8-1920

A Servicable Farm Barn

R. Patty

Extension Circular No. 32 August, 1920

A SERVICEABLE FARM BARN

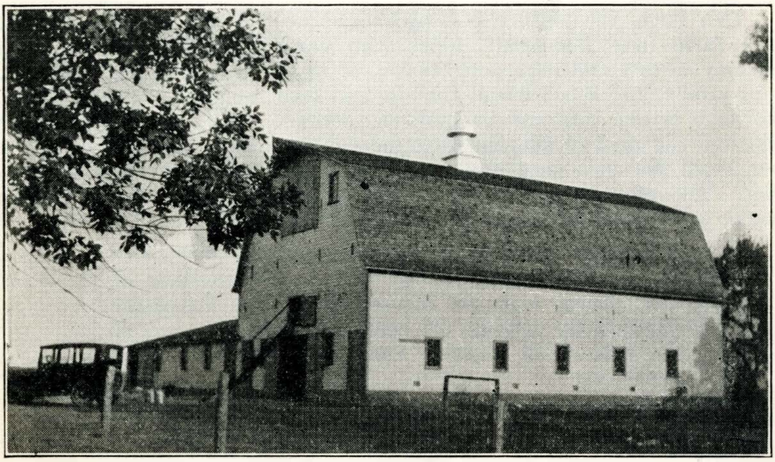


Fig. 1. The complete plan, showing how this barn is built, is inside.

EXTENSION DIVISION

Cooperative Extension Work in Agriculture and Home Economics, South Dakota State College and U. S. Department of Agriculture Co-operating

C. LARSEN, Director

BROOKINGS, SOUTH DAKOTA

CONSTRUCTION OF A SERVICEABLE FARM BARN

By Ralph L. Patty
Extension Specialist in Agricultural Engineering

There is a great demand for a plan of a general barn suitable for a South Dakota farm of from a quarter to a half section of land. Not only are old buildings being replaced but a very great number of larger tracts are being divided into separate farms and entire sets of new buildings are being erected. These facts, more than any others, probably account for the large number of requests received by the Extension Division for such a plan. The plan presented in this circular, we believe, will best meet this need.

This barn, the picture of which is shown on the cover, was built on a farm near Brookings, after very careful consideration of both economy in cost and requirements for caring for the stock. It was built and equipped in 1919, without the silo and feed room, at a cost of $3260. The barn is one that can be built in sections. The main barn can be built and the shed or silo and feed room added later. A beginner might even build the shed first and figure on adding the main barn and silo later. The plan should be of service to one intending to build, even though a different arrangement might be desired.

A blue print plan of this barn consisting of five sheets may be secured from the Extension Division by sending 25 cents to cover the cost of the blue print paper. Send for blue print plan, No. B-3.

Materials

While this barn is built of lumber with the exception of the feed room and the silo, the walls could as well be built of masonry. It is not a difficult matter to build the forms for a concrete wall up as high as the joists under the hayloft floor and in case good gravel is close at hand, it would be practicable. Hard burned clay block or "tile" as it is often called makes a warm and durable wall and is very economical considering the length of life. It could be used for the first story or for the whole side wall, as desired. These blocks should be laid and pointed up with as much care as bricks are laid. The mortar should be richer in cement than for bricks.

General Arrangement

The main barn sets north and south, with the shed on the east. This affords a comfortable sheltered lot on the southeast and a warm location for the silo. A shelter-belt to stop the snow before it gets to the barn is desirable. This will prevent the drifting of snow in the lot. Dry lots are a big asset to a good barn. It is becoming a common practice to install eave troughs and concrete gutters to take care of the excessive amount of run-off from the barn roof so as to protect the barn lot.

If the location is such that the barn should be built north of the

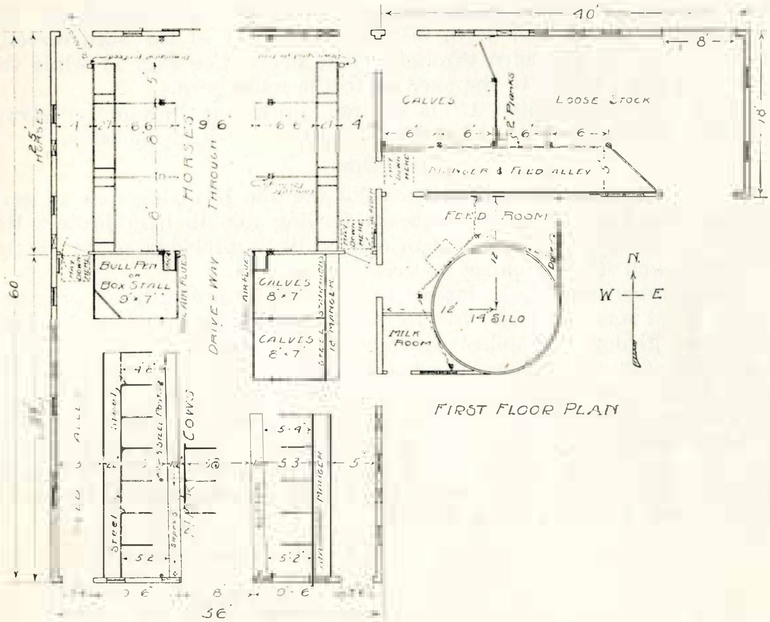


Fig. 2. **This is the floor plan of the barn. It is arranged for a north and south barn (main part) fronting north. That is, the north end is closest to the house. The horses, of course, are in this end. Only necessary dimension lines are shown. All dimensions on the inside are standard except the width of the horse stalls. For large horses 9 foot stalls are recommended.**

house instead of south, the general plan would be the same but the horses and cattle would be reversed in the barn to bring the horses in the end closest to the house. An alternate floor plan is shown for this reason.

Size of Barn

The main barn is 36 feet wide and the posts are 14 feet high. This is of standard and serviceable width. It furnishes ample space for hay storage above and allows room below for caring for the stock quickly and conveniently. A barn of much greater width is not so handy for "mowing away" hay and the framing for a self-supporting roof will not be so strong without spending more money proportionately. A narrower barn will not only crowd the stock and reduce the feeding space, but the inexpensive hay room in the mow is lost.

The length of the barn was figured according to the amount of stock to be housed in it. The length could be changed without materially altering the plan.

