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COLLEGE OF AGRICULTURE

Agricultural Experiment Station

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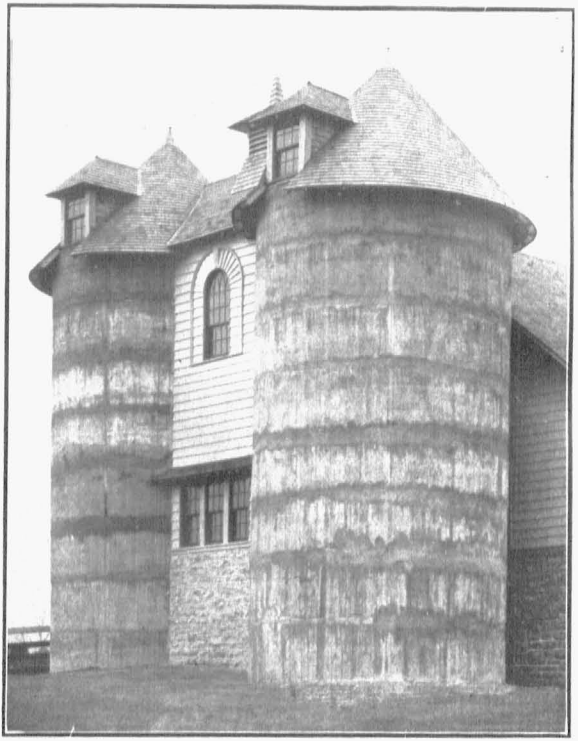

The Silo for Missouri Farmers.

COLUMBIA, MISSOURI
May, 1912

UNIVERSITY OF MISSOURI

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Agricultural Experiment Station

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(1) On leave of absence, session 1912-13.
(2) In the service of the U. S. Department of Agriculture.

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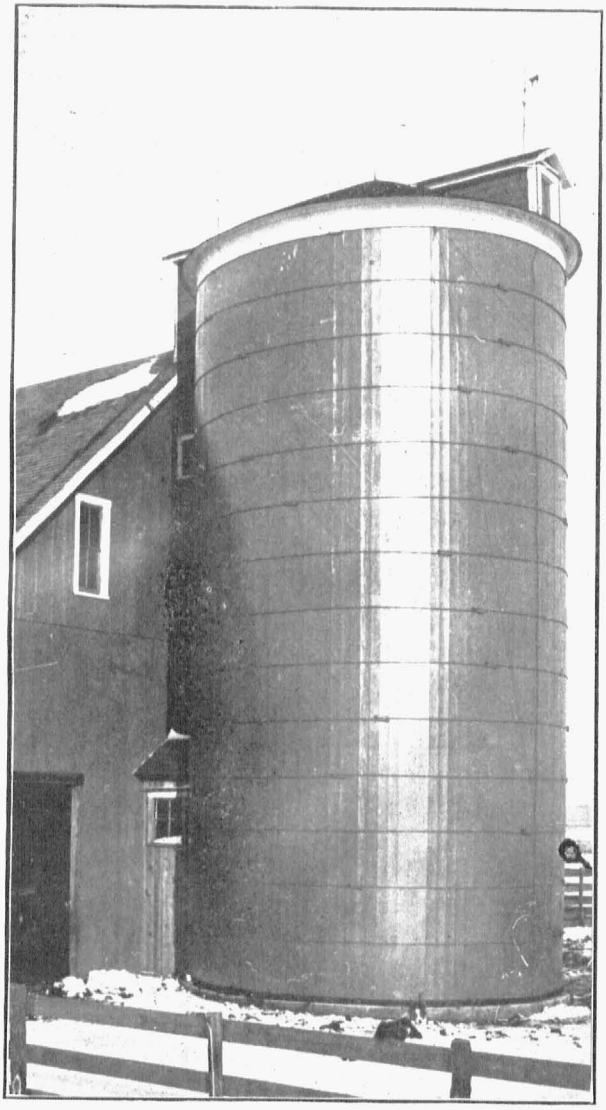


A WOOD STAVE SILO.

This silo is situated on the farm of R. E. Elliott, Lathrop, Mo. A silo of this type is the easiest to erect and gives good results. It may be expected to last from 10 to 15 years.

THE SILO FOR MISSOURI FARMERS.

