction of the face grain would be crosswise.

Building the Hoops

Instructions for building the hoops⁴, a relatively simple process, are:

"A level floor, such as a barn floor or level platform, is needed on which to construct a temporary form for the hoops. (Fig. 2) Take a 1x4 or similar board, drive a nail in one end, driving the nail in the exact center of the platform so the board can swing around the nail as a pivot. From the center of the pivot nail measure off on the 1x4 a distance equal to the radius of the inside of the hoops plus the thickness of the hoop when built and cut the board at this mark. With a pencil, mark a circle at the end of the board at the outer edge. This circle will mark the outer face of the hoops. Cut enough 2x4x8 inch blocks as shown so that they can be nailed at about 18 inch centers, one end just flush with the circle and the length of the block on the outside of the circle. Toe nail them at the ends and sides to the floor so they will remain firm.

⁴ How to Build a Wood Stave Wood Hoop Douglas Fir Silo, West Coast Lumbermen's Association.

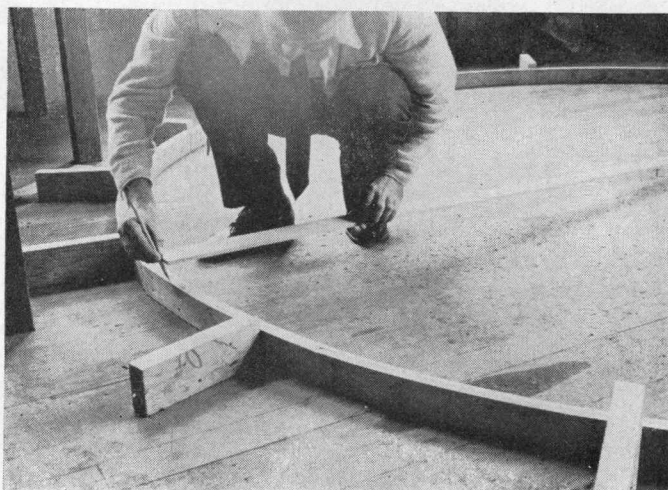


Photo by W. C. L. A.

Fig. 4.—Making the hoops.

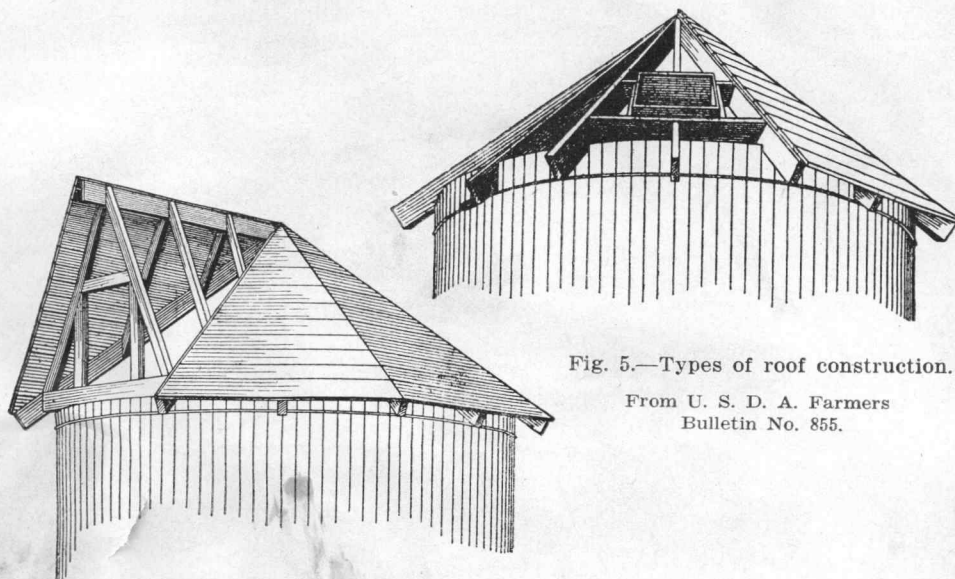


Fig. 5.—Types of roof construction.

From U. S. D. A. Farmers
Bulletin No. 855.

