THE SILO AND ITS USE

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COLLEGE OF AGRICULTURE

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(2)
The Silo and Its Use

C. H. Eckles

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 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 twenty-five 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.

It is not definitely known who built the first silo in Missouri. Corn silage has been fed regularly at the College of Agriculture since 1887. At present there are a large number of silos in use in Missouri but data are not at hand to make possible an estimate of the number. There are localities where twelve to fifteen have been built within a radius of four or five miles. A number of silos in the state have been in regular use for from ten to fifteen years. A farmer near Calhoun has used a silo for more than twenty years. These facts should help to remove the common idea that the silo is new and still in the experimental stage.

Advantages of the silo.—There are several 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 present 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 per cent of the food value of the corn crop is taken with the ears, while 30 to 40 per cent 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 department of soils gives the figures 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.

<table>
<thead>
<tr>
<th>Yield of corn bushels</th>
<th>Yield of silage tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>6</td>
</tr>
<tr>
<td>40</td>
<td>8</td>
</tr>
<tr>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>60</td>
<td>12</td>
</tr>
<tr>
<td>80</td>
<td>16</td>
</tr>
<tr>
<td>100</td>
<td>20</td>
</tr>
</tbody>
</table>

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 livestock 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 the same 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 corn is put in the silo it is handled but once and then under the most favorable conditions. 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. If the silage is not needed during the summer months, the silo may be refilled in the fall after a layer of rotten material which will be found on top has been taken out. 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 is to have a large silo for winter feeding and a small one for summer use. Some dairymen in the state were fortunate enough to have silage on hand during the recent dry summers and report that they were able to maintain the flow of milk from their herds practically as well as if the cows had been on good pasture.

Size of silo to build.—The size of the silo to build 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 two 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 sixteen 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 pounds per day. Feeding 30 pounds per day will require 900 pounds per month per animal, or about 5400 pounds to feed each animal six months. The figures in Tables 1 and 2 give a general idea of the size of silo needed for herds of from 10 to 50 cows. It is assumed that 40 pounds will be fed per day to each animal.

**Table 1.—Relation of Size of Silo to Length of Feeding Period and Size of Herd**

<table>
<thead>
<tr>
<th>Number of cows in herd</th>
<th>Feed for 180 days</th>
<th>Feed for 240 days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Size of Silo</td>
<td>Size of Silo</td>
</tr>
<tr>
<td></td>
<td>Estimate of silage consumed tons</td>
<td>Diameter feet</td>
</tr>
<tr>
<td>10</td>
<td>36</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>43</td>
<td>10</td>
</tr>
<tr>
<td>15</td>
<td>54</td>
<td>11</td>
</tr>
<tr>
<td>20</td>
<td>72</td>
<td>12</td>
</tr>
<tr>
<td>25</td>
<td>90</td>
<td>13</td>
</tr>
<tr>
<td>30</td>
<td>108</td>
<td>14</td>
</tr>
<tr>
<td>35</td>
<td>126</td>
<td>15</td>
</tr>
<tr>
<td>40</td>
<td>144</td>
<td>16</td>
</tr>
<tr>
<td>45</td>
<td>162</td>
<td>16</td>
</tr>
<tr>
<td>50</td>
<td>180</td>
<td>17</td>
</tr>
</tbody>
</table>

**Table 2.—Capacity of Silos of Varying Sizes**

<table>
<thead>
<tr>
<th>Depth of silage feet</th>
<th>Inside diameter of silo in feet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Tons</td>
<td>Tons</td>
</tr>
<tr>
<td>25</td>
<td>36</td>
</tr>
<tr>
<td>28</td>
<td>40</td>
</tr>
<tr>
<td>30</td>
<td>44</td>
</tr>
<tr>
<td>32</td>
<td>50</td>
</tr>
<tr>
<td>34</td>
<td>53</td>
</tr>
<tr>
<td>36</td>
<td>57</td>
</tr>
</tbody>
</table>
Material used for building silos.—For the last fifteen years practically all silos built have been cylindrical, 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 that the silage can settle properly, and a structure sufficiently strong to hold the enormous pressure of the silage, and one 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, tile, wood, brick and iron. It is not the purpose of this bulletin to give details for construction of silos but rather to give information regarding the subject in general and somewhat in detail of the first four 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 and requires 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 statement regarding the average number of years wood will remain without decay is supplied by the Bureau of Forestry, United States Department of Agriculture.

<table>
<thead>
<tr>
<th>Species</th>
<th>Average number years of life untreated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cypress</td>
<td>14</td>
</tr>
<tr>
<td>Redwood</td>
<td>14</td>
</tr>
<tr>
<td>Douglas fir</td>
<td>10</td>
</tr>
<tr>
<td>Yellow pine</td>
<td>8</td>
</tr>
<tr>
<td>White pine</td>
<td>8</td>
</tr>
</tbody>
</table>

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 last from ten to fifteen 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 16 by 32 feet will cost about $350 at present. The foundation and cost of erection are not included in this estimate.

