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EC713 The Trench Silo in Nebraska

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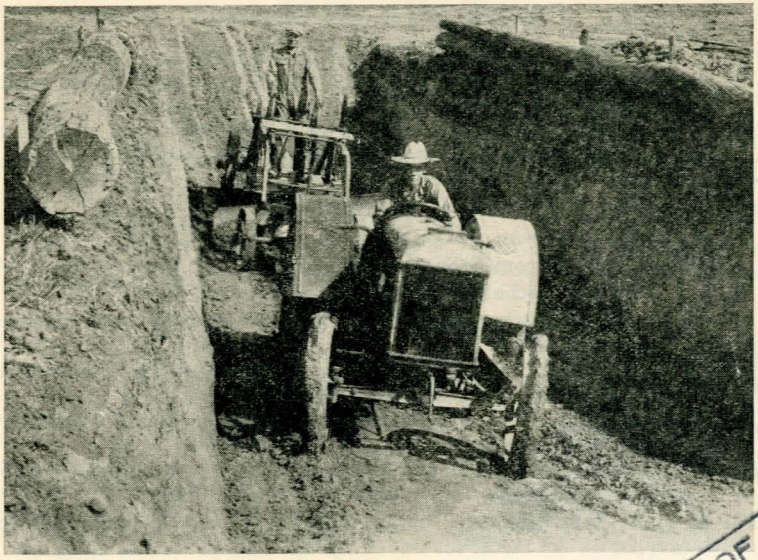

The University of Nebraska Agricultural College Extension Service
and United States Department of Agriculture Cooperating
W. H. Brokaw, Director, Lincoln

Fourteen Trench Silo Features:

1. Quickly and cheaply built for emergency use.
2. Can be built with unskilled labor and with machinery easily procured on the farm.
3. Any desired capacity can be had by increasing length of trench.
4. Can be built any place where drainage is sufficient for a house basement.
5. Not easily destroyed by storm or fire.
6. Little danger from poison gases.
7. Little trouble from frozen ensilage.
8. Can be filled without a blower.
9. Machines for cutting ensilage in field can be used without extra blower or elevator.
10. No hoisting apparatus required. Ensilage easily removed in wagons, feed carriers on tracks or feed carts.
11. Is better adapted than other silos to preservation of whole corn bundles, when ensilage cutter is not available.
12. Unless trench is lined, caving will result after first year. Open trench is dangerous and unsightly unless roofed.
13. If made too wide, the percentage of spoiled ensilage will be large.
14. It preserves ensilage with relatively small amount of spoiling if corn is cut at proper time, packed and covered with waste material such as chaff, straw, or earth.

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The Trench Silo in Nebraska

By IVAN D. WOOD AND E. B. LEWIS

The original idea of using a trench for the storing of ensilage seems to have been the outgrowth of the practice long used in several European countries of storing clover and beet tops in pits. Shorty after the World War, western Canada followed by Montana and North Dakota began to use the trench silo. In Nebraska the true trench silo made its appearance about 1925 or 1926.

Agricultural statistics for 1930 show that only about 48 per cent of the farms in Nebraska are operated by the owners, eastern Nebraska showing about 45 per cent and the western districts about 51 per cent. Many farm owners and most of the renters have felt that most all silos were too high in first cost per ton capacity. The very low first cost of the trench silo seemed to offer a partial answer.

During September 1930, two trench silos were dug at the Agricultural Experiment Station Farm, University of Nebraska, Lincoln, one at the Agronomy Farm and one at the sheep barn on the main campus. Both of these when finished had cross-sections very closely conforming to that illustrated in Figure No. 1.

Careful studies were made during construction of these silos and while filling and using the ensilage from them to obtain first hand information on features peculiar to the trench type.

Pick Well-Drained Location Near Lots

It is important that flood water from rains does not enter the trench silo. A muddy floor may cause difficulties in feeding and caving of the side walls may result from water pouring over them. In most instances, a well drained location near the feed lots and buildings can be found. A very advantageous location is one in which the trench can be excavated in a bank, yet have one end open at a lower ground level as shown in Figure No. 2. This arrangement permits excellent drainage and reduces the labor of feeding to a minimum where feed carriers or ensilage carts are used.

In some cases, it may be possible to bring one end of the trench up to the foundation of a bank barn or even to use one foundation

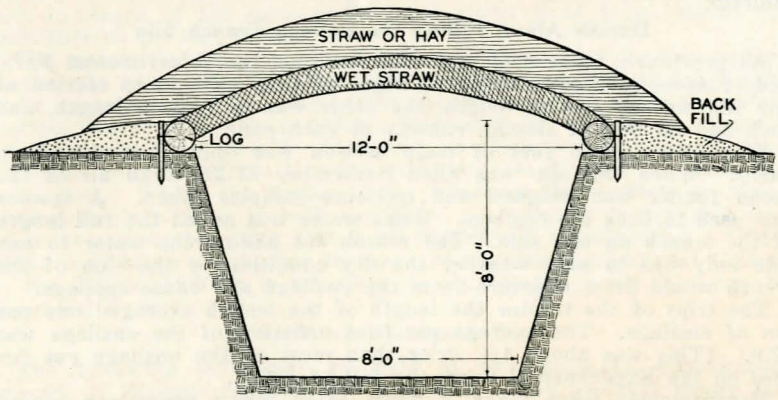

Fig. 1.—Typical Cross-Section of Trench Silos Built at College of Agriculture Experiment Farm. Logs were used to retain the back fill of earth at the sides.