The Shed

The shed of the original barn is 18 feet wide by 50 feet long. It may be made as long as desired to furnish sufficient room for the loose stock. The plans show a length of 40 feet simply as a matter of convenience in scaling. A shed so located with reference to the main barn has the advantage of convenience in feeding and caring for the loose stock. Hay is fed down into the feed alley of the shed directly from the mow of the barn through a side door, (See Fig. 7) while the other feed is as handy to the shed as to the main barn.

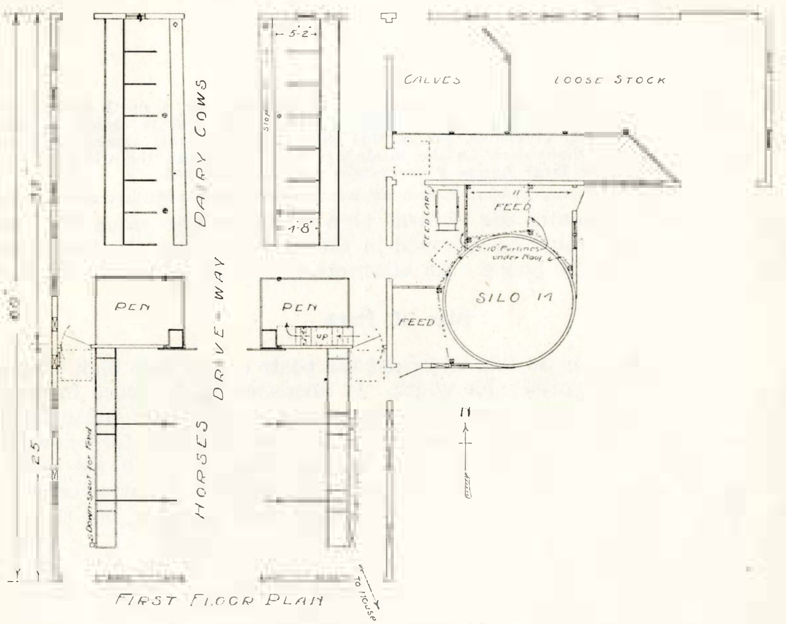
If a more elaborate "L" is desired, providing storage for straw overhead, our Dairy Barn Plan No. B-2 shows such an addition.

Feed Bins

The advantage of feed bins around the silo is mainly one of centralizing the feed for convenience in feeding and to help protect the silo from freezing. The saving in side walls is probably offset by the extra care and labor required to roof this portion.

The simple shed roof sloping to the east is probably as practical for this feed room as any. Six by six inch posts are used upon which 2 x 10 inch girders are spiked which carry the rafters. The number of posts necessary will depend on whether this portion of the barn is built at the same time as the rest or whether it is built later.

The feed bins overhead, in the main barn, for horse feed, as shown in the alternate plan, make this an exceptionally handy barn for feeding. They may, of course, be put in the original plan as well. The 2x10 inch joists should be doubled under these bins, making them 12 inches on center. (See Haymow Plan, Fig. 4.)



ALTERNATE FLOOR PLAN

Fig. 3. This floor plan is for the same barn, setting north and south, but fronting south. That is, the south end is closest to the house. This plan also suggests how more cow stalls may be put in with less box stall room in the main barn when such arrangement is desirable. It also suggests how a stairway may be put in either plan. Note the convenient feeding arrangement. Any dimension not shown may be found on the floor plan (Fig. 2).

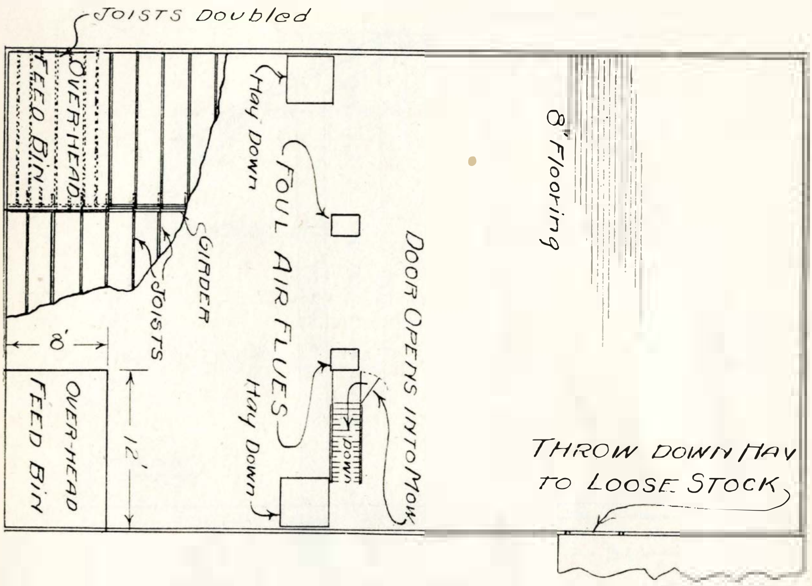


Fig. 4. This is the plan of the hayloft over the main barn showing the overhead feed bins, openings for foul air flues, hay doors, and framing underneath. Note the door for throwing down hay into the feed alley of the shed for the loose stock.

Box Stalls

Box stalls can always be used to good advantage in a barn. If a bull is kept on the farm the three box stalls will not be too many. If not the two box stalls shown in the alternate floor plan will probably suffice.

Stairway

The hayloft is reached by ladders in the original plan. A suggested way in which a stairway may be built in is shown in the alternate floor plan.

POINTS IN CONSTRUCTION

Foundation

This barn is set up on an exceptionally high foundation. The foundation extends 18 inches above the floor line. Fourteen foot posts are used on top of this foundation. This is a very good practice if gravel is not too expensive. It may be made a foot higher if desired. If the barn is set on the ordinary foundation, 12 inches above the grade line, the 16 foot posts shown in Fig. 5 are recommended. The width of the foundation runs from 8 inches on top to 12 inches at a point 2 feet under the ground. Here it widens to 18 inches for a footing. All posts have a concrete footing under them.

