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TRENCH and STACK SILOS

Purdue University
Agricultural Extension Service
LAFAYETTE, INDIANA
TRENCH AND STACK SILOS

By I. D. Mayer

Increased interest in roughages has also increased the need for silos for storing these roughages, particularly the grasses and hay. Poor haymaking seasons for the last several years have emphasized the need for improved methods of preserving the first crop. The difficulty in handling the first cutting will probably be with us for some time because we are not only increasing the acreages of hay, but also they yield per acre. Grass-legume silage appears to be one solution. Consequently, interest in trench silos and stack silos as low initial cost storages has increased tremendously in the past few years.

Stack and trench silos are not new. The canning industries have made stack silos of pea vines successfully for many years, but their methods were hand operation, stacking it with the pitchfork, packing the silage by trampling. Most farmers are not willing to spend this much labor to conserve their hay or their corn crops. Consequently, stack and trench silos should be so designed that mechanical equipment can be used for placing the material in the stack, for packing it and for removing it for feeding.

Size and shape of the stack should be governed by local conditions, that is, the terrain of the soil, the number of cattle to be fed, the quantity to be fed daily and the length of the feeding season. It is desirable to remove at least 3 inches of silage from the vertical face of the trench or stack each day or an average of 3 inches each day in order to prevent excessive spoilage. Consequently, the cross-sectional area of the stack or trench should be governed by the quantity of silage to be fed daily. In calculating this area, use 35 to 40 pounds per cubic foot of silage depending upon the type of material in the silo. The actual weight per cubic foot, of course, will vary depending upon the moisture content of the material, the fineness of cut, the amount of compaction and also upon the depth of the stack. Usual practice is to determine the cross-sectional area of the stack or trench by the quantity of silage to be fed daily and the length of the stack determined by the number of days to be fed allowing a minimum of 3 inches per day.

A trench silo is usually considered as one with earthen or masonry side-walls. The common conception is a trench dug into the side of a sloping area. This trench need not, however, conform to the slope of the soil or be entirely submerged in the slope. It may be only partially beneath the original grade or ground surface. The soil which is removed from the trench is piled up on the sides to extend the height of the silo walls. Frequently, baled straw is placed along the upper edge of the trench and the soil is built up behind the bales to extend the silo. This makes the silo only 2 or 3 feet below the normal ground level. This type of construction may be desirable because it may facilitate drainage which is one of the essential factors of a trench silo. This drainage may be accomplished by the slope of the floor or may be accomplished by drain tile laid along the edges of the floor of the silo or under the middle of the floor of the silo. This tile should, of course, be connected with good outlets. For natural drainage, silo floors should have a slope toward the outlet of approximately one foot for each fifty feet of length of the silo, but never less than 6 inches for each 50 feet. It is desirable to have this slope towards the end from which the feeding is to be done so that the area in which the unloading of the silo is to be carried out will be a well drained area. Since most of the unloading is to be done during the winter season when rain and snow are prevalent and drying out is slow, adequate drainage is necessary if tractors or trucks are to be used for removing the silage. It is usually desirable to crown the floor of the silo so that drainage will be toward the sides, unless the tile is placed in the middle of the floor.
Trench Silo Construction:

A trench silo can be constructed with a number of different types of equipment, but the backhoe or trench hoe mounted on a truck or on caterpillar treads provides one of the best tools for digging the trench to grade and side wall specifications. A bulldozer is frequently used to dig out the soil and to pile it along the sides of the bank. Draglines have been used with success, but usually more trimming is necessary after the dragline has completed its portion of the job than when the backhoe is used. Smaller tools such as manure loaders, tractor scoops or slip scoops have been used with success, but the operation is much slower and usually more costly if labor is hired or if the going value is placed on farmer labor. A good power-machine operator can construct a 150 to 200 ton silo in less than one day. This usually makes a rather low cost storage. However, these earthen silos do require some annual maintenance, depending largely upon the erosion resistance of the soil after the silage is removed. Freezing and thawing, rains, snow and wind tend to make trench silos with earthen banks somewhat larger each year. This may be a determining factor in the type of silo to construct if the herd is small.

The banks of the earthen trench should be sloped slightly, the grade depending upon the type of soil. A slope of one foot horizontal to 4 feet of vertical depth is sufficient for most soil. It may be necessary to revise the slope slightly after the silo has been used for a year or two.