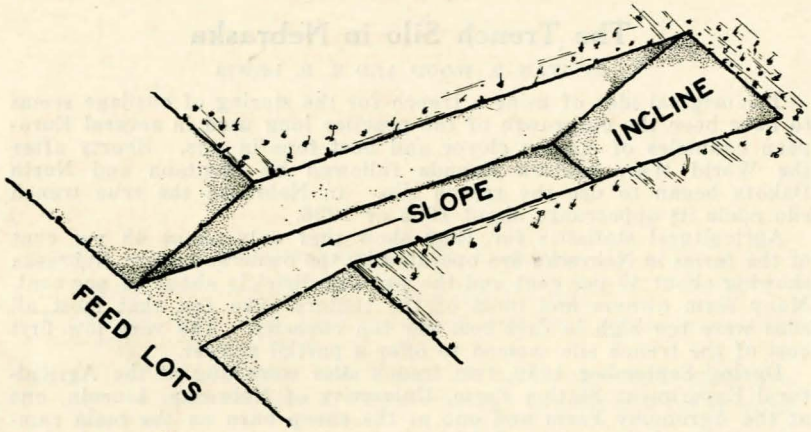

Fig. 2.—Location of a trench silo in a bank with one end opening on a lower level. This not only permits ease of filling but makes possible the use of feed carriers or carts in feeding.

wall of the barn as one side of the trench silo as shown in Figure No. 3. In most instances, it is necessary to make the excavation on fairly level ground and in this case the trench is dug with a sloping runway at either end. Even though no convenient location near the buildings can be found, it may pay well to have available the excellent feed that good ensilage provides. Wagons can be easily loaded by backing them down into the runway of the trench and the ensilage transported to the feed bunks wherever they may be located.

Where sand or gravel beds or rock ledges may be encountered, it is well to investigate the proposed location to a depth of 6 or 7 feet with a soil auger. Most of the sub-soil formations in the uplands of Nebraska stand well if some slope is given to the side walls of the trench. Where sand is present in considerable quantities, it will probably be necessary to line the side walls as described elsewhere in this bulletin.

Details About Filling the College Trench Silo

As previously mentioned both silos built on the Experimental Farm had cross-sections conforming to Figure No. 1. The deep section of one silo was 40 feet in length, the other was 75 feet in length, and each had 20 feet of sloping runway at each end.

The silo with 40 feet of main section was built near the sheep barns. When this silo was filled September 23-25, 1930 all of the green fodder was weighed and moisture samples taken. A tractor was used to pack the ensilage. Some water was added the full length of the trench on one side. The reason for adding the water to one side only was to note whether the dry condition of the side of the trench would draw moisture from the ensilage and cause spoilage.

The trips of the tractor the length of the trench averaged one per ton of ensilage. The average per cent moisture of the ensilage was 72.9. (This was about 4% drier than most of the ensilage cut for silos on the Experimental Farm the fall of 1930).

Measurements were taken 5 hours after filling operations ceased and showed the rounded ensilage to be 2 feet higher than the top of

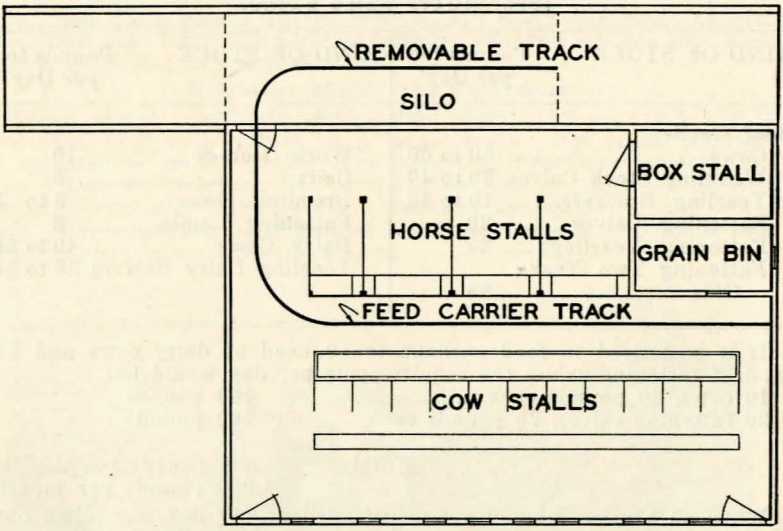

Fig. 3.—Suggestion for using one wall of the basement barn as one side of the trench silo. This places the feed near the point of consumption.

the logs at the sides of the trench. With these conditions at filling time the ensilage when settled completely filled the trench shown in Figure No. 1.

