

S

ilage -

FEED OF EXCELLENCE



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OUR COVER

At the present time, only limited experience has been had in self feeding silage. Originally it was estimated that 12" width of silo would be required for each head of livestock. However, a number of good dairymen in the state that are self feeding have found that only a 6" width of silo is required for each head. On this basis, a 20' wide silo would accommodate 40 head of dairy cattle.

Self feeding of silage has perhaps not been adopted as readily by beef cattle feeders as with dairymen, but experience has shown that an even larger number of beef cattle can be self fed.

FOREWORD

The Missouri Experiment Station has conducted research on silage over a long period of years. The research has included work on production of crops for silage, making silage, construction of silos, methods of feeding silage, and the value of silage for beef cattle, dairy cattle, sheep and brood sows. Results of this research have been published in bulletins and circulars by the Experiment Station and Extension Service.

The information on silage is here summarized and published as an integrated story in which each reader may find ideas which will be useful in his operations.

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of Agriculture and
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Top quality corn silage was nutritionally adequate for ewes during pregnancy when it was supplemented with soybean meal, 1/3 pound per head daily and a mixture of steamed bonemeal and salt. Lambing percentage averaged about 160 and the lambs were strong and the ewes milked well. Corn silage was constantly before the ewes which allowed them to consume large amounts, up to 13 pounds per head daily.

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Silage -- Feed of Excellence

SILAGE IS THE BEST known substitute for pasture. Silage has the advantage of being less susceptible to damage from adverse weather than does hay. The first cutting of alfalfa frequently is damaged by rain. This same alfalfa can be put in the silo while much too damp to bale or stack, and it makes good feed.

Too Few Silos

Silage has so many advantages, it is surprising there are so few silos on livestock farms.

Why do we have so few silos? The answer may be found in the cost of harvesting and storing the crop. Farming today is a form of mechanized production. Even the smallest commercial operator has tractor equipment. No longer do we have the stationary cutter and corn binder. These have been replaced by the field chopper.

Ownership of a modern chopper equipped with pick-up and row crop attachments requires an investment of approximately \$2000. Interest on the cost and depreciation on the machine amount to approximately \$4.30 a ton for 60 tons of silage; \$1.75 a ton for 150 tons of silage or a reduction, because of increased volume of \$2.55 for each ton.

There are many other harvesting and storing costs. A tractor must be provided to pull the field chopper. The silage must be hauled to the silo and packed in it. The farm family must do the work in cooperation with neighbors or hire workers to do it. A silo must be built and kept in repair. When all of these expenses are considered, the total cost makes silage look like expensive feed to the farmer who cannot keep each item low.

How Costs Can Be Lowered

Silage is good feed, but successful use of it requires that the cost of harvest, storage, and delivery to the animals that eat it be kept low. Here are some suggestions for lowering the cost of silage:

1. Use a horizontal (trench silo). The floor and sides should be paved with cement and it should be equipped with a creep so the animals can eat the silage where it is stored.
2. The farm business should be large enough to keep the cost per ton of providing harvesting equipment low, or the farmer should work with neighbors toward cooperative ownership and use of items such as field choppers, blowers, and other specialized silage-making machines.
3. Farmers interested in lowering silage costs should investigate the cost of hiring a custom operator to cut and store it. In many cases, the owner of a small herd can get the work done at lower cost than he can do it himself. This is especially true if satisfactory cooperative harvesting rings cannot be organized.

The silage being used on Missouri farms now approximates 3,000,000 tons a year—roughly the equivalent in feeding value of 1,000,000 tons of hay. Around one fourth of this quantity is grass silage—made from small grain crops, Sudangrass, and other grasses and legumes—and the remainder is fairly evenly divided between corn and sorghum crops.

The production of silage in Missouri and in the United States has increased greatly in the past 10 years and is still increasing at an accelerated rate.

SILAGE PRODUCTION IN MISSOURI
(in tons)

		1949	1956
Corn -	Acreage	53,616	118,000
	Tonnage	409,609	1,003,000
Sorghum -	Acreage	28,415	118,000
	Tonnage	242,777	1,156,000
Grass Silage -	Acreage	insignificant	130,000
	Tonnage	insignificant	636,000

ESTIMATED SILAGE PRODUCTION IN
THE UNITED STATES*
(in tons)

	1946	1956
Grass Silage	400,000	13,500,000
Corn Silage	36,000,000	54,614,000

*Not including Sorghum and Sudangrass silage.