Floors

The dairy barn portion is floored entirely with concrete as shown

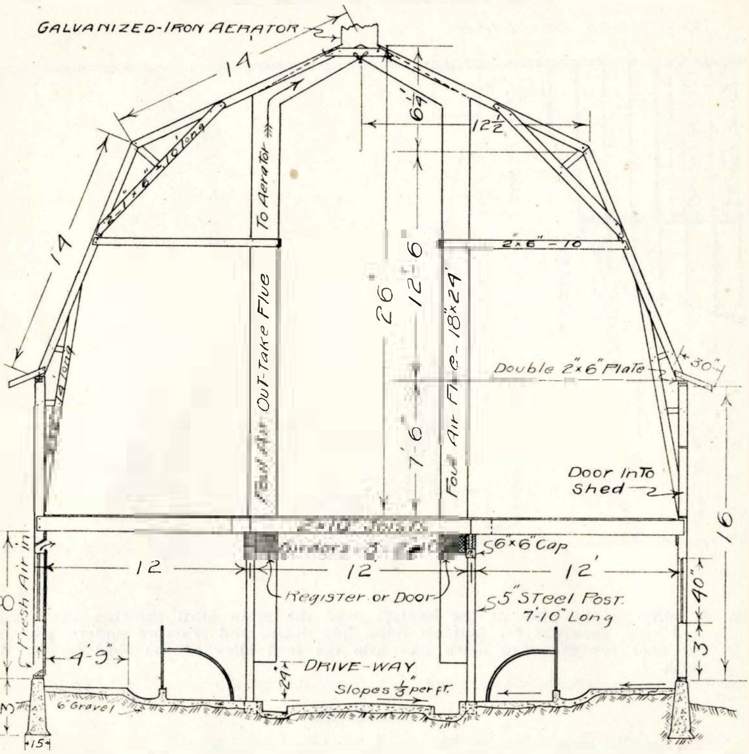


Fig. 5. This is a cross section of the dairy barn showing the framing, floor, fresh air and foul air flues of the ventilating system, etc. It will be noticed in the floor plans that the foul air flues are located in the partition between the two sections. Registers similar to the ones shown in this figure are on the opposite, or horse compartment side also. See Fig. 6 for detail of cow stall and manger.

in Fig. 5. The feed room around the silo is also concrete. The shed and horse barn have clay and cinder floors. Concrete floors are used satisfactorily for horses in many barns today. A detail of a satisfactory false floor over concrete is shown on the blue print plan of this barn.

Stalls

The stall details for the dairy are shown in Fig. 6. The width is 3 feet, 6 inches. The length of stalls varies from 4 feet, 8 inches for the shortest to 5 feet, 4 inches for the longest. The difference in length is made by putting in the gutter at a slight angle with the stanchions. The double horse stalls are 8 feet wide. By increasing the length of the barn 2 feet, they could be made 9 feet wide for large horses.

Mangers

The dairy mangers as shown in Fig. 6 are standard mangers as adopted by the American Society of Agricultural Engineers. Plank mangers are used in the horse barn and shed.

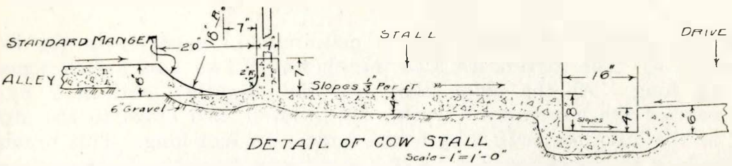


Fig. 6. A cross section through the cow stall, manger and gutter. The dimensions shown are standard and have been proven out many times. The manger and curb are standard as adopted by the A. S. A. E.

Framing

The self-supporting gambrel roof is used with the "Wing" type of bracing. Two by six inch studdings are spaced 2 feet on center all the way around the walls. Two by six inch rafters are used, also spaced 2 feet on center and in the same corresponding position as the studding so each rafter may be tied down to the studding with 14 foot braces. These braces may be one 2 by 6 or two 1 by 6s at each studding. The "Shawver" type of framing which allows the siding to extend "up and down" can, of course, be used on this barn if desired.

Columns

Two rows of columns or posts extend lengthwise through the barn 12 feet from each side. Round steel posts 5 inches in diameter are used in the dairy barn. Caps of 6 by 6s and about 3 feet long rest on top of the posts (detail shown on blue print) and the girders are carried on these. This divides the span for the joists evenly at 12 feet.

In the horse barn the posts are built up of one 4 by 6 and one 2 by 6 carrying the 2 inch plank partition between them as shown in the floor plan. (Fig. 2)

Girders (See Fig. 5)

The girders are carried on the posts and in turn carry the joists of the hayloft floor. They are built up of three 2 by 10s. Built-up girders are safer and less expensive than solid timber. The "joints are broken" in building up the girders. The lines of the girders are not shown on the floor plan as they lend confusion to the plan.

Joists

Since the span of the joists is 12 feet, they must be 2 by 10s if spaced 24 inches on center. This allows for a load of 100 pounds per square foot in the loft. While the span of the joists is 12 feet on each side of the row of posts and between them, the plan calls for 14 foot joists for the center span. The object of this is to have the center joist lap over the side joists a foot or more on each end in order to make a good splice. The joists should also be "bridged" or braced with short braces in the center of the span.

If the feed bins overhead are not over 6 feet deep, the joists underneath should be doubled. If deeper than 6 feet, the spacing will be figured for any condition, on request to the Extension Division.

Roof

Two 14 foot rafters are used for each side of the roof of the main barn, giving the top rafter one-fourth pitch. This shaped roof combines the greatest strength with a maximum of capacity in the loft. (See Fig. 5) The rafters are tied together with two 1 by 6 inch braces, 10 feet long. At the ridge they are tied together with a 2 by 6 that carries the hay carrier track. The roof is tied down to the studding at the loft floor with 2 by 6 inch braces 14 feet long. This bracing is standard as recommended by the American Society of Agricultural Engineers. The sheathing under the shingles is not tight. A space of 1 to 1½ inches is left between the boards. The roof is shingled. Heavy prepared, slate-surfaced shingles would be very satisfactory for this barn.

Windows

All the windows in the barn, except in the grain bins are of the same size. They are of six 10 by 12 inch panes making the sash 22 by 42 inches. They are both serviceable in size and neat in appearance. They fit in between studding spaced 24 inches on center, saving both time in framing and strength of the side walls. At present this window is not generally carried in stock. If a special order is necessary, the extra charge should be small on so large an order. There are 28 windows of this size in the whole barn as shown in the "Bill of Material" on page 11.