The hoops may be constructed from 5/16x2 1/2 inch standard Douglas fir battens or from 1x3 or 1x4 resawn. Unless the material is green it should be soaked for several hours in water so that it will bend easily.

Square the end of a batten and nail it to a form block so the square end of the board is in the center of the block, tacking it occasionally to make it fit against all the blocks and keeping it in touch with the floor. Bring the batten around so far as it will go and cut the end square, on the center of a block. Nail it just enough to hold it in place. Proceed in a similar manner with another batten until the first layer of the hoop is completed.

Start the second layer four feet to one side of a joint in the previous layer so that the joints of any two layers will not come on the same block. Upon completion of the second layer start driving the nails to hold the plys together. The nails, cement coated and not less than 3/8 inch longer than the thickness of the hoop, should be placed on 6 inch centers in two rows about 1/2 inch in from each edge. As each layer of the hoop is completed, the nails should be driven so the point penetrates the piece but does not interfere with the placing of the next ply. After all required plys have been placed drive the nails tight and clinch the points on the inside of the hoop.

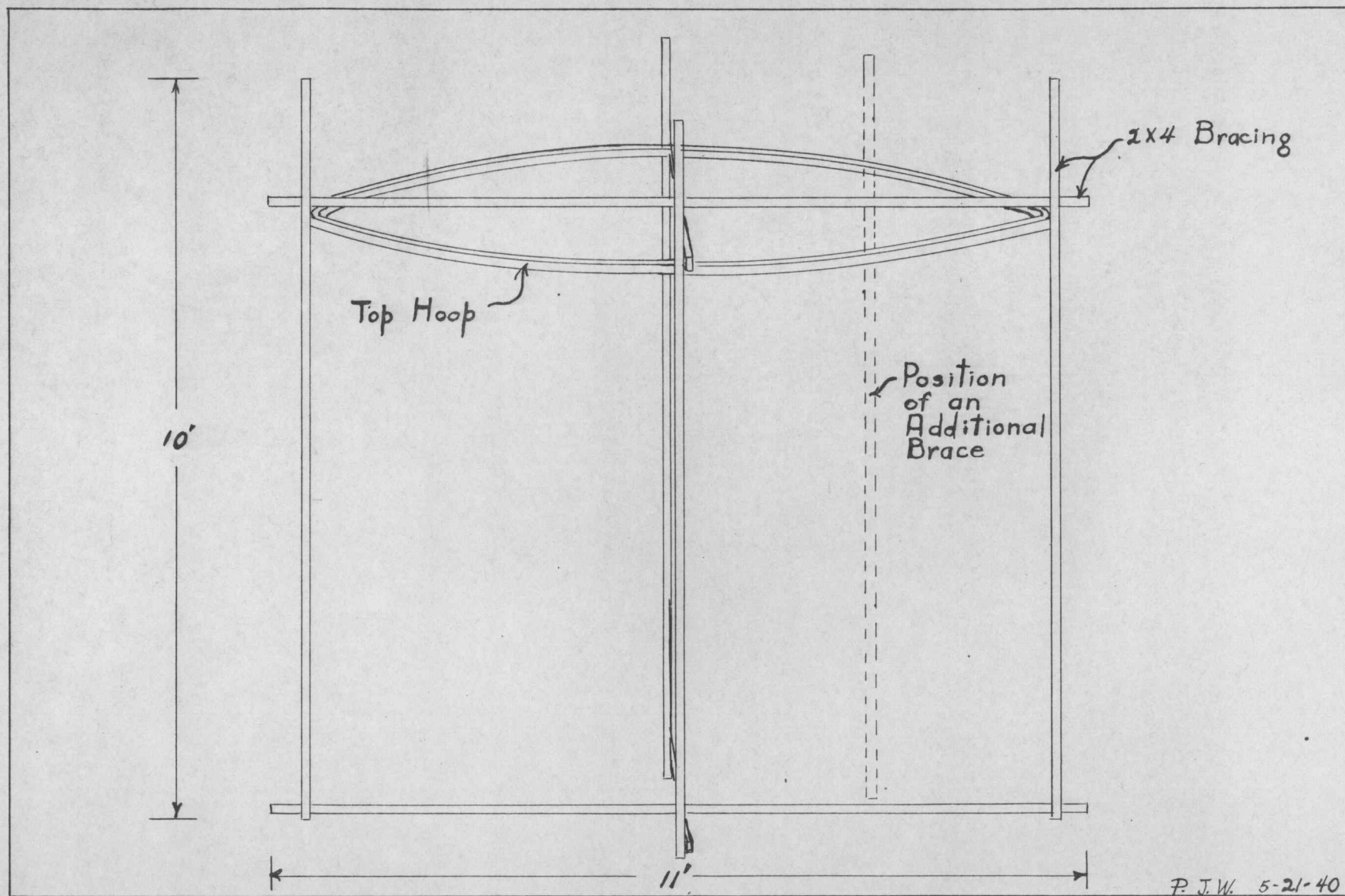
A sleeve of light gauge galvanized sheet metal about 8 inches long should now be placed around hoop where joints occur on the outside ply, and nailed to the hoop."