Most Forage Crops Make Good Silage

ALL GREEN FORAGE CROPS can be made into silage. The crops most commonly used in Missouri are corn, sorghums, legumes, grasses and cereals. Good silage results when the crop is cut at the right stage of maturity, chopped fine, the moisture content controlled, well packed and the air excluded.

The method of harvesting should fit the plan for storage, handling and feeding. Any of the common types of silos—trench, or upright—will preserve silage satisfactorily. One should be chosen which best fits the farming operation.

Silage making involves bacteriological and chemical changes. Acid production which prevents the growth of undesirable bacteria and prevents rotting (putrefaction) is the most important. Good quality silage is characterized by a mild, pleasant aroma, slightly acid taste, green color, and freedom from mold and sliminess.

Silage provides a high quality, palatable, succulent, low cost feed for any season of the year. It is good drought insurance, and extends the benefits of good pasture through periods of short pasture and the winter months.

Silage crops may be put into the silo when weather does not permit curing them into hay or dried forage. Such crops are thus saved for feed. More color and vitamins are put into the milk when the crop is conserved and fed as silage.

The loss of nutrients—dry matter, protein, minerals and vitamins—is less than when the crop is made into dry fodder or hay. Losses caused by rains, sun bleaching and shattering of leaves are reduced. Low grade and weedy crops which would not make good dry forage may be made into satisfactory silage.

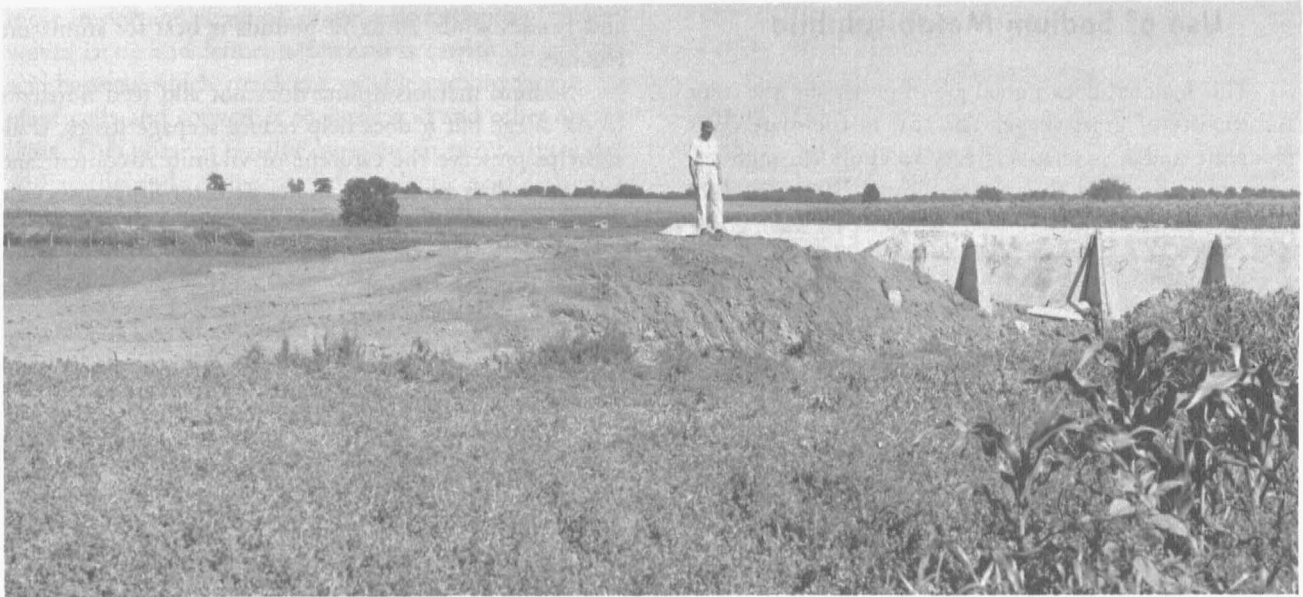
Silage is ordinarily more economical and a more satisfactory feed than dry corn, sorghums or other dried forage. It is eaten with almost no waste. It is cleaner and has less dust. When devoted to silage crops the ground is cleared early and it may be prepared for another crop.