C. H. ECKLES.

There is a disposition to look upon the silo as an entirely new thing that has been developed within the last decade. As a matter of fact, the silo is in no sense an experiment and is not new. According to ancient writers it was a common practice as far back as the time of Greece and Rome to preserve grain and green feed in underground pits. It has been the custom for hundreds of years to preserve green feed in the same manner in northern Europe where the uncertainty of the weather and the low summer temperature make it difficult to cure hay. This practice attracted little attention until the French farmer, Goffart, in 1877, published a book giving the results of 25 years experience in preserving green feed in this manner. The first silo in the United States is said to have been built in Michigan in 1875.

We are not able to say who built the first silo in Missouri. Corn silage has been fed regularly at the Agricultural College since 1896. At the present time there are a large number of silos in use in Missouri but data is not at hand to make it possible to estimate the number. There are localities where 12 to 15 have been built within a radius of 4 or 5 miles. A number of silos in the state have been in regular use for from 10 to 15 years. These facts should help to remove the common idea that the silo is a new thing and still in the experimental stage.

Advantages of the Silo.—There are a number of advantages that go with the use of the silo but the greatest of all is the possibility it affords of utilizing all the corn crop. There was a time when land was cheap and an abundance of coarse feed at hand that had little market value. Under these conditions it was not a serious loss if a portion of the corn crop was wasted. At the present time with both farm lands and feeds high in price, conditions are quite different. When the ears of corn are husked in the ordinary way and the fodder left in the field from 60 to 70% of the food value of the corn crop is taken with the ears, while 30 to 40% remains with the fodder. It is possible to utilize a small portion of this fodder by turning cattle into the stalk fields in the ordinary manner. But every farmer knows that the benefits derived in this way are comparatively small.

Prof. M. F. Miller of the Agronomy Department gives the fig-

ures below as the average yield of silage per acre for corn varying in yield from 30 to 100 bushels. These figures are the average of results of experiments at Columbia and at several other places in the state.

AVERAGE YIELD OF SILAGE PER ACRE.

Yield of Corn, Bushels.	Yield of Silage, Tons.
30	6
40	8
50	10
60	12
80	16
100	20

According to these figures a crop of corn that will yield 50 bushels to the acre will furnish at least 10 tons of silage. Upon the basis of total food value 2½ tons of silage are equal to 1 ton of timothy hay. This means that a yield of 10 tons of silage per acre is equivalent in feeding value to 4 tons of timothy hay per acre. On the same basis, when corn is worth 50 cents per bushel a ton of silage is worth $3.35. Calculated in this way, an acre of corn yielding 50 bushels per acre when put into the silo is worth $33.50, while at 50 cents per bushel the grain is worth $25.00.

The next most important advantage of silage is its palatability as a food. Any farmer knows that green corn at the stage it is cut for fodder in the fall makes good feed for live stock and that if it could be preserved in this way it would make an excellent ration for winter feeding. A silo makes it possible to preserve corn in this condition. Silage bears a similar relation to fresh corn that canned fruit or canned sweet corn does to the fresh article. The feeding of silage in the winter makes it possible to keep the animals in practically the same condition that they are when on pasture in the summer. A good quality of silage is so palatable that many animals will eat it in preference to grain and cows in milk will eat silage even when on good blue grass pasture.

As compared with the cutting of the corn and shocking in the field the use of the silo is a distinct saving of labor. When putting corn in the silo it is handled but once and then under the most favorable conditions. That is to say, it is handled in large quantities and with an organized force and under favorable weather conditions.

The Summer Silo.—It is a safe prediction that in the course of time the majority of stock farmers in the state will not only have a silo to preserve feed for use in the winter, but will also have sufficient capacity to keep a reserve supply for use in the summer. Silage

may be kept without loss from one year to another and if it is not needed during the summer months the silo may be refilled in the fall after taking out a layer of rotten material which will be found on top. If the pastures are short on account of temporary lack of rainfall the silo may be opened and the stock kept in good condition. On farms where a considerable amount of stock is kept the best solution of the problem of supplying summer feed will be to have a larger silo for winter feeding and a smaller one for summer use. A number of dairymen in the state were fortunate enough to have silage on hand during the summer of 1911 and report that they were able to maintain the flow of milk from their herds practically as well as though the cows had been on good pasture.