Since the horizontal pressure of light silage is similar to grain, the number of plys (3), 5/16 inch by 2 1/2 inches wide, required for hoops for a silo 10 feet in diameter and 25 feet high would readily support the walls of the granary.

Placing the Hoops

When the required number of hoops has been made, prepare four 2x4 pieces, each about 10 feet long, for vertical supports during erection. Similarly, four 2x4 pieces, about 11 feet long, should be made to act as horizontal cross braces (Fig. 3). The four vertical supports should be marked to locate the hoops.

Fig. 3



P. J. W. 5-21-40

Nailing on the Plywood

After the framework has been set up with the hoops held in their proper place, one man with the aid of two assistants, one to aid in bending and the other to brace from the outside, can bend and nail in 7 of the eight panels. The eighth panel will be used in constructing a door which is to be discussed later. In bending the panels, there is a strong possibility that the hoops, in spite of the bracing, will tend to lose their round shape and become oval. One solution to this problem would be to nail the first four panels at 4-foot intervals along the circumference and at the braced points; this might tend to balance the forces distorting the hoops. Also, four additional vertical supports without horizontal bracing would afford a stronger frame and the initial four panels could be nailed against them eliminating conflict with the horizontal braces that is bound to result in the first case.

Building A Door

One panel should be constructed into a door. Actually, it seems feasible to make several doors, one for each interval between hoops from the top down to the bottom; this would permit separate openings for different grain levels. Since the doors must open out there must be removable retaining boards to eliminate the pressure of the grain against the doors and to permit opening them without loss of grain (Fig. 4).

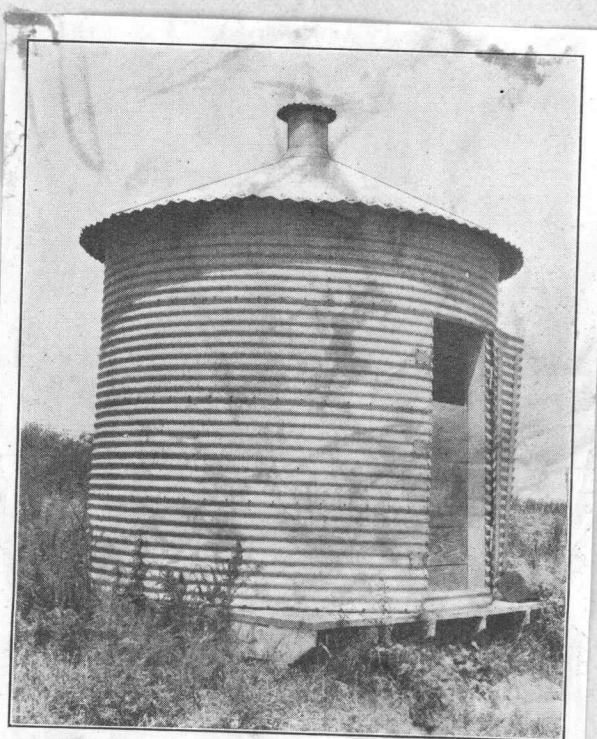


FIGURE 40.—A 500-bushel portable bin of corrugated metal,
mounted on skids

Dormitory
OLD RELIABLE BOND
PERCENTAGE

The Floor

The floor and skids supporting the 500-bushel metal bin in Fig. 4 is one tested and approved method. Another proven type has been developed by the Agricultural Experiment Station at Oregon State College; it consists of random-length 2x4s laid with the 2 inch face up; and this gives a sturdy as well as a cheap floor, particularly in this region where random-lengths can easily be obtained. (Fig. 1)