The crop devoted to silage may be stored in less space and usually at lower cost. A cubic foot weighs about eight or nine times as much as a cubic foot of loose hay and contains three times as much feed value.

Fire hazards are eliminated when the crop is stored as silage instead of as dried roughage. It is well adapted to intensive farming as it helps make possible the keeping of more livestock on the farm.

Most silos are not covered as a prevention against spoilage. A good job of tamping is a real necessity however. Here, however, silo was covered with asphalt treated paper weighted down with sawdust. A type of covering that is receiving an increasingly large amount of use of late is plastic. Such plastic comes in wide widths, sells for as low as 2¢ per sq. ft. and in most instances does an excellent job of preventing spoilage. Edges need to be weighted down to keep out air. Usually best way to do this is to place dirt around edges with front end mounted scoop. The plastic does not need to be entirely covered—just the edges.





This dirt ramp makes filling of this silo easier because load of silage is brought up dirt ramp rather than up slope of silage in this above ground silo. Engineers developed both the above ground and the below ground trench silo because each has its place on Missouri farms. The silo needs to be properly located for convenience and accessibility. By having both designs, it is possible to select one that best fits the location. In flatter areas where silos should be located near buildings, the above ground unit is ideal.

Use of Silage Preservative

Corn, sorghum, and similar crops require no preservative but give best results when the dry matter content is at least 27 to 30 percent (70 percent moisture). Grass silage without preservative should contain 30 to 35 percent dry matter (65 percent to 70 percent moisture). Lower moisture contents tend to result in molding and spoilage.

Higher moisture content of grass silage may be reduced to the proper level by wilting. Preservatives help to preserve and improve the quality in legume or grass silages when put in the silo direct from the field without wilting. The addition of preservatives, of course, increases the cost.

It seems desirable to add a preservative where the moisture content of the crop is high, especially in legume crops. No preservative is needed when the moisture content is between 65 and 70 percent, while the addition of water is more important than a preservative if the crop runs below 65 percent in moisture.

Preservatives in Making Silage

A number of materials have proven satisfactory as preservatives. Blackstrap molasses can improve the quality of silage and add to its feeding value because of the sugar it contains.

Approximately 40 pounds of molasses should be added to a ton of cereal crops, 60 pounds to mixed grasses and legumes, 70 to 80 pounds to legumes, and 80 to 90 pounds to soybeans that are ensiled before the seeds are

formed. A gallon of molasses weighs about 12 pounds. The amount can be measured rather than weighed.

The molasses can be run into the blower of the silage cutter as the silage is put into the silo by placing a barrel on an elevated platform and running a pipe from the barrel to the cutter. A valve attached to the end of the pipe can be used to regulate the flow.

Grain as a Preservative

Excellent grass silage can be made by adding ground corn or other cereal grains as a preservative. One hundred pounds of ground corn should be added to each ton of cereal grain silage, 150 pounds to mixed grasses and legumes, 200 pounds to legumes, and 250 pounds to soybeans. Ground barley, wheat, rye or sorghum grain may be substituted for the ground shelled corn. When ground corn and cob meal are added to the silage, the amount should be increased by one-fourth over that of shelled corn.

Two hundred pounds of ground grain added to a ton of green material containing 25 percent or 500 pounds of dry matter will lower the moisture content from 75 to about 69 percent.

It is estimated by research workers that about 80 percent of the feeding value of the grain is recovered when the cattle consume the silage. The use of grain reduces seepage and it improves the feeding value enough that the grain rations can be slightly reduced.