Size of Silo to Build.—The size of the silo that should be built will depend upon the number of animals to be fed. As a rule, the mistake is made of building the silo too large in diameter rather than too small. The silo should be small enough so that the animals will consume a quantity each day equal to a layer of at least 2 inches over the entire surface. Silage keeps better in a deep silo than in a shallow one because it is more firmly packed and at the same time more feed can be stored in the same space. Except with a very large herd it is not advisable to build a silo more than 16 feet in diameter. If more capacity is needed a second silo should be constructed. As a rule the height of the silo should be at least twice the diameter. After the silo is opened silage should be taken out regularly, otherwise that which is exposed to the air at the surface will spoil within two or three days. The amount of silage ordinarily fed to a dairy cow, or to a mature beef animal of the same size, is from 30 to 40 lbs. per day. Feeding 30 lbs. per day will require 900 lbs. per month per animal, or about 5¼ tons to feed each animal six months. The figures in the table below give a general idea of the size of silo needed for herds of from 10 to 50 cows. It is assumed that 40 lbs. will be fed per day to each animal.

RELATION OF SIZE OF SILO TO LENGTH OF FEEDING PERIOD AND SIZE OF HERD.

Number of Cows in Herd.	Feed for 180 Days.			Feed for 240 Days.		
	Estimated tonnage of silage consumed. Tons	Size of Silo		Estimated tonnage of silage consumed. Tons	Size of Silo	
		Diameter. Feet	Height. Feet		Diameter. Feet	Height. Feet
10	36	10	25	48	10	31
12	43	10	28	57	10	35
15	54	11	29	72	11	36
20	72	12	32	96	12	39
25	90	13	33	120	13	40
30	108	14	34	144	15	37
35	126	15	34	168	16	38
40	144	16	35	192	17	39
45	162	16	37	216	18	39
50	180	17	37	240	19	39

The following table gives further figures regarding the capacity of silos of different sizes:

CAPACITY OF SILOS OF VARYING SIZES.

Depth of silage. Feet	Inside Diameter of Silo in Feet.				
	10 Tons	12 Tons	14 Tons	16 Tons	18 Tons
25	36	52	68	96	122
28	40	61	81	108	137
30	44	68	90	115	150
32	50	72	95	126	162
34	53	77	108	142	171
36	57	82	114	158	194

Material Used for Building Silos.—For the past 15 years practically all silos built have been round in shape and this is the only style to be recommended at present. The essential things in silo construction are to have an air-tight wall smooth on the inside so the silage can settle properly, and a structure sufficiently strong to hold the enormous pressure of the silage and durable enough so that it will not be necessary to replace it for some time. Successful silos have been built in a variety of ways and of a variety of materials including wooden staves, concrete, wood plastered with cement, stone, wood, brick, iron, and tile. It is not the purpose in this circular to give details for construction of silos but rather to give information regarding the subject in general and the advantages of the first three types mentioned.

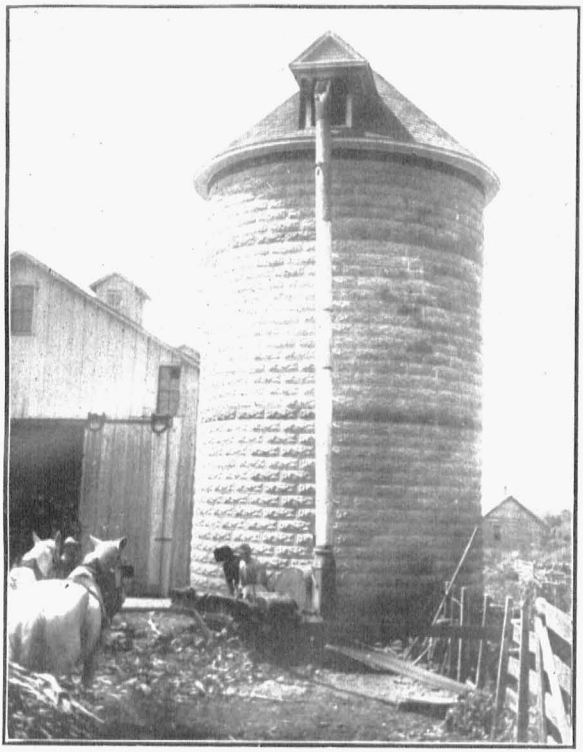
The Stave Silo.—The most common silo found in this state is that known as the stave silo. This is built on the plan of a stave water tank. It is purchased ready to put together requiring only that the foundation be made. A foundation is built of concrete. The walls should be about eight inches thick and should extend two or three feet into the ground. On this the silo is erected. There are many types and forms of stave silos and it is impossible to say which is the best. It is preferable to use those having one piece staves. The continuous door is more convenient. Little positive evidence is at hand as to which wood is the most suitable and durable for silo building. The following statements regarding the average number of years wood will remain without decay is supplied by the Bureau of Forestry, U. S. Department of Agriculture.