The concrete silo.—The concrete silo may be built of blocks or with solid walls. The latter type 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 one with a wooden wall. 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 true that both these conditions have been met in a few cases.

Reinforced solid concrete silo.—This silo, 16 by 34 feet, is located at Columbia, Mo., on the farm of Marshall Gordon. It has been filled six times and the silage has kept perfectly. When properly built this type of silo is fire and storm proof and will last indefinitely.

Among the several hundred concrete silos which have been built in this state, the writer has heard of but three which have cracked. In one case no reinforcement was used, and in the other two the amount used was entirely too small. If the concrete silo is properly reinforced, there is not the least danger of its cracking or falling down. There is no more danger of silage spoiling by moulding in a concrete silo than in one built of any other material. If the corn is put into a
concrete silo without containing sufficient moisture, there is danger of mould developing next to the wall. This condition is just as certain to develop in a silo made of any other material, provided the conditions under which the corn is put in are the same. In building a concrete silo, it is important to make sure that sufficient cement is used to make the wall impervious to air. It is a good plan to go over the inside wall of a concrete silo every year, or at least every second year, before filling, with a mixture of cement and water. This mixture should be about the thickness of whitewash. This helps to close up the pores of the wall and to exclude air. In case a silo has been constructed from concrete that is too porous, possible trouble from mould next to the wall may be avoided by applying a cement and water mixture as described. It is also well in a case of this kind to wet the walls of the silo thoroly as the silage is put in to prevent the absorption of the water from the silage.

Cost of a concrete silo.—The cost of this type of silo will vary more in different localities than that of a stave or Gurler 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 materials required in a cubic foot of the 1 :2 :4 mixture are .058 barrels of cement, .0163 cubic yards of sand, and .0326 cubic yards of gravel or stone.

Table 3 shows 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.

<table>
<thead>
<tr>
<th>Silo</th>
<th>Cement, barrels</th>
<th>Sand, cubic yards</th>
<th>Gravel, or stone, cubic yards</th>
</tr>
</thead>
<tbody>
<tr>
<td>12x28 ft.</td>
<td>37</td>
<td>11</td>
<td>21</td>
</tr>
<tr>
<td>14x30 ft.</td>
<td>45</td>
<td>13</td>
<td>26</td>
</tr>
<tr>
<td>16x32 ft.</td>
<td>55</td>
<td>15</td>
<td>30</td>
</tr>
</tbody>
</table>

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 tile silo.—This type of silo has become popular within recent years. It has the same advantages as concrete in respect to durability, safety from fire and storms. When properly erected from good material it is a permanent structure, and at the same time pre-
serves silage as well as other types. It should receive consideration especially from the man who desires to build a permanent silo but who is not located where material for concrete is close at hand. The material used in this kind of silo is hollow vitrified tile blocks. When properly erected, the walls are smooth and impervious to air and moisture, which insures proper preservation of the silage. The blocks are curved to make the wall smooth inside. Reinforcement is used in the form of heavy wires or iron bands. The reinforcement is placed in the mortar between the blocks or in a groove in the block made for this purpose. The tile silo is erected on a concrete foundation and the bottom may be two or three feet below the level of the ground if preferred.

This type of silo is erected without the use of expensive forms but requires scaffolding and the services of a person familiar with the work of a mason. As a rule a local mason should be hired to erect the walls, and the directions issued by the company from which the tile is purchased should be followed carefully.

Blocks for tile silos are shipped at low freight rates and may be easily had at any railroad point in the state. The price for material is about the same as or a little higher than for a wooden stave silo of the same size. The expense of erection, however, is more than for the stave silo. As a rule the cost will not be far different from that of a monolithic concrete. Where material for concrete is close at hand and proper supervision can be had at a low cost the concrete silo will probably be less expensive. Where all material has to be shipped the tile will ordinarily be the less expensive.

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 are purchased at a lumber yard at current prices, a silo 16 by 32 feet will not cost more than $150 for materials, including the roof and foundation. The total expense including labor need not be more than $250. A silo of this kind keeps the silage as well as any. It has the same disadvantage in regard to durability as 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 ten to fifteen years, depending upon the lumber used and how well it is protected.