Ventilation

The main barn is ventilated by means of fresh air inlets and foul air out-take flues as shown on the floor plan. (Fig 2) This figure shows

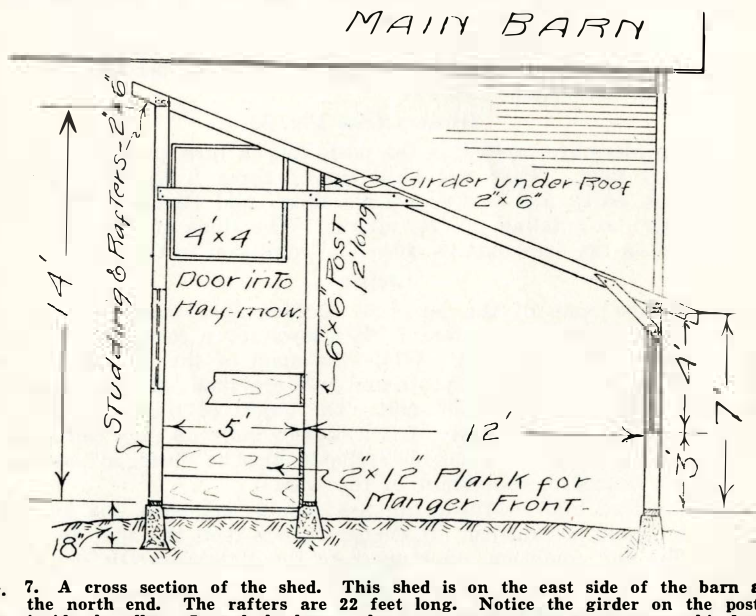


Fig. 7. A cross section of the shed. This shed is on the east side of the barn at the north end. The rafters are 22 feet long. Notice the girder on the posts inside the alley. It and the braces shown are very necessary to carry this long span. The braces are 6 feet apart or at every post. The manger is built of 2 x 12 inch plank. Note the door into the haymow of the main barn.

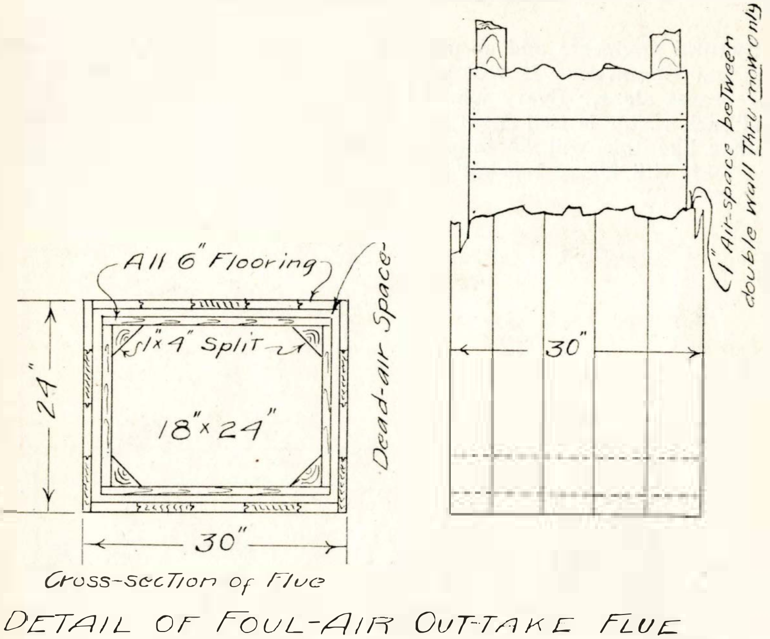


Fig. 12. Showing how the foul air flue is made, where it extends through the mow. The double wall and air space is necessary to insulate the inside of the flue from the cold. Since the inside of this flue is exposed to moisture, a coat or two of heavy paint on the inside will pay well for the trouble of putting it on.

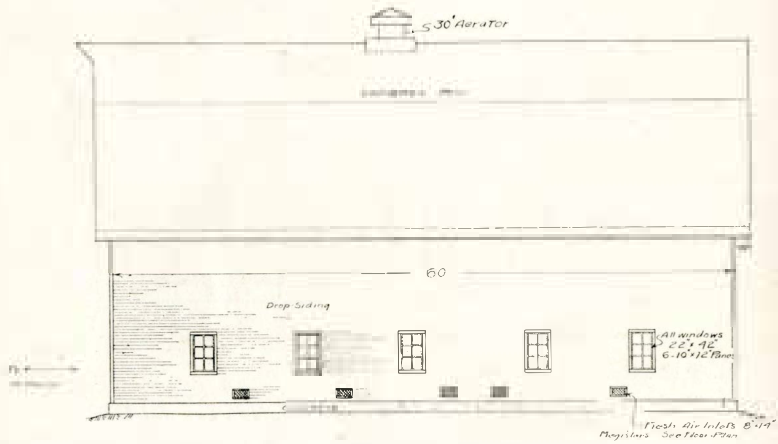
the foul air flues extending up through the hayloft and Fig. 12 shows the manner of insulating them from the cold air in the loft. A single wall is sufficient for the flues in the lower barn. The cross sectional area of the two foul air flues is a trifle over 6 square feet. This provides a square foot for each 5 horses, a square foot for each 5 or 6 cows and enough surplus to take care of the young stuff in the main barn. The seven fresh air inlets provide practically the same amount of cross sectional area and may be regulated for wind velocities. An attractive galvanized iron aerator is installed on top. The ventilation of the shed is taken care of by the fresh air inlets on the north and the doors and windows.

Barn ventilation is discussed more fully in Extension Circular No. 31 entitled "Farm Building Ventilation." It may be obtained free by addressing the Extension Division, South Dakota State College, Brookings, S. Dak.

—NOTES—

Nailing—A warning has been issued to builders over the country recently not to "skimp" in the use of nails. This comes from the fact that failures have already occurred in new buildings due to a lack of proper nailing. Many of our flimsily braced buildings of the past have been held together only by plenty of nailing.

Bracing—The bracing shown in this plan is standard as accepted by structural engineers and as adopted by the American Society of Agricultural Engineers. It will seem like quite a bit of lumber to some for braces alone. Every joint of each rafter is tied securely together and each rafter is tied down securely to the studding. A roof tied together like this will be found standing straight and true long after the roof with flimsy bracing is gone.



WEST ELEVATION

Fig. 8. Showing the windows and fresh air registers on the west side of the barn. There are 28 windows of this same size in the barn.

BILL OF MATERIAL

(Including no Hardware Except Nails)

MAIN BARN

Foundation—

(Two feet underground and one foot above)

(1-3-6 mixture) 88 sacks cement, 10 yds. sand and 20 yds. gravel, or (1-5 mixture pit run) 110 sacks cement, and 22 yds. of pit run sand and gravel.