Species	Average number years of life untreated
Cypress	14
Redwood	14
Douglas fir	10
Yellow pine	8
White pine	8

The stave silo preserves the silage as well as any type in use. It is easily erected and can also be taken down if it is desired to move it. The disadvantage of this type of silo is that it gives some trouble on account of drying out and attention must be given to keeping the hoops at the right tension. It should be fastened securely with wire cables attached to sleepers placed in the ground a short distance from the structure, otherwise it may blow over or collapse when empty. The stave silo should be expected to last from 10 to 15 years, depending upon the wood from which it is made and other conditions. Those that are made of wood treated with creosote or other suitable wood preservatives are more durable than the untreated. The cost will vary and can easily be obtained from agents. In the central part of Missouri, a stave silo 16x32 feet will cost about $350 at the present time. The foundation is not included in this estimate.

The Concrete Silo.—The concrete silo may be built of blocks or with solid walls. The latter is sometimes called monolithic. The kind most to be recommended is the solid wall structure. The advantages of a concrete silo are that when once properly built it is a permanent structure, and is not damaged by fire or wind or from drying out. It does not preserve the silage any better than does one with a wall of wood. On the other hand if the concrete wall is properly constructed so that the air is kept out the silage will be

preserved in perfect condition. The objections that are often raised to the concrete silo, especially by those interested in the sale of the stave silo, are that it will crack and fall down, and furthermore, that it will not preserve the silage. It is quite true that both these condi-



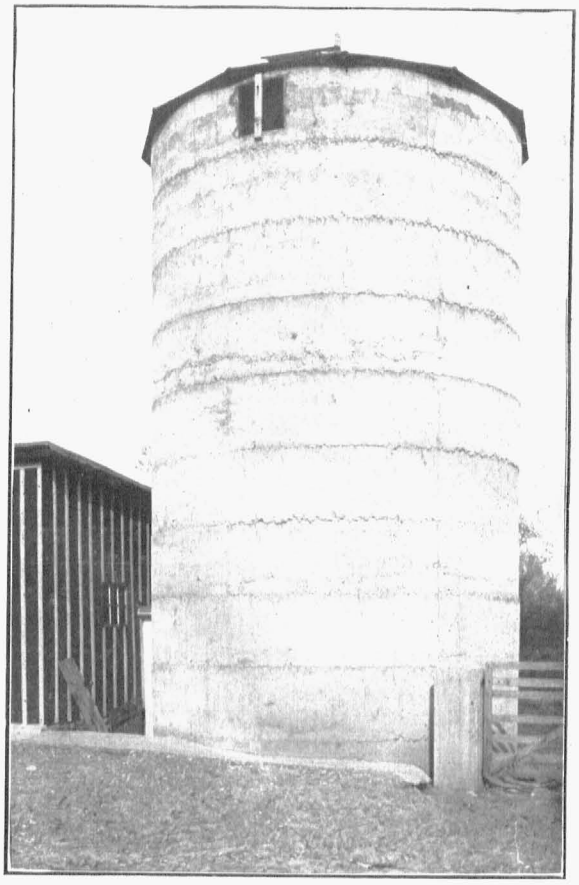
CONCRETE BLOCK SILO.

The above silo is located at Marshfield, Mo., on the farm of John Hosmer. It was built in 1908 and has given excellent satisfaction. A silo of this type must be well built and strongly reinforced to prevent cracking.

tions have been met with in many cases. If the structure is properly reinforced there is not the least danger of it cracking or falling down. If the walls are made of a mixture containing sufficient cement so that the wall is not too porous the silage does not spoil. It requires some little skill to properly build a concrete silo. A farmer who has had no experience in concrete work should secure the assistance of some one who has had such experience before attempting to build a concrete silo.

The two things to be especially regarded in building the concrete silo is to have an abundance of iron for reinforcement and

sufficient cement in the mixture to make the wall impervious to air. It is a good plan to go over the inside wall of a concrete silo each year or at least every second year, before filling, with a mixture of



REINFORCED SOLID CONCRETE SILO.