Crops for the silo.—The silo has been tried as a means of preserving practically all the common crops grown on the farm. How-

7Directions for building a Gurler silo are found in Circular 67, Missouri Agricultural Experiment Station.
ever, 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

Gurler or plastered silo.—This silo, 16 by 32 feet built at the University of Missouri in 1896 and partially rebuilt in 1903 after blowing down, gave excellent results. It was taken down after 16 years of service. The studdings were covered on the outside with sheet iron.

of total nutrients per acre of this crop is greater than ordinarily is 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 by growing it in the same way that it is grown for 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 obtained 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. 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 except that it is difficult 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 for each 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 which results.

Kaffir corn for silage.—This crop stands next to corn in quality of silage produced. It is used successfully in those sections where lack of rainfall makes it a safer crop than corn. The feeding value of silage from this crop is only slightly below that of corn. Care should be taken that the kaffir is well matured before it is cut for silage. This crop is successful as far as the quality of silage is concerned, and whether it should be used depends on whether or not it is better adapted than corn to the particular locality in question.

Sorghum for silage.—This crop stands third in value for silage and in Missouri ranks second only to corn. Almost as much feed per acre is obtained as with corn, and the quality of the silage is good. Recent experiments indicate that the feeding value of sorghum is only slightly below that of corn. The yield per acre is about the same as corn under good conditions, or occasionally may be even more. Sorghum should be well matured when put in the silo. As a rule it is not ready to be cut until about two weeks after corn is ready. The seed should be hard at this time, but the stalk still filled with juice. If the crop is frosted before it is cut, it should be put in the silo as soon as possible, and sufficient water should be added to make the entire mass wet. If the sorghum is put into the silo too early a strongly acid silage results.
Stage of cutting crops for the silo.—It has been demonstrated that plants such as corn gather the greatest part of their feeding value after the plant is full grown. A corn plant at the time the ear begins 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 too early some of the feeding value is lost, since the plant has not had time to mature sufficiently. Furthermore, 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, altho it still develops a sufficient amount to preserve it. If the corn crop gets past this stage before it is put into the silo, and the leaves or husks are dried, it is always advisable to add some water. The cut corn in the silo at filling time should be moist. 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 wet it properly. 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 mould. For this reason it is advisable to use too much rather than too little water. The water may be added to the silage at filling time by running it into the blower with a hose, or, if convenient, it may be added to the silage in the silo. 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 has been frosted, it is well to use an abundance of water on the silage to moisten the entire mass properly.

Filling the silo.—When corn is used for silage, the entire plant including the ear is cut into about one-half inch lengths with a large power cutter. A large cutter which permits filling the silo rapidly is the most economical. It is advisable for three or four farmers to buy a silage cutter together. Then by helping each other they are able to fill the silos for the group at minimum expense. The cutters used to fill medium to large size silos have a capacity of from ten to fifteen tons per hour. From four to six teams are required to haul the corn from the fields, depending upon the distance and other conditions.

Another plan which is followed with advantage, and is preferred by some, is to use a small outfit, and fill the silo by making use of the labor ordinarily employed on the farm. A small cutter with a chain elevator in place of a blower can be purchased for less than one-half the expense of a large outfit and may be operated with a seven to ten horsepower gasoline engine. By using an outfit of this kind, an average silo can usually be filled in four or five days, and without requiring a large force. Another advantage of following this plan is that most of the settling takes place while the filling is in progress, which makes it possible to put in a larger quantity. The corn may be cut in the field with a corn binder or a one-horse sled-type cutter, if one is at hand, or it 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 thirty feet high and for this reason where rapid filling is practiced the silo will not be full after the silage has settled. If it is convenient to allow the machine to stand two or three days for the silage to settle, the silo may be filled again. 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. 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 a 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. Since silage spoils only when exposed to air, the air should be excluded as quickly as possible from the surface when the filling is completed. Several plans are followed with success. The simplest is to wet the surface thoroughly and tramp it as firmly as possible. 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 silage should then be tramped firmly against the wall once each day for several days after the filling is completed. Thorough wetting of the surface and plenty of tramping reduces the loss. Some make a practice of running two or three loads of grass or weeds in on top of the silage. This heavy green material helps to form a layer which will exclude the air quicker than the corn itself. The object is to form a heavy, wet layer which protects the silage below from the air. From six inches to one foot of silage will usually spoil under the best conditions. 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.

Spoiling of silage.—Silage spoils almost entirely as the result of mould. Mould requires the presence of air before it can develop. The main factor in preserving silage, therefore, is a complete exclusion of air. The air cannot be entirely excluded unless the material is wet. If air is present, the mould develops and is usually seen as a white growth. If the growth of mould continues for some time, the silage rots and has the appearance of rotten manure. Spoiled silage always indicates the presence of air. While the lack of water is the most common cause of air being present, it may also enter thru cracks or thru a porous wall. Another cause of spoiling is the lack of sufficient trampling next to the wall during the filling.