Silage Weighed 45 Pounds Per Cubic Foot

All ensilage was weighed out of this trench as it was fed and it was found to weigh almost 45 pounds to the cubic foot. The main section, 40 feet in length, held slightly more than 80 tons of ensilage and the two sloping 20 foot ends held about 26 tons. From these conditions at filling time and from weights of ensilage taken out it was shown that approximately 2 tons of ensilage were stored for every foot in length of the main trench, and about .6 of a ton stored for each foot of the end slopes.

The number of pounds of ensilage per cubic foot in this experimental silo was higher than has been generally accepted as the weight to be expected but it is believed the conditions under which the information was secured can easily be duplicated on any farm. Several have estimated the weight of ensilage in these trench silos at from 30 to 40 pounds and most of the estimates are 30 to 35 pounds per cubic foot. Where the fodder is dry when cut for ensilage or where poor packing is done or both conditions are true, it is probable that 30 to 35 pounds per cubic foot is all that should be estimated. Where filling conditions are similar to those met at the Agricultural College in the fall of 1930 it is felt that 45 pounds per cubic foot can be depended upon.

How Much Will Stock Eat?

The following table may be used to determine the approximate amount of ensilage required for any farm. The amounts shown are figured for a full allowance of ensilage and would be reduced if supplemented with considerable quantities of other feeds.

APPROXIMATE DAILY RATION

KIND OF STOCK	Pounds fed per Day	KIND OF STOCK	Pounds fed per Day
Beef Cattle			
Cows	50 to 60	Work Horses	10
Weanling Stock Calves	30 to 40	Colts	5
Yearling Stockers	40 to 45	Breeding Ewes	3 to 5
Fattening Calves	20	Fattening Lambs	2
Fattening Yearlings	25	Dairy Cows	40 to 50
Fattening Two Year Olds	35	Yearling Dairy Heifers	25 to 30

If it is desired to feed ensilage to 10 head of dairy cows and 20 head of fattening calves the requirements per day would be:

10 cows, 40 pounds each	400 pounds
20 fattening calves, 20 pounds each	400 pounds
Total	800 pounds per day or 24,000 pounds per month

When an average of 800 pounds of ensilage per day was taken out of the two experimental trench silos at the Agricultural College no waste occurred. The following table is given to aid in determining the dimensions best fitted to a farm:

CAPACITIES OF TRENCH SILOS

Depth	Top Width	Bottom Width	Capacity per Foot Length
8 feet	10 feet	6 feet	1.44 tons or 2880 pounds
8 feet	12 feet	8 feet	1.80 tons or 3600 pounds
8 feet	14 feet	10 feet	2.16 tons or 4320 pounds
10 feet	14 feet	9 feet	2.58 tons or 5175 pounds
10 feet	16 feet	11 feet	3.02 tons or 6075 pounds

These data are based on 45 pounds per cubic foot. In the main 40 foot section of the trench near the sheep barns the ensilage weighed out 80 tons or 2 tons per foot of length instead of the 1.8 tons shown in the table. The weight of the ensilage in the deep section with quality considered good enough to feed sheep was 50 pounds per cubic foot. This included none of the discolored or burned out ensilage on top which was light in weight.

Dig Silo With Farm Tools and Labor

A trench silo is well adapted to emergency use because it can be quickly constructed when a corn crop is drying up or has been frosted before maturity. The tools and equipment necessary to construct one may be found on most every farm. One man with a plow, slip scraper and a spade could do the job if the time element were not important. Two men and two teams can work to good advantage, one plowing while the other runs the scraper. A crew of three men, using four horses on a Fresno and two on the plow also make a good working

unit. The four horses on the Fresno will move big loads of dirt. The extra man holds the plow or scraper or trims up the side walls with a spade in spare moments.

Neighbors Might Pool Equipment

Where several neighbors contemplate digging silos it will pay to pool equipment and operate on a larger scale. For speed and ease of operation a crew of three men operating two light tractors, two 5 or 6 foot Fresnos, one two-bottom plow and a 6 foot wheel, road grader will usually make excellent headway unless the ground is too hard. For extremely hard ground it may be necessary to use a road plow or even to resort to explosives.

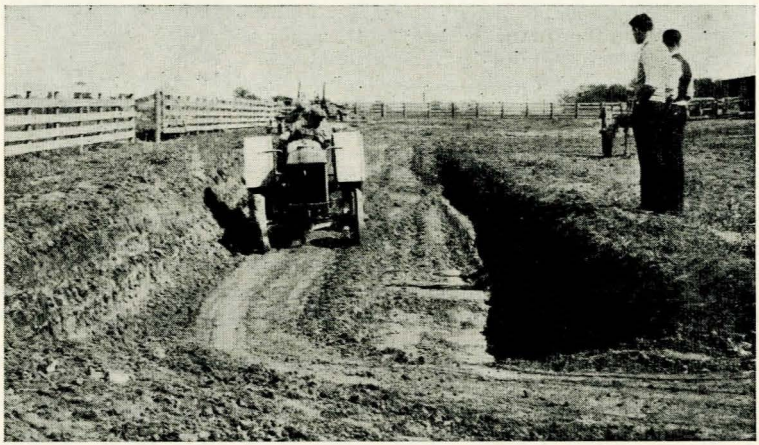

Fig. 4.—Starting the excavation for the trench silo at the sheep barn. The ground was plowed with a two-way plow and removed in Fresno scrapers drawn by tractor power.