The above silo, 16x34 feet, is located at Columbia, Mo., on the farm of Marshall Gordon. It has been filled three times and the silage has kept perfectly. When properly built this silo is fire and storm proof and will last indefinitely.

cement and water. The mixture should be about the consistency of whitewash. This helps to close up the pores of the wall and to exclude the air. After a concrete silo stands empty during the summer the walls become very dry. When the moist silage is put in the walls absorb moisture from the silage. This may result in white mould forming near the outer edge. This condition when present

indicates that the concrete has been made too porous. First of all, the concrete should have been made richer in cement when built. The trouble may be avoided in case the wall has been made too porous by applying the cement and water mixture as described. It is also well where the concrete has been made too porous to wet the walls with water as the silage is put in to prevent the absorption of water from the silage.

Cost of a Concrete Silo.—The cost will vary more in different localities than that of a stave or Gurler silo on account of the difference in local supply of sand and gravel. The approximate local cost of the materials may be estimated from the following: The common mixture used is 1 : 2 : 4, that is, one part cement, two parts sand, and four parts gravel or crushed rock. To estimate the amount of each required, calculate the number of cubic feet of concrete required. Then by using the figures below the material can be estimated.

Mixture	Material in cubic foot. Cement, bbls.	Sand, cu. yds.	Gravel or stone, cu. yds.
1 : 2 : 4	.058	.0163	.0326

Below is a calculation showing the approximate amount of each required for the walls, floor and foundation of silos of the size indicated with wall 6 inches thick. A barrel of cement is four sacks.

MATERIAL FOR SILOS OF VARYING SIZES.

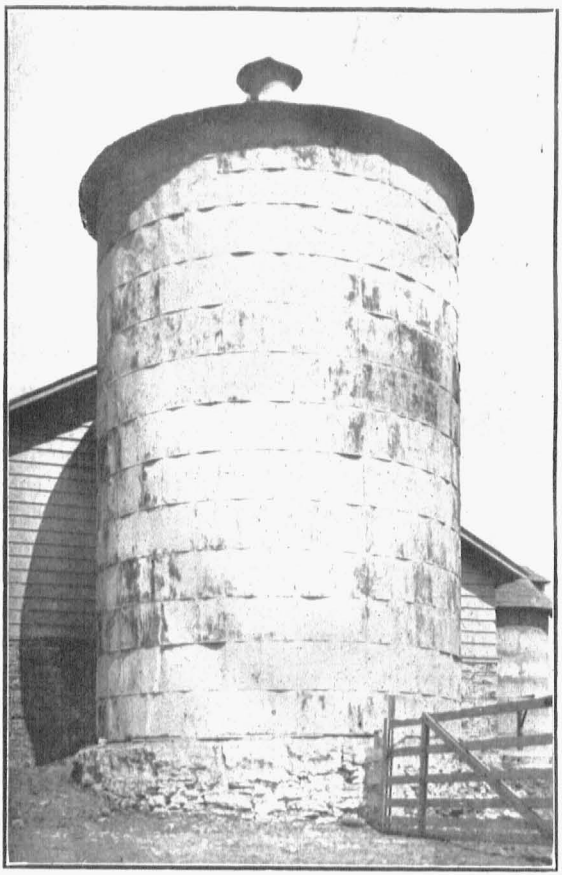
	Silo 12x28 ft.	Silo 14x30 ft.	Silo 16x32 ft.
Cement, barrels	37	45	55
Sand, cubic yards	11	13	15
Gravel, or stone, cu. yds	21	26	30

The forms for building a concrete silo cost about $50. For this reason it is desirable for a number of farmers to club together and build the forms. One set of forms may be used for several silos and in this way the cost of construction can be reduced.

The Plastered or Gurler Silo.—This type of silo is one of the easiest to build and has the additional advantage that native lumber may be used in its construction. If the material, lumber and cement, for this type of silo be purchased at a lumber yard at current prices, a silo 16x32 feet will not cost over $150 for materials, including the roof and foundation. The total expense including labor need not be over $250. A silo of this kind keeps the silage as perfectly as does any kind made. It has the same disadvantage in regard to durability as does the stave silo. It is not affected, however, by the

drying out of the lumber during the summer and there are no hoops to be tightened. The life of a silo of this kind is from 10 to 15 years, depending upon the lumber used and how well it is protected.

Crops for the Silos.—The silo has been tried as a means of preserving nearly all the common crops grown on the farm. However,



GURLER OR PLASTERED SILO.

