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Construction of a Silo

HORACE ATWOOD.

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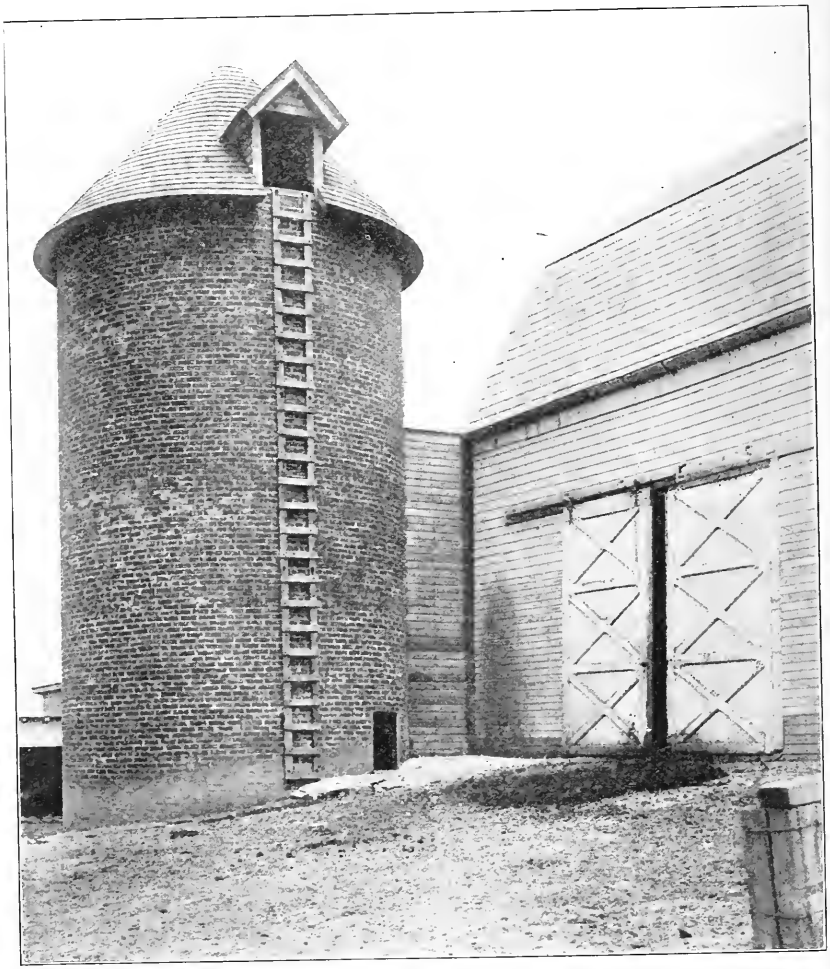


A REINFORCED BRICK SILO

A Reinforced Brick Silo.

IMPORTANCE OF SILAGE FOR DAIRY COWS.

On a dairy farm a silo is almost a prime necessity, and the dairymen of West Virginia are fortunate that corn, the King of silage plants, can be grown so easily in nearly all sections of the state. During summer there is nothing cheaper or more satisfactory for milch cows than good pasture, but in winter all the feed must be provided, and at the prevailing high prices for hay and grain it is important to produce on the farm as much of the ration as possible. The growth of corn for the silo ful-fulfils this condition, as heavy yields can be secured when the soil is properly fertilized and the crop intelligently cultivated. Silage, too, is succulent, adds variety to the ration, is relished by the animals, and promotes a more healthful condition of the digestive system than when dry feed only is supplied. Moreover, corn silage can be produced cheaply, thus reducing the cost of the ration of which it is a part.

It is not the purpose of this bulletin to enter into an extended discussion of the principles underlying the construction of silos, or of the use of silage for dairy animals, as detailed information may be obtained about these matters by writing to the U. S. Department of Agriculture, Washington, D. C. for the Farmers' Bulletins on this subject**. It is sufficient at this time to say that for a silo to be satisfactory the walls must be air tight, and sufficiently rigid to withstand the pressure to

**Information regarding silos and silage is contained in the following Farmers' Bulletins of the U. S. Department of Agriculture: No. 32, "Silos and Silage"; No. 292, "Cost of Filling Silos"; No. 56, pp. 7-9, "Robertson Silage Mixture"; No. 103, pp. 20, 21, "Silage for Horses and Hogs," and pp. 23-30, "The Stave Silo"; No. 124, p. 25, "Alfalfa Silage"; No. 133, pp. 31, 32, "Losses in the Preparation of Silage"; No. 190, pp. 21-23, "The Octagonal Silo"; No. 222, pp. 31, 32, "Silage in Place of Grain for Dairy Cows"; No. 267, pp. 29-31, "Effect of Silage on the Flavor of Milk"; No. 309, p. 19, "Silage from Frosted Corn."