Stake Out Dimensions

The first step in excavating the trench silo built near the sheep barn at the Agricultural College in 1930 was to stake out the size on the ground. The silo proper was 12 feet wide at the top, 8 feet wide at the bottom, 40 feet long, and 8 feet deep. At each end was a 20 foot runway making a total length of 80 feet. Stakes were set at all corners and at points where runways were to join the main part of the silo. The top soil was plowed and immediately removed with one 5 foot Fresno grader and one common slip scraper, each pulled by light tractors. As soon as dirt was removed the plowing was resumed and the scrapers started again as shown in Figure No. 4. A two-way plow was found better than the common variety as plowing operations could start at one side and continue to the other side without the necessity of making rounds.

It was not possible to plow and scrape near the side walls so a light wheel road grader was used to remove the shoulder which remained as shown in Figure No. 6. In the absence of a road grader it would be possible to get much nearer to the side walls by using one slip scraper with a chain hitch and one Fresno, the slip scraper being used along the walls and the Fresno near the center. A plow can be used nearer the walls when hitched about 4 feet behind the doubletrees.

Figure Actual Time and Expense

Very little difficulty was encountered in getting up and down the runways with tractors and machinery. The side walls required a slight amount of trueing up with a tile spade when the excavation was finished. The actual time required for various operations is shown in the following table: (Size of silo 12 foot top width, 8 foot bottom, average 7 foot excavated depth, two 20 foot sloping runways at ends).

Item	No. of Hours
Road Grader	2
Plow	6
Fresno (5 foot)	21.5
Slip scraper	16.5
Killefer (deep tillage tool)	1
Two-way plow	2.5
Man labor	116
Tractor	60
Fuel	62 gallons
Oil	4.5

Advantages of Sloping Side Walls

The side walls of the trench silo are generally sloped about one foot inward for each four feet of depth whether or not a lining is used. This feature of construction has the following advantages:

1. Packing of the ensilage is more easily accomplished because tractor, team or truck can get closer to the edge than with perpendicular walls.
2. As the ensilage settles there is less likelihood of air pockets forming to cause spoilage.
3. There is less likelihood of destructive caving if dirt walls are used without any type of lining.
4. Gives greater stability where masonry or other types of lining are used.

Temporary Linings

In one experimental silo a section of side wall was lined with a tough waterproofed building paper and another section lined with boards placed vertically. As far as could be determined neither of these linings could be called worth while. In fact, near the logs at the top of the trench more spoilage resulted from pockets formed when the settled ensilage forced the linings to give way. This was especially true where paper lining was used.

May Use Unlined Walls Year or Two

The success of unlined walls will depend largely on the type of soil in which the trench is dug and how well they are protected against entrance of water. The unlined dirt walls of the two silos at the College of Agriculture, University of Nebraska are in good condition after one year of use. The trench at the sheep barn, built and filled in September 1930, is in excellent condition and can be filled in the 1931 season without any work being done on the walls. The one at the Agronomy Farm is in good condition with the exception of one spot where, owing to the digging of a post hole near the edge of the wall, water entered and caused caving which will require several hours to repair.

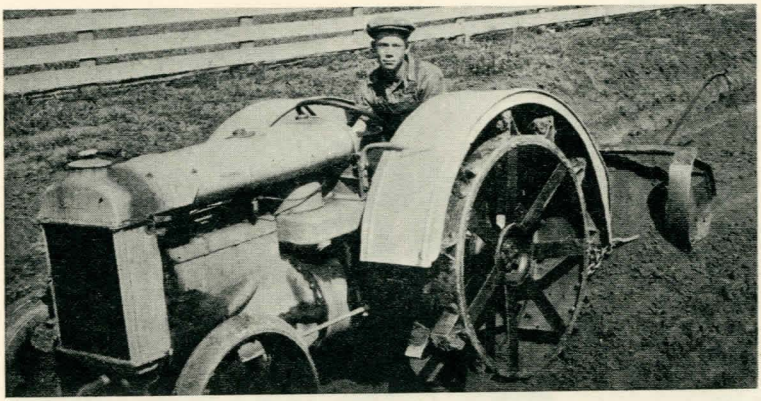

Fig. 5.—Fresno scrapers handled large loads but could not be used near the walls.

Where unlined walls are used, some slaking and caving can be expected and it may be necessary, from time to time, to trim the side walls to a new cross section by removing 3 or 4 inches of soil with sharp spades. This slightly increases the size of the trench but exposes a new layer of earth which will resist caving for a time.