The above silo, 16x32 feet, built at the University of Missouri in 1896 and partially rebuilt in 1903 after blowing down, has given excellent results. The studdings are covered on the outside with sheet iron.

it cannot be said to be an unqualified success except with a limited number. Corn is pre-eminently the crop for the silo. The yield of total nutrients per acre with this crop is greater than ordinarily secured from any other. It has the further advantage of packing well to exclude the air and contains the proper amount of sugar to

form the acid needed to preserve it without becoming too sour. The best results are obtained as a rule by using the variety of corn best adapted to the locality and grown in the same manner as is done when grown for the grain. Larger yields of silage per acre may be secured from some of the special varieties known as silage corn, but these produce a less amount of grain and the total feed value secured is no more than from other varieties grown for grain.

Cowpeas for Silage.—On account of the fact that corn silage lacks protein it is a rather common practice to combine a certain amount of green cowpeas with the corn. The cowpeas on account of their high protein improve the silage as a ration in this respect. This combination has been found to be successful if too large a proportion of cowpeas is not used. If one-third cowpeas and two-thirds corn are put together in the silo the resulting silage is of excellent quality and somewhat better in feeding value than that from corn alone. The plan of growing corn and cowpeas together has been recommended. This works well with the exception that it is found to be a difficult matter to harvest a crop on account of the vines tying the corn together. However, some Missouri farmers have followed this plan for several years and continue to use it. Others who follow the practice of mixing cowpeas with corn in the silo prefer to grow them separately. In filling, one load of peas is cut to two loads of corn. Cowpea silage alone is not of good quality. It undergoes a change more in the nature of rotting and does not make a palatable or satisfactory feed. Both clover and alfalfa have been frequently tried, but neither is very satisfactory on account of the poor quality of silage resulting.

Sorghum for Silage.—The next best crop to corn undoubtedly is sorghum. Almost as much feed per acre is obtained as with corn and the quality of the silage is good. Care should be taken that the sorghum is quite well matured before being put into the silo. The tendency is for an excessive amount of acid to be formed, due to the large amount of sugar present in the cane.

Kaffir Corn for Silage.—Numerous inquiries have been received in the last few years regarding the use of Kaffir corn for silage. This crop is more closely related to the sorghum plant than to the corn plant and when used for silage makes a quality of feed somewhat intermediate between the two. It can be recommended only in those sections of the country where Kaffir corn can be grown to better advantage than ordinary field corn.

Stage of Cutting Crops for the Silo.—It is a well demonstrated fact that plants such as corn gather the greater part of their feeding

value after the plant is full grown. A corn plant at the time the ear commences to form contains a comparatively small amount of food and is mostly water. The greater part of the food value of the plant is formed from this time until the ear ripens. If corn is cut to be put into the silo at too early a date some of the feeding value is lost since the plant has not had time to mature sufficiently. Furthermore, it is found that when immature corn is used the silage is too sour. The proper stage to cut corn is when it shows the first sign of ripening. In a year of normal rainfall this is when the husks first begin to turn yellow at the end of the ear, while the leaves of the plant are still green. At this time the kernels are entirely past the milk stage and are glazed and dented. Silage made from such corn does not develop so much acid, as when cut in a less mature stage, although it still develops a sufficient amount to preserve it. If the corn crop gets past this point before it is possible to put it into the silo, and the leaves or husks are dried it is always advisable to add some water. The cut corn as found in the silo at filling time should feel moist to the touch. Corn can be put into the silo with reasonable success even up to the time when the leaves are nearly all dry, provided a sufficient amount of water is used to properly wet it up. No bad results follow the use of too much water. It means that there will be more water to carry out with the silage when fed. On the other hand if too little water is used the silage may spoil by the formation of mould. For this reason it is advisable to be on the safe side and use too much rather than too little water. The water may be added to the silage at the time of filling by running it into the blower with a hose from a barrel, or, if convenient, it may be added to the silage in the silo as the filling progresses. In putting kaffir corn or sorghum into the silo the seed should be past the milk stage and the stalks beginning to show the first sign of ripening. If a crop of corn, sorghum, or kaffir corn becomes frosted, it is well to go ahead with the work using an abundance of water so as to moisten the entire mass properly.