which they are subjected when the silo is filled with heavy green material. For ordinary silos filled with corn silage this pressure increases eleven pounds per square foot for each foot in depth of the silo. Consequently the outward pressure becomes very great at the bottom of deep silos. The wall must be strong enough to withstand this pressure for if cracks open air is let in and the silage rots.

The silo should be of sufficient depth so that the weight of the silage compresses itself thus excluding the air. Few silos are now being built less than thirty feet deep. The greater the depth of a silo the greater its relative capacity on account of the fact that the silage packs in more solidly. One silo thirty feet deep will hold more silage than two silos each fifteen feet deep, all being of the same diameter, to say nothing about the superior quality of the silage in the deeper silo. With the modern ensilage cutter with blower attachment, a deep silo can be filled as easily as a shallower one, although somewhat more power is required.

FEEDING AREA.

As silage soon spoils when exposed to the air it is usually removed by raking from the top a sufficient amount for each feed, care being taken to disturb the underlying silage as little as possible. In this way the fresh silage which is continually being exposed is fed before sufficient time has elapsed for it to mold. The depth of silage which should be removed each day in order to keep ahead of decay depends somewhat upon the weather, as silage decays more slowly at low temperatures. In general from one and one-half to two inches in depth should be removed daily, and the size of the silo should be so proportioned to the number of stock kept that this result can be accomplished. A cow will consume about forty pounds, or one cubic foot of silage daily, and with this figure in mind it is easy to calculate the proper size of the hortizontal feeding area of a cylindrical silo. For example if twenty-five cows are kept, about twenty-five cubic feet or 43,200 cubic inches of silage will be fed daily.

Dividing this by 2, the depth to be fed daily, we obtain 21,600 the required horizontal feeding area of the silo in inches. Dividing this by 3 1-7 and extracting the square root of the quotient we obtain approximately 83 which represents one-half of the inside diameter of the silo in inches, or a total inside diameter of 166 inches or approximately 14 feet.

CAPACITY OF SILOS.

The following table gives the approximate weight in tons of well matured corn silage that may be stored in cylindrical silos of various heights and diameters:

DEPTH OF SILO FEET	INSIDE DIAMETER OF SILO, FEET.												
	10	12	14	15	16	18	20	21	22	23	24	25	26
20	26	38	51	59	67	85	105	115	127	158	151	163	177
21	28	40	55	63	72	91	112	123	135	148	161	175	189
22	30	43	59	67	77	97	120	132	145	158	172	187	202
23	32	46	62	72	82	103	128	141	154	169	184	199	216
24	34	49	66	76	87	110	135	149	164	179	195	222	229
25	36	52	70	81	90	116	143	158	174	190	206	224	242
26	38	55	74	85	97	123	152	168	184	201	219	237	257
27	40	58	78	90	103	130	160	177	194	212	231	251	271
28	42	61	83	95	108	137	169	186	204	223	243	264	285
29	45	64	88	100	114	144	178	196	215	235	265	278	300
30	47	68	93	105	119	151	187	206	226	247	269	292	315
31	49	70	96	110	125	158	195	215	236	258	282	305	330
32	51	73	101	115	131	166	205	226	258	271	295	320	346

In this connection it may be well to observe that a silo thirty feet deep will furnish silage for practically six months when fed from at the rate of two inches in depth daily. Under ordinary conditions this will cover the feeding season unless silage is required to supplement pasturage.

WHEN TO CUT CORN FOR THE SILO.

Corn for the silo should be cut just before it becomes fully mature. At that time there is still enough juice in the stalks so that the cut or shreaded material packs into the silo firmly and yet there is not that earlier superabundance of juice whose presence tends to produce a very sour or acid silage. During

the latter part of the growing period, the accumulation of nutritive materials in the corn plant is very rapid, so on this account also harvesting should be delayed until the crop is practically mature. When the lower leaves become dry and some of the ears are ripe enough to be snapped off for seed the crop is ready to be stored away. On the approach of cold weather if the corn is still immature it is better to take the risk of a slight frost rather than to cut the corn too green, as the accumulation of nutritive materials at this time will usually more than offset any ordinary damage from frost.