Floor—

(1-3-5 mixture) 100 sacks cement, 11 yds. sand and 17 yds. gravel, or (1-5 mixture pit run) 105 sacks cement, and 20 yds. of pit run sand and gravel.

Lumber—

		inches	
150	pieces	2x6	16ft. long for studding
48	pieces	2x6	12ft. long for plates and sills
126	pieces	2x6	14ft. long for rafters
60	pieces	2x6	14ft. long for braces
15	pieces	2x6	16ft. long for braces
120	pieces	1x6	10ft. long for braces (fencing)
15	pieces	2x4	10ft. long for lookout rafters
31	pieces	2x10	14ft. long for center joists
70	pieces	2x10	12ft. long for outside joists (including extra under bins)
32	pieces	2x10	12ft. long for girders and hood
2	pieces	4x6	16ft. long for posts
5	pieces	6x6	16ft. long for posts and caps
2	pieces	2x6	16ft. long for posts
222	pieces	6inch drop siding	16ft. long for siding
272	pieces	6inch drop siding	12ft. long for siding
76	pieces	6inch drop siding	18ft. long for siding
116	pieces	4inch flooring	16ft. long for doors

40 pieces 4inch flooring 12ft. long for doors
42 pieces 1x6 inches finish 18ft. long for casement, etc.
3300 board feet—Sheathing for roof (allowing about 1-6 cracks)
360 board feet—Nail ties for doors
2600 board feet—8inch flooring for loft
264 board feet—8inch flooring for partition
140 bunches shingles, (5inches to the weather) or 38 squares of roofing.
17 Window sash 22x42 inches
1 Galvanized Iron Aerator, 36 inches

Nails—

162 pounds of 20 d
15 pounds of 30 d
60 pounds of 10 d
210 pounds of 8 d com.
80 pounds of 8 d box
136 pounds of shingle nails

Inside Equipment—

8 steel posts
12 steel stalls and stanchions
8 steel calf stanchions
3 steel pens and gates
12 pieces 2 x 12 inches 18ft. long for stall partitions
3 pieces 2 x 4 inches 18ft. long for stall partitions
10 pieces 2 x 6 inches 16ft. long for stall partitions
12 pieces 2 x 12 inches 16ft. long for mangers and troughs
8 pieces 1 x 12 inches 16ft. long for mangers and troughs
12 pieces 1 x 6 inches 16ft. fencing for mangers

Ventilating System—

120 board feet of 6 inch W. P. flooring for fresh air flues
650 board feet of 6 inch W. P. flooring for foul air flues
500 square feet of building paper for foul air flues
4 registers 12 x 18 inches for foul air flues
7 registers 8 x 14 inches for fresh air flues outside
7 registers 8 x 14 inches for fresh air flues inside
10 pieces 4 x 4 for corners of flue

FOR 40 FOOT SHED

Foundation—

18 inches as shown in Fig. 7.
(1-3-6 mixture) 20 sacks cement, 2¼ yards of sand and 4½ yards of gravel, or
(1-5 mixture pit run) 27 sacks cement, and 5 yds. of pit run sand and gravel.

Lumber—

48 pieces 2 x 6 inches 14ft. long for studding
18 pieces 2 x 6 inches 16ft. long for sills, plates and girders
8 pieces 2 x 6 inches 14ft. long for braces
21 pieces 2 x 6 inches 22ft. long for rafters
6 pieces 2 x 12 inches 12ft. long for manger and partition
3 pieces 2 x 12 inches 16ft. long for manger and partition
6 pieces 6 x 6 inches 12ft. long for posts
28 pieces 1 x 6 inches 18ft. long for casements, etc.
42 pieces 4 inch flooring 16ft. long for doors
100 pieces 6 inch drop siding 18ft. long for siding
800 board feet of sheathing for roof
34 bunches of shingles or 9 squares of roofing
120 lineal feet of nail ties for doors
9 window sash 22 x 42 inches
2 registers 8 x 14 inches for fresh air flues outside
2 registers 8 x 14 inches for fresh air flues inside

Nails—

25 pounds of 20 d
15 pounds of 10 d
35 pounds of 8 d box
15 pounds of 8 d com.
36 pounds of shingle nails

FOR FEED ROOM AROUND SILO

Masonry—

Wall 400 pieces 5 x 8 x 12 inches hollow clay block (8 inch wall)
1 bbl. lime, 8 sacks cement

Foundation—

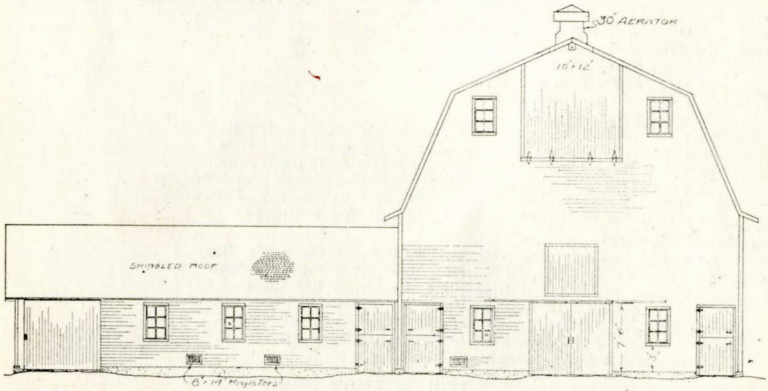
(3-6 inches deep 12 inches wide at bottom)
(1-3-6 mixture) 9 sacks cement, 1 yd. sand and 2 yds. gravel, or (**1-5 mixture** pit run) 12 sacks cement, and 2¼ yds. pit run **sand** and **gravel**

Floor—

(1-3-5 mixture) 14 sacks cement, 1½ yds. sand and 2 yds. gravel, or
(1-5 mixture pit run) 17 sacks cement, 2 yds. pit run sand and gravel

Lumber—

2 pieces 6 x 6 inches 14 feet long for posts
2 pieces 6 x 6 inches 12ft. long for posts
3 pieces 6 x 6 inches 10ft. long for posts
3 pieces 2 x 10 inches 16ft. long for girders under rafters
4 pieces 2 x 6 inches 22ft. long for rafters
12 pieces 2 x 6 inches 16ft. long for rafters and door frame
4 pieces 1 x 6 inches 16 ft. long for casement, etc.
12 pieces 4 inch flooring 14ft. long for doors
250 board feet for sheathing for roof
10 bunches of shingles
2 sheets of galvanized iron for water proofing joint with silo
2 window sash 22 x 42 inches
2 window sash 24 x 30 inches



NORTH ELEVATION

Fig. 9. This is the north end of the barn that faces the house. The shed in the picture on the cover is 10 feet longer than shown in this figure. Doors for elevating the feed into the overhead feed bins should be installed in this end of the barn to suit the type of elevator used. The upper pitch of the gambrel roof is one-fourth.