Need Wood or Masonry Walls Eventually

Wall linings of some type are desirable if the trench silo is to be made permanent. Unlined earth walls may serve the purpose for a few years but constant trimming and straightening of the sides will eventually give a trench too wide for practical use. In soils which are given to caving a lining will be necessary at once and under other conditions some type of permanent side wall construction, either wood or masonry, should soon be resorted to if possible.

Inasmuch as drainage is important, it is suggested that wall linings be carried up above the natural grade from 12 to 18 inches as shown in Figure No. 3, No. 7 and No. 8. As dirt is scraped from the trench it can be back-filled against the trench lining as shown to prevent surface water running in. In the case of the unlined trench, a log or old telephone pole can be staked down to hold the dirt as shown in Figures No. 1 and No. 6.

Rough Rock Linings Impractical

A number of trench silos with rough rock walls have been constructed in the state but the results have not been encouraging. The rock walls caused too many air pockets during the settling process and too much waste ensilage resulted.

If after the rock walls are laid, two or three heavy coats of cement plaster were applied as shown in Figure No. 7, this difficulty would be largely obviated. The rock lining might well be used up to the ground surface and above that solid concrete would be more likely to give good results.

Make Concrete Lining as Shown in Figure 8

No experience has been had with concrete linings but the following suggestions are given for those who may want to try them. First, lay the foundation as shown in Figure No. 8, then set up the forms and run the entire height of the wall at once, being sure that the reinforcing rods are in their proper place as shown in Figure No. 8.

Fig. 6.—A small wheel type, road grader proved very useful in removing dirt near the walls. Very little hand work was necessary in finishing the walls.

Might Use Other Masonry Linings

There is reason to believe that several types of masonry other than those mentioned can be used. Brick, concrete block and hollow tile or any material which go to make up the walls of above ground silos can, undoubtedly, be used as linings for the trench. During the 1932 season various types of linings will be used in an experimental way on the trench silos at the Agricultural College. At the present time no experimental data are available as to the best structural uses of the various trench linings. The drawings are given as suggestions.

Trench Silo Filling Not Hard Work

Hard work seems to have connected itself to most silo filling methods. With the use of the ensilage harvester or the field cutter type machine, wagons equipped to dump or strips of woven wire fencing placed in the bottom of wagon boxes, in such a manner that the ensilage can be rolled out by horse or machine power, and with tractors, horses, wagons and trucks to do the packing much of the heavy lifting and hard work disappears.

Many farmers are trying to lighten filling costs and lessen the housework of feeding a large number of men by filling over a longer period and using smaller crews. With a small crew the farmer does not need to work early and late doing chores, nor bother with a large amount of exchange labor nor wait too long before filling because all his neighbors are busy. Also, the ensilage has more time to settle and more can be placed in the silo and the corn need not be cut so far in advance of filling as is often true when large crews are used.

The trench probably can be used for storing bundled green corn better than any other silo. In an emergency the man with no equipment except a cutter can store bundled corn by placing bundles parallel

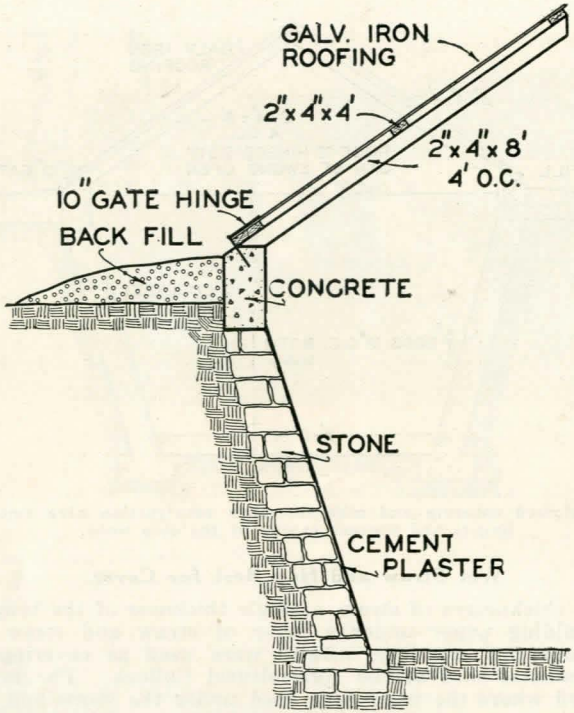

Fig. 7.—If stone walls are used the thickness should be about 12 inches. Two or more coats of cement plaster will give the walls a smoother finish.

to each other lengthwise of the trench, using teams and wagons to pack solid, cover with several feet of straw and have the advantage of the good feed and not the disadvantage of heavy expense for machinery and labor.

Packing Ensilage With Tractor Truck or Horses

It has been previously mentioned that a tractor was used to pack the ensilage in the two experimental silos. When care is taken trucks, wagons, horses or combinations of any of these serve very well. Even packing over every part of the trench is to be strived for and the more solid the packing the greater amount of feed stored. Two or three trips along the length of the silo for every load of fodder will do a very good job of packing provided a light weight tractor or equivalent weight is used.