The placing of bales of hay or straw along the upper edge on the natural soil will tend to reduce erosion to some extent, particularly the first few years until the banks of the silo are well established.

Provisions should be made at both ends of the silo, if possible, for driving through with the loaded wagons or trucks at the time of filling. It may be desirable in some cases to construct a concrete wall at one end of the trench with the idea of backing the loads up to this wall and dumping the silage over the wall until the silo is sufficiently full to drive over it. One end should always be prepared for taking out the silage in wagons or trucks or with a tractor. Do not slope the floors so that you go down into the silo as you unload. The slope should be such that when entering you go slightly up into the silo. This will provide adequate drainage and better footing at the time of unloading. The following table indicates suggested dimensions of silos for various herd sizes, assuming feeding at the rate of approximately 35 pounds of silage per animal per day.

SIZE OF TRENCH SILO TO BUILD

on basis of corn silage, feeding 35 lb. of silage per animal per day for 180 days and with silage averaging 35 lb. per cu. ft.

<table>
<thead>
<tr>
<th>No. of animals</th>
<th>Silage needed (Tons)</th>
<th>Depth (ft)</th>
<th>Width Top (ft)</th>
<th>Width Bottom (ft)</th>
<th>Length at top (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>16</td>
<td>6</td>
<td>8</td>
<td>6</td>
<td>23</td>
</tr>
<tr>
<td>10</td>
<td>32</td>
<td>8</td>
<td>10</td>
<td>7</td>
<td>28</td>
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<tr>
<td>15</td>
<td>48</td>
<td>8</td>
<td>12</td>
<td>8</td>
<td>36</td>
</tr>
<tr>
<td>20</td>
<td>63</td>
<td>8</td>
<td>12</td>
<td>8</td>
<td>47</td>
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<td>12</td>
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<td>35</td>
<td>111</td>
<td>8</td>
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<td>8</td>
<td>81</td>
</tr>
<tr>
<td>40</td>
<td>126</td>
<td>8</td>
<td>12</td>
<td>8</td>
<td>92</td>
</tr>
<tr>
<td>50</td>
<td>158</td>
<td>8</td>
<td>15</td>
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<td>99</td>
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<tr>
<td>100</td>
<td>315</td>
<td>10</td>
<td>17</td>
<td>12</td>
<td>126</td>
</tr>
</tbody>
</table>
The exact dimensions for width and depth of the trench or stack may, of course, be varied to meet local conditions. Do not, however, make the average width of the silo less than one and one half times the width of the wheel spacing of the tractor or implement which you expect to use to compact the silage. It is necessary that the entire surface be compacted uniformly. Do not make tracks through the silo. The ends of the silo may be constructed so that you can drive in and out readily, but they may be closed in with a bulkhead of timber or baled straw or hay held in place with stakes or braces to reduce spoilage. Waterproof paper behind this bulkhead will reduce spoilage to a minimum. It will, however, be necessary to do some hand compaction along this bulkhead in most cases.

If the trench silo is to be made a permanent structure, or if some difficulty is being experienced in maintaining the silo walls to the original or desired shape of the silo, the walls may be reinforced with masonry or timbers. It may be plastered with a concrete plaster one or two inches thick if the soil is well-drained. If, however, there are some moisture problems in the soil, the masonry walls should be about 4 inches thick and should be reinforced with welded steel reinforcement. Thicker walls may be necessary under extreme conditions. The walls may be constructed out of Monolithic concrete, concrete block, concrete staves or clay block or bricks. The material which is most available would probably be the most economical. This wall may be extended above ground if it is properly reinforced and protected by pilasters, if pressures are greater than masonry can withstand without reinforcement. Wooden wall linings are satisfactory for limited periods only, because the wood will decay quite rapidly under silage. However, temporary use of wood lining may help to stabilize the soil so that future service may not require additional lining. The wooden lining should be held in place sufficiently with cross-ties to prevent slipping during loading and unloading of the silo. These cross-ties may be temporary so that the wood lining may be removed readily or they may be put in more or less permanently.