A BARN IMPORTANT

By C. Larsen
Professor of Dairy Husbandry

To build a barn is a business proposition. Without a comfortable protection against the more or less severe climate, the cows cannot be expected to return the maximum amount of beef, of milk and butterfat for the feed consumed. Neither can the owner expect to raise the best quality of young stock. More profit will be obtained from animals that have shelter.

A certain farmer had a big red barn on his place, a landmark for many miles away in that country. His dwelling house was notably poor, being a log cabin that remained since the homesteading days. One day an agent came around. He asked the owner of the farm, "Why is it that you have such a magnificent barn on your place for your cows, but such a small house for yourself and family?" The farmer replied, "By this sort of management I will some day have a good dwelling house. With the income from the stock I have managed to build the barn, and now the barn is earning me money for building a new house. The barn is where we make our money and the house is where we spend it. I believe in making the money before I provide a place for spending it." Stock cannot stand in a cold shed, or out in the open by a hayrack eating snowy hay, or be turned out to the cornfield on a cold stormy day to rustle for their food. The animals are thus used as stoves for heating up the universe. No cow can make profitable returns from this sort of treatment. To build a dairy barn is a profitable investment.

Second: If the barn is properly built it provides a convenient and comfortable place in which to do the work incident to the care of stock of all kinds. The old way of caring for a herd was far from being most convenient and comfortable. A shed built from poles cut by the river, set up and covered with straw, having no floors, no gutter, no manger, no hay and grain room is not encouraging for the man to continue in the stock business. These conditions are all right as a means to a better end. Under such condititions the caretaker must go out and dig away snow from the haystack or hitch up a team to bring in a load of cornfodder. This must be done, no matter how the weather is. Even under summer conditions flies and mosquitoes and nervous cows make it uncomfortable for the milker without a good barn. It is this sort of stock farming that discourages the old people and keeps the young people from going into the farming business. A barn, properly built and planned, properly lighted, properly ventilated, having hay and grain room and a silo connected with it, is convenient and comfortable, in which any member of the family can work.

Third: A neat, well built and well kept barn is a pride to any farm place. It elevates; it causes all to take pride in the stock and farm place. When visitors come, a pride can be taken in showing them around. When conditions are such that this pride and interest cannot be taken in one's work, then there is little but drudgery left. A good barn will do much to instill pride and interest into stock raising.

Location of Barn

An important point is to locate the barn so it is not too far from the house. Some barns are so far from the house that it is necessary to walk close to half a mile before one gets to the barn. If the barn is sanitary and kept so, the barn need not be more than 200 feet from the house.

If possible, locate the barn on ground that slopes away from the house to prevent the drainage from running towards the house during the rainy season. At the same time, the barn must not be located on low ground. It is very important that the barn be located on sloping ground that will provide naturally drained yards. If the lay of the land is naturally low, the foundation should be high enough to permit grading dirt up around and thus provide drainage. When such conditions exist, the barn site and yards should be well underdrained. It is very important that a drainage system for carrying off liquid manure, spill water from the mangers and seepage from the root cellar be provided for before the barn is located.

Locate the barn so it can be seen from the road. There is no building so attractive, and that can be made so much of an advrtising medium as can a neat, well kept barn surrounded with a splendid herd of cattle.

A grove for northwest shelter, the direction of prevailing winds, and the location in respect to pasture, are also factors that should be considered in locating the barn.

One of the important points to consider is to locate the barn north and south to provide a maximum amount of sunlight from the east and west. If a barn is located east and west, one side is exposed to the north, from which no sunlight is obtained, the other side is exposed to the south. During the winter month considerable sunlight is obtained from this direction, but during the summer, at the middle of the day the sun is higher in the heavens and relatively little sunlight gets into the barn. When the barn is located in this direction, there is also a tendency for the shingles on the south side of the roof to dry excessively and curl up, while on the north side of a large roof there is tendency for the shingles to remain moist and rot. So a barn should be located north and south.

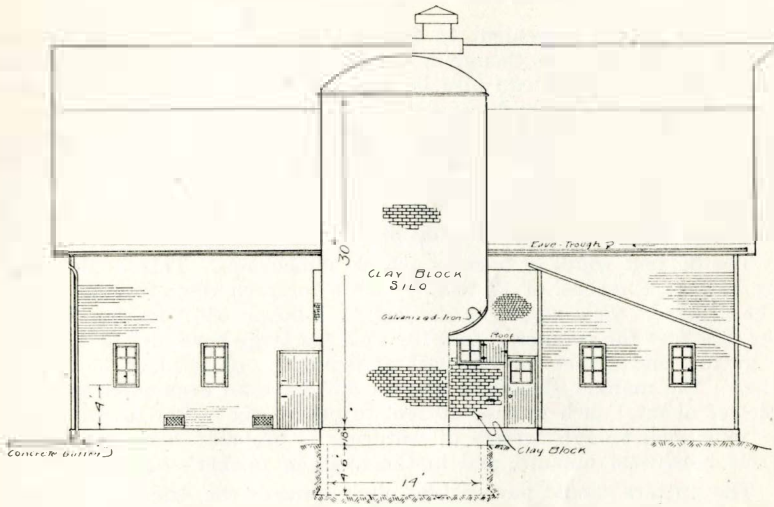
If possible, provide a run shed to the east from the north end of the barn. This will give a sheltered southeast yard.

The hay lift should be on the north side of the barn. In the summer the south end of the barn is very warm for unloading hay.

Arranging Inside of Cow Barn

The arrangement and building of a barn should be thoroughly studied.

First, from the carpenter's and architect's standpoint. Such men should help to decide on the kind of material from which to build. Shall the dairy barn be built from re-inforced concrete, from concrete blocks, from hollow burnt clay blocks, or from lumber? If the latter, what kind of lumber and how heavy shall the various parts be, and how shall they be combined? This part of barn building shall not be considered further in this connection.