Watering Side Walls Did Not Help

When the trench at the sheep barn was filled the suggestion was offered that the soil was too dry on the sides of the trench, that much of the moisture in the ensilage would be absorbed into the bank and cause undue spoilage. For this reason about 8½ tons of water were added to one side of the feed during the filling process. When the ensilage was removed about the only difference noted was in the per cent moisture content. Very little spoiled ensilage was found on the trench sides except near the top in either experimental silo.

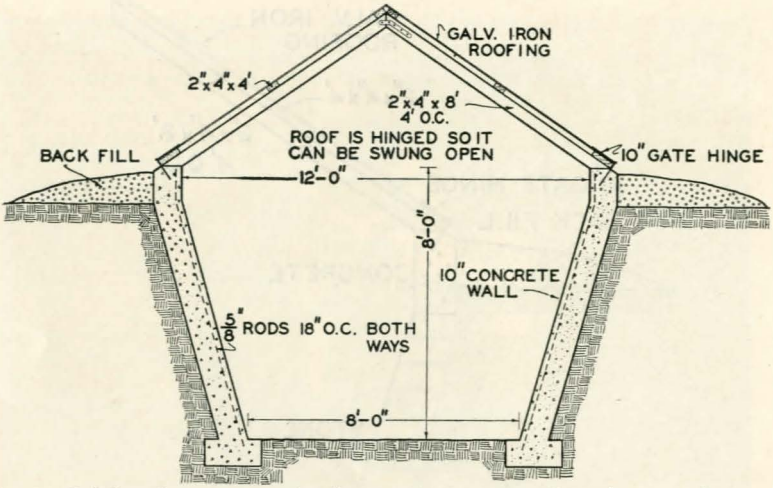

Fig. 8.—Reinforced concrete and other masonry construction give smooth trench linings and prevent caving of the side walls.

Wet Straw and Hay Best for Cover

Different thicknesses of straw, a single thickness of the tough waterproofed building paper under a layer of straw and straw under a three or four foot depth of alfalfa were used as covering for the two experimental silos at the Agricultural College. The most spoilage occurred where the paper was used under the straw and the least amount of spoilage was found where the three or four feet of alfalfa was stacked over the 12 to 14 inches of wet straw. Water was thrown on all the straw covering. It was felt that part of the cause of more depth to the spoiled ensilage at the sides of the top than in the middle could have been prevented if the straw and other coverings had extended farther over the sides of the trench. That is, if the top of the trench is 12 feet across then the covering should be 15 feet or more wide.

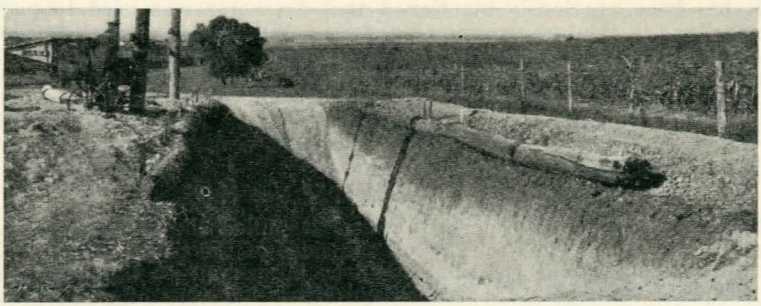

Fig. 9.—The trench silo at the Agronomy Farm completed and ready to fill. The top width is 12 feet, bottom width 8 feet, excavated depth 7 feet, length of main part of trench 75 feet. At each end is a 20 foot sloping runway.

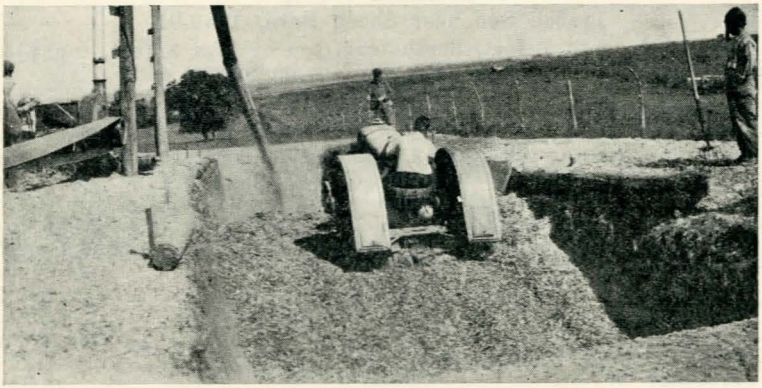

Fig. 10.—Running a light tractor over the ensilage during the filling process proved an effective means of packing.

Some advocate covering the ensilage with wet straw, then covering the wet straw with dirt. In many instances extra hay or straw piled near at hand is very convenient during the time ensilage is being fed. This hay or straw can very often be placed on the trench at less cost than the dirt and may prove less troublesome while the ensilage is being removed.