Some trench-type silos have been built entirely above ground out of reinforced concrete. In such cases, the reinforced concrete floor approximately 4 to 5 inches thick was laid as the silo floor and frequently as part of a feeding floor. The surface of this floor may be oiled or building paper laid down, and reinforced concrete wall slabs constructed on the floor, to be tipped up into wall position by a crane as a manure loader. Manure loaders will not handle very large slabs. The auto wrecker is frequently used for this purpose and gives very satisfactory results. Be sure to supply some method of holding the wall sections, either with clamps, hooks, holes or chains or other attaching devices. It should be possible to hold the wall sections in place long enough to stabilize the slabs and line them into the wall satisfactorily. It is usually necessary to leave small openings between the wall slabs so that a pilaster can be constructed to tie the sections together and also to reinforce the wall. If such a construction is to be used, detailed construction designs should be obtained from an engineer.

The floor of the silo should be of such material that year round access will be possible. In sandy or gravelly soils, no additional treatments may be necessary. In clay or loam soils, it is usually desirable to have some waterproof type of surface for the floor and have the floor crowned the same as a highway. Drain tile placed along the edge of the floor just below the floor level will assist in maintaining a dry floor. Gravel or crushed limestone have given good results if traffic was not heavy and the sub-soil was not too wet. In some locations, concrete or asphalted the floors have been found necessary for satisfactory removal of the silage. These floors should be well constructed on a well drained base and have sufficient strength to maintain the load which you expect to place upon it. This usually means a concrete floor not less than four inches thick reinforced with welded wire or a Monolithic concrete floor six inches thick. An asphalt floor should be about 6 inches thick.
SURFACE SILOS

The surface mound or stack silo is little more than a compacted haystack. It should be located on a well drained area and should be so located that it will be convenient to take the silage out in the wintertime. Drainage is very essential. The size and shape of this stack should be determined much the same as that for the trench silo. It is advisable to have some type of retainer such as a low wall of soil, a fence, or a concrete retaining wall to prevent the silage from squeezing out as it is compacted and also to make it possible to get your compacting implements to the edge of the silage stack. These retainers may be permanent or they may be of a temporary nature such as a fence which can be removed after the stack has been completed. If retainers of some type are not provided, it is difficult to hold the stack to the desired size and it is also very difficult to compact the silage along the edges. Lack of thorough compaction will usually result in excessive spoilage.

An above ground trench or stack which appears to be quite satisfactory is made by erecting a pair of fences of heavy planking usually along the edges of a feeding floor. These fences are to be used as retainers for an above ground trench or stack. These heavy poles and planking may be set up permanently or they may be of a temporary nature. If the silage is placed on a masonry floor, this same floor can be used for the feed bunks as the silage is taken out. Some efforts have been made toward self-feeding, but there are problems of feeding the silage rapidly enough to prevent spoilage and still allowing sufficient space for the cattle to get up to the silage.

Surface drainage must be provided to make certain that water does not enter the silo from the ends or the sides because excess moisture will result in dark-colored, strong smelling, sour silage. Diversions above a trench silo and a small dike or ditch around the silo should be constructed to divert the water, but care must be exercised to be sure that the water does not reach the entrance of the silo. Building up the silo walls above normal ground level is a good way to prevent surface water from entering the silo.

Filling the silo:

When filling either a trench or a stack silo, compaction is important. Level and pack every load or you will have difficulty getting into the silo and may have excessive spoilage. When cutting grass silage particularly, cut the silage as short as your machine will permit. While the shorter cut silage requires more power, it increases the ease of compaction and also makes it easier to remove the silage. Excluding the air is important and compaction is necessary because the depth of the stack is not sufficient to eliminate the air. While long hay can be ensiled, it is quite difficult to compact it and extra labor is required to do a good job. It is also difficult to remove long silage unless you have a chain saw or some similar implement.

The best silage is made at a moisture content between 65 and 70 percent. There is, however, a greater hazard in making silage which is too dry than too wet because the drier silage will not compact sufficiently to exclude the air. While adding moisture is possible, it is not very satisfactory, particularly in the grasses. Moisture can be added to corn silage more readily because it takes the moisture more uniformly and thoroughly. Consequently, if you are using the wilted silage method, be sure that you do not mow too much ahead of the cutter and do not permit the forage to dry too much. This is particularly true for the material on the top of the stack. Some operators use wilted silage for the lower part of the stack, but use direct cut forage for the upper three or four feet.
While many types of equipment can be used for placing silage into the silo, it is usually desirable to use the wagons or trucks for hauling as part of the compacting operation by driving through the silo. This will require that compaction be continuous or you will not be able to drive through with the loaded vehicle. Self-unloading wagons, dump trucks, dump wagons and wagons with false end-gates have given very satisfactory results when properly operated. Some skill on the part of the operator is necessary for good trouble-free filling.