EAST ELEVATION

Fig. 10. The east elevation showing the east end of the shed, the feed bin built in around the silo and the 14 foot clay block silo with a total depth of 36 feet. An eave trough to catch the water off the roof with a concrete gutter to carry it out away from the barn will often be necessary to save having a muddy lot on this side of the barn. The roof over the feed bin is a plain shed roof. See Fig. 11.

Second, from a standpoint of convenience and comfort of the cow and the herdsman. This in turn may be considered under the following heads:

1. Providing proper room for the milk cows.
2. Providing proper box stalls for bull and sick cows.
3. Providing proper place for the calves.
4. Providing for sufficient hay and grain storage space and feed for all stock.
5. Providing for milk room.

Room for the Milk Cows

In the northwest a cow should have 500 cubic feet of barn space. This is no more than a cow should have for comfort for getting sufficient ventilation without too much cold and draft. A space for each cow equal to 8 feet in length, 3½ feet in width and 8 feet in height is about right. These dimensions may be used as a basis for obtaining the dimensions of the barn.

If good light and ventilation are to be had all over, two rows of cows in the barn are enough. The barn should thus be 36 feet in width. There is some difference of opinion as to which way the two rows of cows should face. Some favor having them face towards each other, or towards a feeding alley running through the center of the barn. Others favor having them face towards the outside walls and a driveway through the center and behind the cows. The latter arrangement is probably the best. The cows are not always spattering the walls behind.

It is many times convenient to be able to drive a team and wagon through the barn, even though a system of manure and feed carriers is installed. The cows can also be seen and show up better when the spectator walks behind both rows of cows at once. It is also more sanitary to have cows face away from each other. Cows facing towards each other are continuously breathing in each other's faces, making it easier to transmit certain contagious diseases. By having a feed cart or a feed carrier, it is comparatively easy to do the feeding, even though it is necessary to go over two feeding alleys.

The 36 feet width of barn is outside dimensions. This would leave only 34 feet, 8 inches, or 17 feet, 4 inches for each row of actual space to be utilized. This would be divided as follows: 4½ feet for feeding alley, 2½ feet for manger, 5 feet for stall for large cows, 1 foot 4 inches for gutter, and 4 feet for one-half of driveway, or total of 17 feet, 4 inches. The manger should be smooth and have an even pitch towards outlet of about 1 inch in each 10 feet to permit the water to run away. The individual trough system of watering is probably not advisable in in this northwest climate, and in the average farmer's barn.

The gutters should have a like pitch towards the drain, and in addition the bottom should tilt away from the cow about 1 inch. If the bottom of the gutter is level, too great a pitch is required to carry away the liquid manure. If the bottom slants away from the cow, the liquid manure does not spread all over the level bottom, but will run off much quicker.

The floor of manger and feeding alley should be even. All the floor should be concrete with the possible exception of the center part of cow stalls. Cork bricks are very satisfactory for covering stalls. They are a little expensive. Plank frames are used as units for covering stall floors. Concrete may also be used. In that case the ground should be first covered with cinders and be well tramped, then a 4 inch layer of concrete troweled down to a rough surface. If the cows are well bedded, such a stall is satisfactory.

The stall should slant about 1 inch towards the gutter. It is not a good plan to have cows stand in a slanting stall. This slant can be counteracted by making an inch depression in the front part of the stall to extend back from the manger about 14 to 20 inches. This gives the cow a level place on which to stand.

The drop from the stall to the gutter should be from 8 to 10 inches. If it is less, then the cow is more likely to stand in the gutter with her hind feet. This is also about the right elevation to make the cows show up well from behind. If the drop is much more than 10 inches, the cows are more likely to injure themselves in going in and out of the stall.

The gutter should be 16 inches wide. If less than this, the manure piles too high over night, and liquid manure does not drain away. It should also be wide enough to admit the use of a shovel of ordinary size. If the gutter is wider than about 16 inches, some cows are afraid to step across it. If the cows have to take too long a step across a gutter, they are so likely to slip in the stall when going in and out of it.

The depth of the gutter next to the driveway should not be over

4 inches. Every inch it is deeper than this makes it that much harder to take the manure out. If the gutter is not over 4 inches deep on this side, the driveway behind the cows is at least 4 inches lower than the stall on which the cows stand. An animal always shows up to better advantage under such conditions.

The driveway should not be over 8 feet in width. If more than this it is necessary for the man who cleans the barn to step out of the gutter every time he loads a shovel full of manure on to the manure spreader.

The stalls on one side of the barn may be made full length at one end and gradually become shorter towards the other end of the barn. This permits of placing the cows according to size. In addition to this, the stanchions should be adjustible.

A very important point in finishing the concrete floor of the driveway and alleys where cows walk is to see that the floor is not smooth. Use no surfacing coat. Trowel the ordinary concrete down well with a wood float. A wide shallow creaser for marking the floor into blocks about 4 inches square may be used. Do not use a creaser that makes a deep, narrow depression. It fills with dirt and is unsanitary. Air slacked lime scattered on the cement floor prevents cows from slipping.

Good Ventilation and Light

Ordinary pure air is composed as follows:

Oxygen	20 per cent
Nitrogen	80 per cent
Argon	.09 per cent
Carbon dioxide	03 per cent

An animal may suffocate from lack of oxygen. Less than 3 per cent of oxygen is fatal to a cow. Less than 15 per cent makes her breathe abnormally.

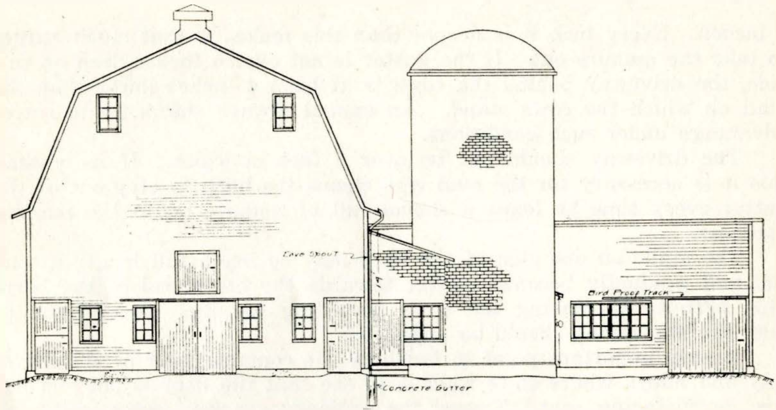
A cow may be poisoned from impure gas. More than 1 per cent of carbon dioxide gas is considered fatal to a cow.