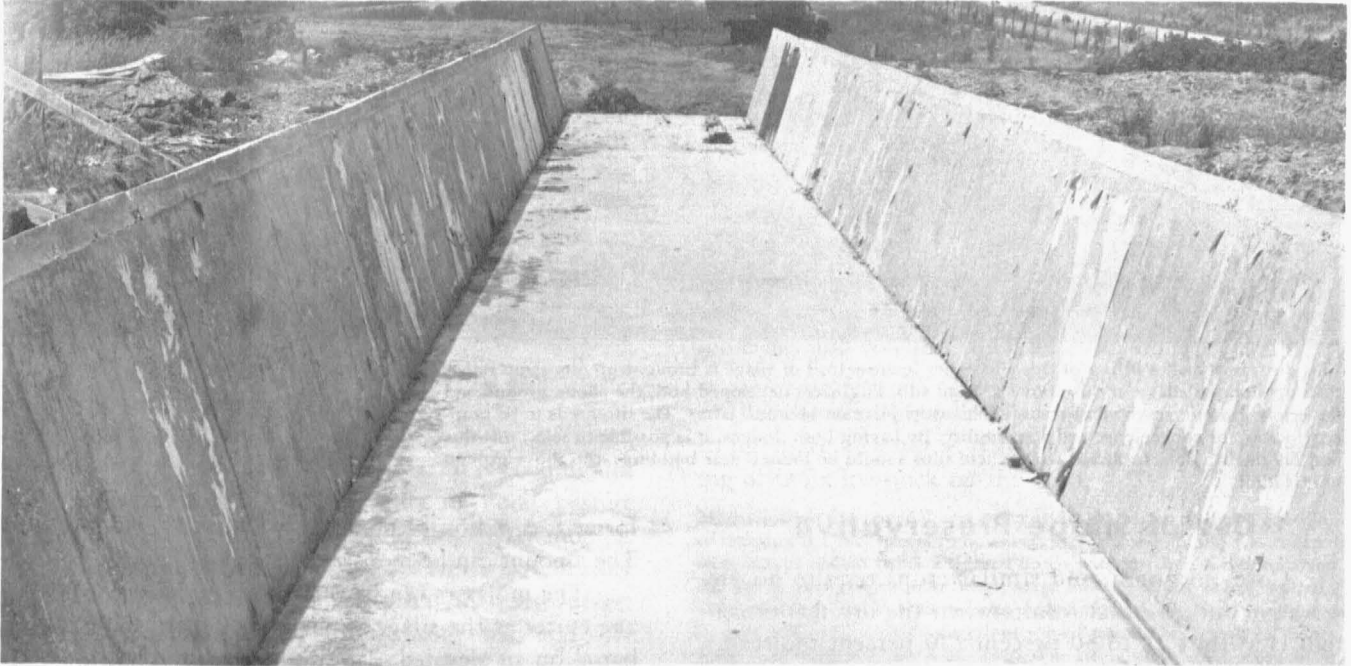
The ground grain can be added as the silage goes into the blower by means of a hopper in which the rate of flow can be controlled.

Use of Sodium Metabisulphite

This material does a good job of preserving the color and quality of grass silage. The cost of the material is moderate and it is relatively easy to apply through the hopper on the field chopper or blower. Seven to eight pounds per ton is required for best results on small grains

and grasses while 10 to 12 pounds is best for immature legumes.

Sodium metabisulphite does not add feed nutrients to the silage but it does help reduce seepage losses. It also helps preserve the carotene or vitamin A content and reduces odors to some extent. It often improves the palatability of the silage.



This 16' wide, 8' deep 300 ton capacity below trench silo was the first poured in the state with the tilt up walls. Ready mixed concrete was used and the total cost per ton storage capacity was less than \$5.

Silage-- A Good Winter Feed

GOOD QUALITY ROUGHAGE for winter feeding is a major requirement in any livestock enterprise involving cattle or sheep. Storage of hay or fodder has long been used by livestock men but even under the best of conditions the loss of nutrients is high. The prime consideration in all attempts to provide winter roughage is to preserve the crop at its best stage of growth and to minimize the loss of nutrients.

Corn and sorghum crops have been successfully ensiled in this country for many years and there is no doubt that as silage more nutrients are retained than when the crops are made into dry roughage. More recently there has been an increased interest in hay crop silage.

How Silage Preserves Nutrients

In order to understand how the ensiling process helps preserve nutrients let us first consider what happens in the silo.

When a green forage is well compacted in a silo the living plant cells continue to respire or breathe for a short time, perhaps five hours. During this time the oxygen entrapped in the silo is used up and carbon dioxide is given off. It is also during this period that heat is produced, the amount being related to the available oxygen and thus to the size of the particles and degree of compression. After the oxygen is used the second and

most important phase of silage making begins. This involves lactic acid fermentation and is carried on by lactic acid bacteria which attack the soluble carbohydrate in the plant cells and convert it to lactic acid and other organic acids. This phase is usually complete in two to three days and at the end of this period the lactic acid content is about one to 1.5 percent of the fresh material.