In cool fall weather, it may be desirable to build more slowly or to allow the silage, particularly legume silage, to stand one or two days to build up back temperatures. In warm weather, this is not a factor, but in cool weather you may get too much buteric action if the stack is filled rapidly and not allowed to warm up. The warmth in silage action is desirable.

Some might be interested in constructing a temporary silo or stack silo using the stationary filler or blower to make a silo rather tall but of small horizontal cross-section using snow fence or welded wire to retain the stack. This is a satisfactory method for small tonnage. The silage should be placed in the silo in layers as nearly level as possible with extra compaction being given around the outside edges. The wire or slat cribbing may be lined with waterproofed reinforced paper to reduce spoilage.

We would like to caution against making this type of silo taller than its width or diameter. This type of silo should be placed on level soil and care should be exercised to keep the side walls vertical. This makes an excellent addition to storage in the permanent type of silo or for the tenant farmer who is not privilege to construct permanent silage storage facilities.

Sealing or topping out the silo:

The trench or stack silo should be compacted for one or two but not to exceed three days after filling ceases. Crown the top of the stack or trench to a rather smooth surface, but one that will shed water to the outside of the silo. Do not permit this surface runoff to enter into the trench. The top of the silo will have spoilage in proportion to the amount of air which is admitted to the silage. thorough compaction reduces this to a minimum, but covering the silo with some impervious material will assist in reducing the surface spoilage. A waterproof paper held down with either soil or agricultural limestone makes a very good seal. This is particularly effective on corn silage, but some deterioration of the paper may be expected over the long summer period for grass silage put up in June. Agricultural limestone placed over the paper reflects heat, holds the paper down, adds weight for compacting the silage, and gives a very effective seal. The limestone can be used for spreading on the soil after it has been used. If a little of the limestone gets into the feed, no harm results. The use of soil has long been standard practice on trench silos, particularly if the storage was to be for a long period, such as storing surplus crops during a season of abundance for a season of drought or crop failure. Soil over the silage, however, requires considerable labor in placing it on the silage and also in its removal. Some objection has been expressed to the quantity of labor required for this purpose and to the soil which gets into the silage. Poor quality hay, corn stalks without ears, or sawdust have been used for tops or covers with some satisfaction. The reduction of spoilage is dependent on the depth of the material used for coverage. Be sure that the covering materials extend out over the edges of the silo so that the moisture will not run in along the silo walls.

Unloading the silo:

In removing silage from a trench or stack, it is desirable to cut the silage
PLANK LINED TRENCH

Fig. III

Trenches may be made semi-permanent by lining them with wood. Two-inch rough lumber can be used safely provided the depth of the pit is not greater than six feet below grade. The use of wood preservatives is recommended. Paper lining must be used to prevent infiltration of air.

CONCRETE SLABS

Fig. III

Concrete slabs are suitable for the more permanent type of wall lining. Reinforcement, both in the ribs and slab, is recommended to lessen breakage. A concrete floor is essential to hold the bottoms of the slab in place. The floor is placed first. After hardening the slabs are cast on the floor with paper between.

MASONRY LINED TRENCH

Fig. III

Masonry makes a permanent lining. The walls are usually 10 to 12 inches in thickness. They may also be built as a retaining wall. This would permit a vertical or nearly vertical face. Mortar should be used in the mortar used in laying the masonry.
CONCRETE RETAINING WALL

FIG. VIII

RETAINING WALLS OF CONCRETE, IF OF GOOD CONSTRUCTION, SHOULD LAST INDEFINITELY. A WALL SUPPORTING AN EARTH BANK 8' 0" HIGH SHOULD BE AT LEAST 2' 6" WIDE AT THE BOTTOM. AS THE BASE OR FOOTING IS USUALLY CAST SEPARATELY, REINFORCING STEEL IS USED TO TIE THE TWO MASSES TOGETHER.

FORM ASSEMBLY

FIG. IX

FORMS FOR TRENCH SLABS MUST BE OILED TO PREVENT ADHESION OF CONCRETE AND FACILITATE CLEANING. FORMS MUST BE HELD IN A RIGID POSITION TO PREVENT SPREADING.

DETAIL OF JOINT

SLATER'S FELT SHOULD BE PLACED BENEATH THE FORM. THIS WILL PREVENT THE SLAB STICKING TO THE CONCRETE FLOOR WHEN BEING CAST.