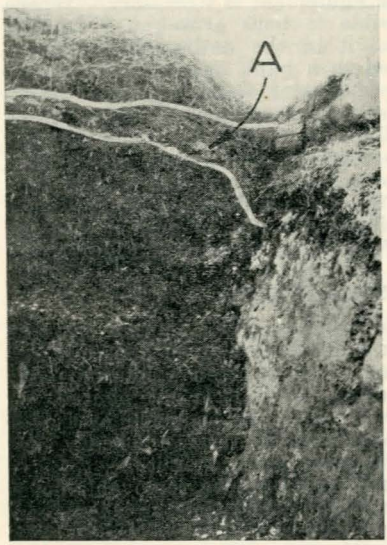

Fig. 11.—Between the two white lines is the zone of spoiled ensilage. It was thickest at "A" due probably to air pocket near the logs and also insufficient cover at this point.

While present information shows no comparison between the loss by top spoilage when a heavy straw covering was used rather than a dirt and straw covering it was shown that 3 to 5 feet of straw or hay covering proved very satisfactory in preventing a great amount of spoilage.

Very Little Waste in Ensilage

In the two silos previously mentioned the ensilage was taken from the end, the thickness of the slab started depending on the amount used per day. In each silo the men attempted to work from top to bottom about two times in five days. From 600 pounds to 4,000 pounds were taken out with the only waste being the spoilage at the very top when the original straw covering was removed. This waste on the top varies from 4 inches at the middle to 18 inches near the logs at the sides as shown in Figure 11. The total waste can best be shown in the following summary table:

SUMMARY TABLE

Trench Silo near Sheep Barn, 1930-31

Excavated depth 7 feet, depth from top of logs 8 feet, top width 12 feet, bottom width 8 feet, two 20 foot inclines at ends.

Tons ensilage put in silo	114.84 tons
Tons water used	8.66 tons
Total tonnage into silo	123.50 tons
Tons good ensilage taken from silo	99.26 tons
Tons waste ensilage taken from silo	7.19 tons
Total tons taken from silo	106.45 tons
Volume of total ensilage when packed	4806.9 cu. ft.
Weight per cu. ft, of ensilage taken out	44.29 lbs.
Total cost per silo *	$96.43
Weight per cu. ft. of waste	13 pounds
Weight per cu. ft. of good ensilage	50 pounds
Waste in % of tonnage taken out	6.76%
Shrinkage in %	13.81%
Average moisture of ensilage put in	72.9 %
Average moisture of ensilage taken out	72.7 %
Average moisture of waste ensilage	63.97%
Average moisture of good ensilage	75.64%

* In finding the total cost of this silo man labor was figured at 35 cents and charges made on all equipment on an hourly basis.

Easy to Get Ensilage Out

One great advantage of the trench silo is the ease with which ensilage can be removed. No hoisting equipment is necessary. Where sloping runways are used, it is possible to back a wagon down the incline, fill it with ensilage and haul it to the desired location for feeding. If the trench can be located in a bank as shown in Figure No. 2 it is very practical to use a feed carrier on an overhead track. The track into the silo can be supported on temporary cross pieces which are laid in place as the ensilage is fed further and further back. Another successful method used where the trench silo is built in a bank, consists of the construction of a car from the wheels such as are used on a handcar trailer. This car should have sloping sides and hold 700 to 1000 pounds of ensilage. It can be pushed into the silo, filled and shoved out into the feed lot as shown in Figures No. 12 and No. 13.

Roof Keeps Out Rain and Snow

The use of a roof has certain advantages which cannot be well overlooked. During the warm season rain water can be kept out and the floor kept dry. In winter drifting snow is often a nuisance and a good roof will prevent it from entering where it is not wanted. A cheap and temporary roof for the trench silo can be made by laying poles across placing brush over the poles and then using a heavy coat of straw or a lighter coat of straw with some earth over it.

Any type of roof to be most convenient should be removable so as to permit driving into the silo with teams at filling time or when feeding. A practical type of construction is shown in Figure No. 8. This shows sections of the roof about 8 feet long hinged at the top of the wall lining and so arranged as to open at the ridge of the roof and lay back on the ground at filling time. Another type is so arranged that whole sections of the roof can be lifted off in 6 foot sections at filling time. For portable roofs where lightness is a factor, frame construction covered with corrugated, galvanized metal is popular.

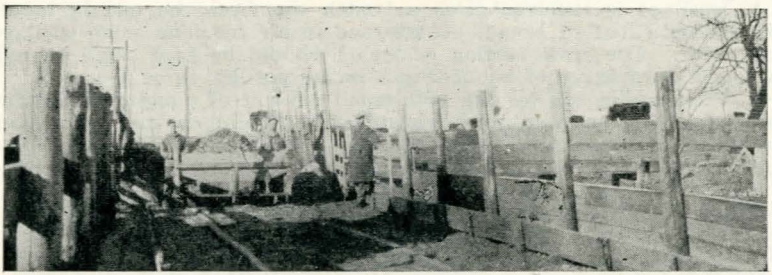

Fig. 12.—Car coming out of the large trench silo in use on the W. A. Apperson farm near Tecumseh. The car runs on rails of 2"x4" material. It holds 750 to 800 pounds and is eased down the slope with a rope snubbed about a post. The scheme was developed by W. A. White, Apperson's manager and partner.