The Roof

Roofs similar to those in Fig. 5 could be used; or by sawing triangular-shaped pieces from 6'x 32", 3/8 inch panels and framing, as with the board construction, a plywood roof could be made. The two right-angle pieces left after sawing a panel could be matched and another triangular piece formed. Copper flashing should cover each joint to give a watertight roof. One triangular panel in the roof should be made easily removable to facilitate loading or filling the bin.

Other Recommendations

Recently, it has been found that here in the moist climate of the coast region there is a tendency for rot to occur between the hoop and the staves of a wood stave, wood hoop silo. Should this be a problem in a plywood granary, it is suggested that a liquid preservative called "Permatol" be applied, preferably before erection, to the inside of the hoop and panel.

Bracing against wind is another contemplated problem. Three guy-wires spaced every 120° on the top hoop and securely staked should remedy this trouble.

ESTIMATED BILL OF MATERIALS

ITEM	DESCRIPTION	FOOTAGE	COST	
			WEST	MIDDLE WEST
Floor:	2x4, Random Lengths	340 bd. ft.	6.12	12.24
Walls:	3/8", Ext. Gr. Ply-wood, 8-4'x8' Panels	256 sq. ft.	23.04	51.20
Hoops:	3 Ply-5/16"x2 1/2" Batten	510 lin.ft.	12.00	20.00
Roof:	1/4", Ext. Gr. Ply-wood, 6-6'x32" Panels	96 sq. ft.	4.80	9.50
	2x4, No. 2 Dimen.	60 bd. ft.	1.25	2.50
Misc.:			5.00	5.00
	Nails			
	Copper Flashing			
	Hinges			
	Etc.			
			<hr/> \$52.21	<hr/> \$100.44

COST OF MATERIALS

ExplanationFloor

The costs of the floor are based upon \$18/M, the retail price here on the West Coast. Freight charges would practically double it in the Middle West.

Wall

3/8 inch, Exterior Grade plywood was figured at a retail price of \$.09/sq.ft. in the West. Based on a freight rate of \$.655/100 lbs., Kansas City, the retail price in the Middle West would be \$.20/sq.ft.

Hoops

5/16"x 2 1/2" batten retails at \$.03/lin.ft. in the West. However, by buying in a quantity as large as here required, a saving would be made. Also, it would hold down the cost if 1x4 or 1x3 resawn material were used. Prices were doubled for the Middle West.

Roof

1/4 inch, Ext. Grade plywood was priced at \$.05/sq.ft. here and doubled, because of freight charges, for the Middle West.

No. 2, 2x4 Dimension prices were based on \$21/M here and \$35/M in the Middle West, or \$14/M added for freight.

Misc.

\$5.00 is an assumed cost and should be nearly constant regardless of where obtained.

Other Portables

500-Bushel Metal Bin = \$90 - \$150, Without floor⁵.

660-Bushel Wooden Bin = \$150⁶.

5 Farm Bulk Storage For Small Grains, Page 39.

6 Ibid, Page 37.

CONCLUSIONS

It would appear that the present uses made of plywood on farms here in the Willamette Valley region, while far from extensive, are, never-the-less, significant and should suggest lines of improvement in the use and method of approaching this potential market. The College through its departments of Agricultural Engineering and Wood Products has expressed and is demonstrating its desire to explore this field.

The detailed plan for constructing a circular plywood granary is suggested because of the possibilities of:

(1) satisfactory construction and (2) sale to a ready market. Plywood has already demonstrated its practicability in farm building construction; new uses can be developed by first, ascertaining just where it can best be used to a construction advantage and enjoy a sizable market; and second, by a process of paper-planning (such as carried out here); and third, by actually testing the finished product.

LITERATURE CITED

American Builder, December 1937.

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