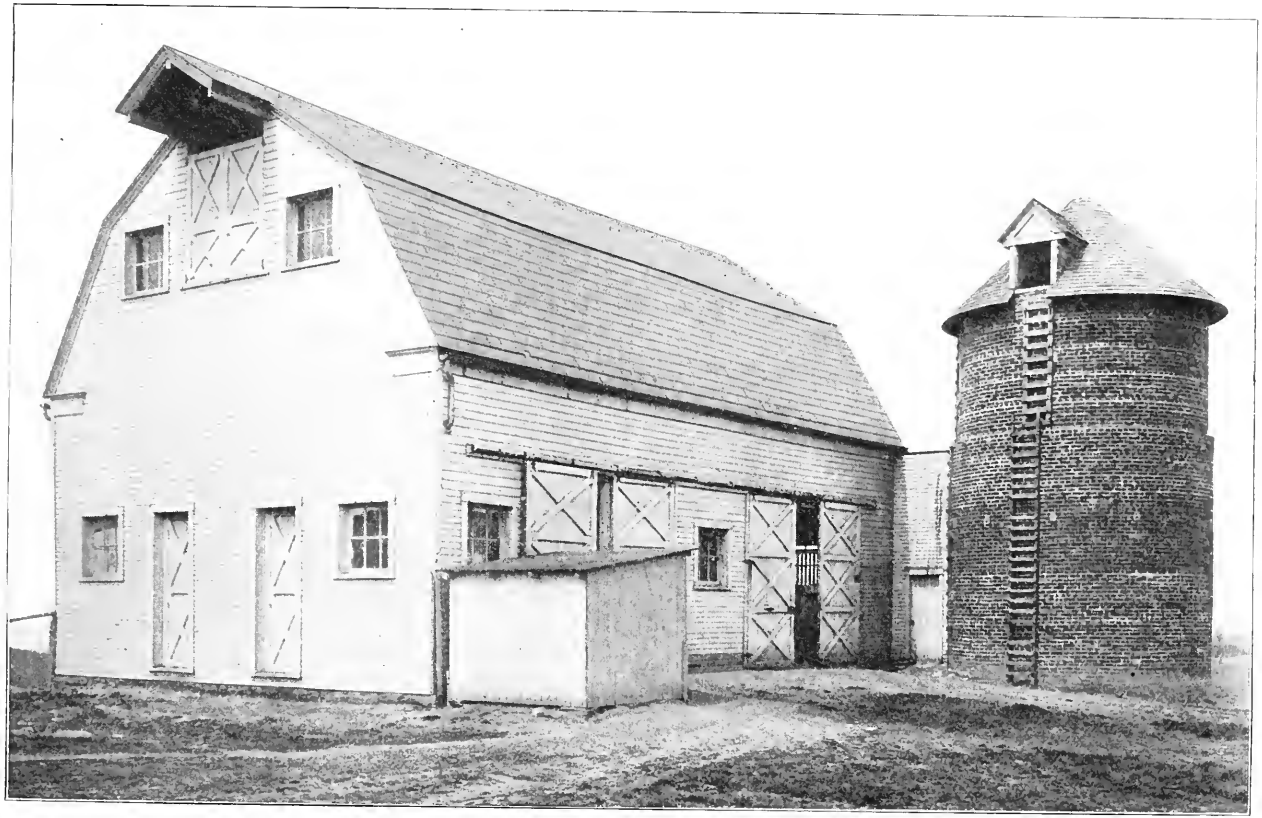
SILO CONSTRUCTION.

In the past most silos have been built of wood, in cylindrical form, the height being about twice the diameter. Wood, however, at the best is not an ideal material for silo construction as the walls take up moisture and swell when the silo is filled, and then shrink when the silo is empty. This swelling and shrinking tends to open the joints so that the walls do not remain airtight and loss of silage results. After a time, too, wooden walls may rot, thus letting in air, and stave silos when empty are easily racked out of shape by the wind or blown down.

Many silos are now being constructed of cement or concrete, reinforced with iron rods or wire, and although these silos when properly built are giving perfect satisfaction, yet the forms necessary for their construction are somewhat expensive, and few farmers care to undertake the construction of cement silos without having had some previous experience. Directions for building solid wall or cement block silos may be obtained by writing to the Atlas Portland Cement Company, New York City, for a copy of "Concrete Construction about the Home and on the Farm." This pamphlet is distributed gratis.