H. J. Gramlich, Chairman of the Department of Animal Husbandry, adds this comment about—

Quality of Ensilage from Trench Silos

"There is rather a popular opinion to the effect that trench silos are productive of a large amount of spoiled ensilage. While we have had but one year's experience with them, it has shown that there is relatively little more spoilage than with above ground silos and if any difference exists in the quality of the ensilage it is favor of that from the trench. In the experimental silo near the sheep barn at the Experiment Farm, we used a tractor to do most of the packing. At times a light truck was also used. The ensilage from this silo was of splendid quality. Our men felt that it was the best we had. The spoilage in this unit amounted to but 2% more than that in our above ground silo on which we kept records.

"We have, perhaps, been inclined to look with scorn upon this simple structure because in theory it constituted a wasteful method of storage, due to the large area of exposed ensilage. As a matter of fact it has been found very easy to minimize waste if careful packing and covering is done. Because of the many advantages which this storage receptacle possesses, it is worthy of being called to attention at this time."

Eleven Essential Facts

1. Trench silos can be cheaply and easily built for any desired capacity with tools and labor to be found on most any farm. They are not easily destroyed by storm or fire and there is little danger from poison gases or frozen ensilage.

2. Location should be such that flood water cannot enter and where there is no danger from ground water.

3. Ensilage weighed out of an experimental trench silo at the University of Nebraska Experiment Farm in 1930 weighed 45 pounds per cubic foot. The silo was 8 feet deep, 12 feet wide at top and an 8 foot bottom width. The freshly cut ensilage contained 72.9% moisture and was packed with one trip of a light tractor over the surface per ton capacity.

4. Ensilage is removed from a trench silo from the end in layers like slicing a loaf of bread. If exposed to air too long some spoilage will occur. The cross section of trench should be kept small enough to permit an average of about 2 to 3 inches per day to be fed.

5. Trench silos can be dug with small amount of equipment but for ease of operation and quick construction neighbors may well pool equipment and use two Fresno graders, one plow, small wheel type road grader and two tractors or eight head of horses.

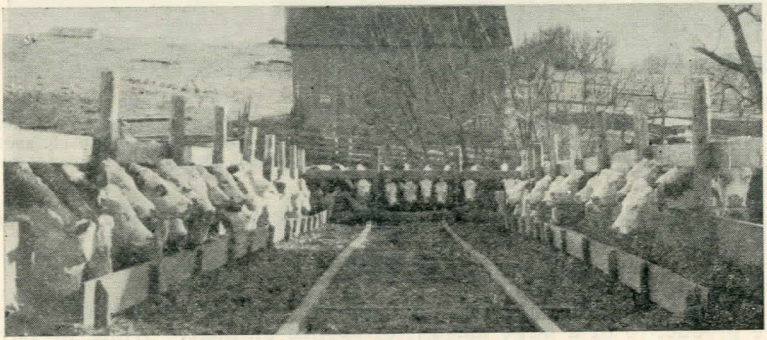

Fig. 13.—The track leads down into the feed lot where 168 head of white faced cows found the silage to their liking in the winter of 1930-31.

6. One experimental silo with 7 feet of excavated depth, 12 foot top width, 8 foot bottom width the main part of the trench 40 feet long and with a 20 foot incline at each end, was built at the University of Nebraska Experiment farm at a cost of $96.00 figuring 116 man hours of labor at 35 cents per hour and making a charge for all equipment used. The actual cash outlay to a farmer would have been for 62 gallons of gasoline and 4½ gallons of oil.

7. A slope of one foot inward for each 4 feet of depth is recommended for the side walls as it permits ease of packing, eliminates danger of air pockets and prevents caving where dirt walls are used.

8. Temporary lining of plank and tough water proof paper in experimental silos did not prove worth while from the standpoint of preventing spoilage of ensilage. Unlined walls stand well in certain soils. Under other conditions a lining of plastered rock, concrete block, brick or clay tile may be necessary.

9. Filling may be accomplished with the least effort by using a field cutter, hauling the ensilage in and dumping it into the pit by driving down the inclines. The unloading may be accomplished by putting woven wire strips on the wagon before loading and pulling these strips out by hooking a rope to them and driving ahead. A cutter and blower may be used at the pit.

10. In so shallow a silo as the trench type, packing is essential to increase the capacity and eliminate the danger of air pockets along the edges. Either teams, trucks or light tractors may be used to good advantage.

11. Coverings of wet straw over which two or three feet of alfalfa hay was stacked gave the best results at the experimental silos. Dirt coverings were not tried. Most spoilage occurred where a tough water proof paper was placed over the ensilage and covered with wet straw.