There are two systems of ventilation: the adjustable and the automatic.

Of the former may be mentioned the muslin method and the ordinary way of opening a window. The covering of windows with muslin shuts out light. Dirt also accumulates in the cloth. After a rain the muslin looks very grimy.

If the window method of ventilation is used, the sash should be hinged at the bottom so it will open in. This slant of the window deflects the current of air towards the ceiling of the barn so the draft does not strike the cows directly. This system is all right during the day, when someone is around to adjust the openings to admit the right amount of fresh air. These adjustable systems of ventilation are more applicable to old barns than to new barns. A new barn should be equipped with a good system of automatic ventilation. No barn is complete without proper provisions for supplying the cows with fresh air. No cow can do profitable work in a stuffy, ill ventilated barn.

The King system of ventilation is recognized as standard. If the inlet and outlet flues are properly constructed, it works well. A square



SOUTH ELEVATION

Fig. 11. The south end of the main barn and front of the shed. Also showing the silo and front of the milk room. If the alternate floor plan is used with horses in this end, it is recommended this milk room be used for feed and a milk room be built out on the west side closer to the house.

The Rutherford system of barn ventilation has in some instances been recommended. By this system the fresh air is admitted into the barn near the floor and the foul air is taken out through openings in the ceiling and flues going out at the top of the barn.

There is always a slow and natural purification of barn air going on. The moisture combines with carbon dioxide gas to form carbonic acid and the ammonia combines with the carbon dioxide to form ammonium carbonate.

Though of the greatest importance, the question of the ventilation of barns cannot be here fully considered.

A barn should have plenty of light. Light is a germ destroyer. Light makes a herd of good cows show up well. A dark barn usually is not kept clean and is not sanitary. The ideal amount of light for each cow is 4 square feet. For the general farm barn in the northwest 3 square feet for each cow is enough.

Provide Good Calf Stalls

If we want big things, we must take care of the small ones. If we want to be raisers of stock that will have good form and excel as producers, it is absolutely necessary that the calves are not halted in their early growth. A stunted calf will never make as good an individual as he would if he had been kept growing all of the time.

A certain farmer had just completed a large barn. Horse stalls on one side, cow stalls on the other, howmow in the center, and runshed for young stock at one end. No. place was provided for calves. So a place was made as fast as they were born. The owner with a hay knife cut a little half moon shaped place into one side of the haymow near the center and in front of the cows. Several calves were put into a place that was only about 6 feet by 4 feet in size. The place was dark, ill ventilated, and usually foul. Many of his calves died, and all were scrawny in appearance.

Another farmer built a new, up-to-date barn. At one end and to one side of this splendid barn a place having stanchions in front was provided. The owner was determined that his calves should occupy as good a place as there was in the barn. During the night when all of the cows were inside, the barn was warm. In the morning the barn doors were opened to let the cows out, and soon the hired man came along with the team and wagon or manure carrier to clean the barn. Meanwhile, the below zero cold air was rushing through the barn. The calves in the one corner of the barn could not get away from it. Soon they began to cough, a discharge began to flow from their noses, soon they began to pant, and pneumonia would finish them.

The importance of providing a place for the calves where the temperature can be kept reasonably uniform should be emphasized. It is not so much a real warm place that is needed as it is a place free from draft, having plenty of sunlight, a dry, well bedded stall, with as little variation in temperature as is possible.

Calf stalls should be provided with stanchions and feed manger. It is better to have several small stalls than to have one large one.

Silage, Hay, Grain and Bedding, Storage Room

The barn should be built not only for holding the stock, but also for holding the feed and bedding necessary to maintain the cows. This means that one should take an invoice of the number of head of stock he expects to keep and the amount of each kind of feed that will be needed. For instance, if 35 head of stock is to be kept in the above described barn for nine months during the year, then a silo holding about 150 tons is needed, a haymow that holds about 75 tons of hay and an overhead granary that will hold about 1400 bushels of grain. It is well to plan on having more feed storage capacity than is necessary. This will enable the owner to keep feed from one year to the other. The cost of the roof to the barn will be the same. The only increase in cost for additional feed and bedding storage room is in the height of sides and ends.

A barn of such dimensions as mentioned above (70 feet long and 36 feet wide) should have studdings no less than 16 feet high. Granting that 8 feet are used for the cows and 1 foot for joists and ceiling there would still be left 7 feet for haymow.

The gambrel or hip roof is self-supporting and if properly braced is the best roof to put on a dairy barn. There are no heavy posts in the haymow to interfere and it gives more room. With such a roof the extreme height of the mow will be about 25 feet, the width 36 feet and the length 60 feet. This will have a capacity of about 100 tons and gives ample capacity for both hay and bedding.

A grain bin 10 feet wide, 10 feet deep and 20 feet long will hold about 1700 bushels of grain. This grain bin should be directly over the feeding and grinding room in the barn proper. This latter room should be sufficiently large to hold bran, oil meal or similarly purchased feeds. The grain above is obtainable any time by opening a spout extending into the feeding and grinding room below.

Milk and Power Room

Every dairy barn should have a milk room connected with it, or at least near the barn. Ideally speaking, the milk room should be separate from the barn. If the milk is produced for city or direct use, then the milk room should be separated from the barn. If the milk is produced for cheesemaking or for buttermaking use, then the milk room may be built onto one side of the barn, or a corner room shut off from the barn may be equipped and used as a milk room. Rooms thus located will provide plenty of outside walls for good ventilation and light.

The milk room should contain a milk and cream cooling tank. It should be provided with spring balances for weighing the milk from each cow, and with milk record sheets for keeping records of all the cows. Shelves should be built for holding the milk sample bottles. A place for a gasoline engine should not be overlooked. If the engine is large and used much, there is danger of the milk absorbing odors. In such a case it should be in a separate room. A small engine for running a milking machine, if exhaust is piped outdoors and it is kept clean, will leave no bad odors. The hot water from the gas engine will come handy in the milk room.

A barn thus equipped for keeping cows, calves and young stock, for hay, silage, grain and bedding, for weighing and handling the milk and cream, for the convenience and comfort of those who do the work, will do much towards more profitable and more pleasurable stock farming.