BRICK SILOS.

In 1904 the Experiment Station constructed the brick silo shown in Fig. 1. This silo is fifteen feet in diameter and thirty feet deep.



THE STATION BARN AND BRICK SILO. (Fig. I.)

The brick were laid in cement and the silo was plastered on the inside with cement mortar. Iron rods about six feet long were imbedded in the mortar above and below each door so as to give strength to that portion of the wall. No other reinforcement was used. The wall is a brick and a half or about thirteen inches thick for two-thirds of the way and the remainder is eight inches thick, exclusive of the plastering, which is about three-fourths of an inch in thickness. This silo has been used continuously since it was built and has given good satisfaction as no cracks have appeared in the wall and the silage has kept well.

REINFORCED BRICK SILOS.

The silo described above not being large enough for the increasing number of animals kept on the Experiment Station Farm it became necessary during the summer of 1909 to build another silo and an attempt was made to construct a silo possessing all of the advantages of a brick structure and yet reduce materially the first cost. Reinforced brick construction was decided upon.

METHOD OF CONSTRUCTION.

An excavation was made about four feet deep to the underlying rock in order to secure a solid foundation. Then a cylindrical brick wall was laid up the width of a brick or four inches thick, cement mortar being used. As the wall was laid 20d wire nails, which previously had been annealed by heating them, were imbedded in the mortar with the ends projecting from the wall about two inches into the silo. About two nails were used per the square foot of surface.

After the wall had stood a few days for the cement mortar to harden, Page woven wire fencing was cut into pieces of the proper length to go around the inside of the silo, lapping somewhat, and the projecting ends of the nails were clinched over the wires so as to hold the fencing close to the brick wall. Page

fencing with "coiled" wire is not well adapted to this purpose as the coil will not permit the fencing to be applied smoothly and evenly to the wall. Only fencing with straight horizontal wires should be used for this purpose, for if the fencing is not drawn close to the wall in all places an unnecessary amount of cement is required for the plastering.

Two thicknesses of wire fencing were put on for about one-half of the depth of the silo and for the remainder only one thickness. Each strip of fencing as put on was lapped about two inches over the lower one. The top course of fencing was allowed to project about four inches above the top of the wall and this was stapled to the plate thus fastening the roof securely to the structure.

After the wire was in place the inside of the silo was plastered with cement mortar, thus covering the wire. The mortar consisted of one part of cement and three parts of sand.

Four openings were provided at convenient distances for removing the silage. These openings are each twenty-four by thirty inches in size. The door frames are of cast iron, one inch in thickness with a projection which laps a couple of inches over the brick work on the inside of the silo. There is also a projection an inch high extending around the frame on the inside and two inches from the face of the frame and against which the door presses when in place.

The doors were made, as is customary, of two thicknesses of seven-eighth inch flooring with roofing paper between, and they are held in place by being bolted to four by four inch pieces of timber which extend across the door frames on the outside. The nuts on the bolts which pass through the doors and the pieces of timber are tightened from the outside and in this way the doors can be drawn snugly against the jamb of the door frames.

This silo has been used only one year but the silage has kept well, and the wall successfully withstood the internal pressure.

It is believed that this method of construction possesses many advantages where a permanent structure is desired. The wire fencing, being protected by the coating of cement, has no tendency to rust, and the life of the silo should be almost indefinite. In every agricultural community the services of a brick mason can be secured easily, the job of laying up the four inch wall is a short one, and the farmer himself can put on the wire and do the plastering.

The following schedule shows the amount of materials used, the cost of the same and the cost of construction, but, as pointed out above, all of the work except laying the brick can be done by common farm labor, and under these conditions the actual cash outlay would be much less than that shown below.

MATERIALS USED AND COST OF CONSTRUCTION FOR SILO FIFTEEN FEET IN DIAMETER AND THIRTY FEET DEEP.

8,600 brick	$59.20
Laying brick	76.39
233⅓ bushels sand	4.66
9½ bbls. cement	19.00
Plastering silo	41.20
3 rolls Page woven wire fencing	14.00
½ keg of 20d wire nails	1.50
Lumber for roof	38.90
3,250 shingles for roof	13.00
Carpenter putting on roof and building doors	15.00
4 cast iron door frames	18.18
Labor excavating foundation	12.00
Total cost	$313.03