The mass is quite acid and has a pH of about four. When this amount of acid has been formed, fermentation is checked and after two to three weeks practically all action has ceased. If fermentation has been successful and air is excluded the silage will then keep indefinitely.

When hay is dried in the field under the best of weather conditions cell respiration goes on for a period of time and this, coupled with mechanical loss, may amount to about 20 percent of the dry matter. If rained upon the loss may be much greater.

Although the loss of dry matter in silage making may approach that of hay making under good conditions, there is little or no loss from rain in silage making and more important the crop can usually be ensiled at the proper stage of maturity without interference from weather conditions.

Silage Holds on to Carotene

From the standpoint of nutrition the preservation of protein, total digestible nutrients and carotene or vitamin A activity is of greatest importance. The losses of protein and TDN in field-cured hay will average about 25 per-

cent whereas the losses in wilted silage average less than 20 percent.

It is in the preservation of carotene that silage has the strongest advantage. Although this important nutrient is readily lost in all methods of forage preservation, the loss in silage making is probably less than in any method except artificial dehydration. To quote an example from "Feeds and Feeding" by Morrison, the carotene content per pound of dry matter of alfalfa when fed after various methods of processing was; wilted silage, 28.1 mg; dehydrated hay, 26.0; field hay (good weather), 5.4 mg and field-cured (rained on), 1.7 mg.

Carotene is sensitive to oxidation and is rapidly destroyed during field drying of hay. As much as 80 percent of the carotene content of a crop may disappear during 24 hours of drying in the field, the destruction being accelerated by sunlight. Not only does ensiling minimize exposure to sunlight and oxygen, but even more important it allows the crop to be harvested when the carotene content is high. The concentration of carotene in the leaves where it is most abundant decreases markedly as the maturity of a plant advances.

Distribution of Carotene

Recent data collected at the Missouri Experiment Station show the distribution of carotene in the corn plant at the time it is ready to be ensiled:

This large trench silo, self unloading wagon and front end mounted tractor scoop makes the job of feeding hundreds of cattle easy. Here the machinery does much of the work.



Portion of plant	Dry Weight of 10 plants lbs.	Carotene per lb. mg.	Carotene in 10 plants mg.
Leaves	2.15	52.2	112.1
Stalks	4.54	2.3	10.3
Shucks	2.26	2.7	6.2
Cobs	0.69	----	----
Grain	2.75	1.3	3.6
Total	12.39	10.7	132.2

When the leaves begin to dry the carotene content drops rapidly. A decrease of four or five percent in moisture content may decrease the carotene content as much as 50 percent.

The compositions of some typical Missouri forages as fed during the winter months have been determined by the Missouri Station and a brief summary is presented in Table I. Analysis of fresh alfalfa shows an average carotene content of 90 mg per pound of dry matter.

When alfalfa is made into hay under average Missouri farm conditions the carotene decreases about to five mg per pound. Ensiling preserves a much higher proportion of the carotene in all crops.

TABLE I--NUTRIENTS IN REPRESENTATIVE MISSOURI ROUGHAGES¹

Type of Forage	No. of Samples	Crude Protein %	N-Free Extract %	Carotene mg./lb.
A. Hays				
First Cutting Alfalfa	27	19.3	41.2	3.2
Second Cutting Alfalfa	33	19.1	41.2	4.9
Third Cutting Alfalfa	25	19.6	42.0	6.4
First Cutting Red Clover	22	14.8	46.4	5.0
Second Cutting Red Clover	8	16.1	47.4	12.0
Lespedeza	28	16.1	46.6	21.2
Ladino Clover	5	20.1	43.2	3.6
Timothy	22	9.0	48.4	4.9
Brome Grass	11	17.0	40.3	9.1
B. Silages				
Alfalfa	1	15.3	33.7	88.0
Alfalfa Brome Timothy	3	12.8	43.4	26.7
Orchard Grass Ladino	5	11.9	44.0	27.0
Red Clover Timothy	1	13.2	40.2	9.7
Corn	1	9.2	62.8	2.3
Corn-Sorgo Mixed	1	10.2	53.6	2.4

1. Calculated on a dry basis from data in Missouri Research Bulletin 533.

Silage For Stress Conditions

Observations made at the Missouri Experiment Station show that silage may possess nutritional value not indicated by the usual chemical analysis. The superior value of silage has been recognized by livestock men for many years, but the reason for its superiority has not been known.