The Filling of the Silo.—When corn is used for silage the entire plant including the ear is cut into about one-half inch lengths using a large power cutter for the purpose. A large cutter which permits of filling the silo rapidly is the most economical of labor. It is advisable for three or four farmers located close together to buy a silage cutter together. Then by helping each other they are able to fill the silos for the group with the minimum expense. The cutters used to fill medium to large size silos have a capacity of from 10 to 15 tons per hour. From 4 to 6 teams are required to haul the

corn from the field, depending upon the distance and other conditions. The corn may be cut in the field with a corn binder if one is at hand, or may be cut by hand and thrown in piles. The cost of filling a silo has been found to vary from 50 cents to $1.00 per ton depending upon the machinery used, the yield of corn per acre, the distance hauled, and upon how the work is organized and handled. With good organization and machinery the cost should not be more than 75 cents per ton.

The silage settles about eight feet in a silo 30 feet high and for this reason where rapid filling is practiced the silo will not be full after it has settled unless filled a second time. If it is convenient to allow the machine to stand two or three days for the silage to settle, it may be filled and most of the capacity made use of. Where no special form of distributor is used in the silo, there is a tendency for the heavier pieces of ears to drop in one place while the leaves and stalks are thrown a greater distance. In order to keep the silage of a uniform composition the portion richer in grain should be distributed over the surface of the silo as the filling progresses. It is especially important to make certain that the silage is packed closely around the walls since this is where the air gets in and where the spoiling takes place. The wall must be smooth to make as little friction as possible in settling. While the silo is being filled, one man, at least, and preferably two, should work in the silo constantly distributing the silage and packing it. The outside next to the wall should be kept higher than the center and should be constantly tramped. There is no necessity for tramping the middle as it will take care of itself. When the filling is completed the top should be leveled off and tramped down as thoroughly as possible over the entire surface. The upper layer should be thoroughly wet with water in some way. This can be done by running the water into the blower as the last few tons are run in, or by putting it into the silo after the filling is completed. The idea is to form an air-tight layer over the top to prevent the silage from spoiling. Some advocate the use of cut straw thoroughly wet on the top of the silage. It has also been suggested that after the silage is thoroughly wet down, oats be sown on top. These will soon sprout and assist in sealing up the silo more quickly.

Feeding Silage.—The feeding of silage may be begun if desired as soon as the filling is completed and under these conditions there need be no loss. However, the fermentation is not completed at that time and the corn first fed does not have all the characteristics of silage, but is perfectly safe to feed. When the owner wishes to

begin feeding, the rotten layer at the top is first removed until a good quality of silage is found. The silage is always taken from the top and the surface should be kept level. At least two inches per day should be taken off to make certain that spoiling will not take place. Spoiled silage should be rejected. If the silo is properly constructed and if the filling has been properly done, however, there should be little loss from spoiling.

Silage Spoils in Two Ways.—One is in the nature of rotting, and silage that shows this type of spoiling has the appearance of rotted manure. This kind of spoiling indicates that air has gained access to the silage. The other kind of spoiling often found is the formation of a white mould. This generally indicates that the silage was too dry and this loss could have been prevented by the addition of more water at the time of filling. If there is a layer of spoiled silage around the outer edge it indicates that the walls of the silo are not air tight or that sufficient tramping was not done in filling.

Sources of Information in Regard to Building Silos.—The following are the names of various publications that may be secured giving specific directions for the building of different types of silos. Information concerning the stave silo may be secured from any of the many companies having them for sale. Information concerning concrete silos may be secured from the various manufacturers of cement.

USE OF SILAGE IN GENERAL.

Silos and Silage—Farmers' Bulletins, 32, 222, 267, U. S. Department of Agriculture, Washington, D. C.

CONCRETE SILOS.

Bulletin 214, Wisconsin Agri. Exp. Sta., Madison, Wisconsin.

GURLER OR CEMENT PLASTERED SILOS.

Circular No. 48, Missouri Experiment Station, Columbia, Mo.

Bulletin 102, Illinois Experiment Staton, Urbana, Illinois.

THE STAVE SILO.

"How to Build a Stave Silo," Circular 136, Bureau of Animal Industry, U. S. Department of Agriculture, Washington, D. C.

OTHER CIRCULARS ON SILOS.

Cost of Filling Silos, Farmers' Bul. 292, U. S. Dept. Agric.

Modern Silo Construction, Bul. 100, Iowa Exp. Sta., Ames, Iowa.

The Iowa Silo (Use of tile), Bul. 117, Iowa Exp. Sta., Ames, Iowa.

Reinforced Brick Silo, Bul. 129, W. Virginia Exp. Station, Morgantown, W. Va.