Recent studies show that silage stimulates cellulose digestion by the microorganisms in the rumen. Furthermore, it contains an antibiotic-like substance which eliminates undesirable organisms from the rumen and helps maintain a normal flora. Thus silage is of particular value to animals under stress conditions such as disease or abnormal environmental temperature.

During the drouth in the summer of 1954 the significance of nitrates in forages was dramatized by heavy losses among cattle fed drouth stricken corn and other forages, and at least one Missouri resident lost his life

while filling a silo.

His death was attributed to the oxides of nitrogen, toxic yellow fumes, which had accumulated in a partially filled silo during one night of fermentation. The high concentration of this noxious gas was due to the accumulation of nitrate in the stunted corn plants which were being ensiled.

The nitrate content of plants depends on several factors—stage of maturity, nitrogen content of the soil and species of plant. The less mature a plant the more nitrate it is likely to contain. Corn plants stricken by drouth during July or early August are likely to be high in nitrate. The stalk of the corn plant is highest in nitrate content and on a dry basis may contain as high as eight to 10 percent of potassium nitrate.

A nitrate content in the total ration of cattle over 0.5 percent is a potential source of trouble in loss of production if not in death of the animals.

Nitrate Is Reduced

During the fermentation process in the silo a portion of the nitrate present, is reduced and given off as gas or converted to non-toxic compounds. On the average one may expect a decrease of one-third in the nitrate content after putting up the silage. Thus silage making does tend to decrease the danger of nitrate toxicity, as it does prussic acid poisoning, but it does not assure safety if original forage is extremely high in nitrate.

Use Care In Filling Uprights

Extreme care must be exercised during the filling of upright silos to be sure that a man does not enter a gas-

filled silo. The space above the silage may be filled with carbon dioxide, a heavy gas which excludes essential oxygen, in any case, or if the ensiled forage is high in nitrate there may be a high concentration of the much more toxic, oxides of nitrogen.

The latter may cause lung damage and even death hours after exposure to a high concentration of the gas. The blower should be allowed to run for several minutes before a man enters a partially filled silo.

This self unloading device powered by electricity eliminates hand labor of taking silage from upright silo. All that is necessary is to push a button at the base of the silo. The auger pulls the silage to the center and suction picks it up and forces it down the chute into an unloading wagon or silage cart.



Silage -- The Milk-Maker

SILAGE IS USED MORE EXTENSIVELY for dairy cattle than for other classes of livestock.

Silage is usually worth more per 100 lbs. of dry matter than hay made from the same crop. Milk production is slightly increased when silage is included in the ration. "Grass silage" is popular and extensively used for dairy cattle. The silage is about equal in feeding value but contains more protein than corn or sorghum silage and less high protein supplement is required.

Silage gives best results when fed with some hay or other dry roughage. Feeding some combination of silage, legume hay and concentrate feed ordinarily results in the

largest, most economical milk production. Cows produce more milk on a ration in which both silage and hay is used as compared with dry roughages alone. Normal feeding is at the rate of one to one and one-half pounds of hay and three pounds of silage per 100 pounds, live-weight.

Three pounds of silage is equal to and replaces one pound of hay. The amounts of hay and silage may be varied widely, according to availability and cost but it is recommended that at least five to seven pounds of hay be included in any ration where silage is used.

Grass Silage Is Laxative

The condition of dairy cows eating large amounts of silage should be watched. Like fresh spring pasture, grass silage especially is laxative. It is also somewhat low in energy. For these reasons the amount of the grain ration may have to be increased to maintain the body weight of the cow under certain conditions.

Silage Is High In Carotene

Milk usually will show more yellow color when grass silage is fed, often approaching the color of milk produced by cows on pasture. This is due to the high carotene content of the silage.

Silage should be fed after the cows are milked to minimize absorption of the silage odor into the milk.

The nitrate and carotene contents of miscellaneous silage samples analyzed recently are shown below:

Description of Silage	KNO ₃ Equiv. % of D.M.	Carotene mg. per lb. D.M.
Drouth corn harvested in July, 1954	1.30	25.5
Corn, 60 bu. yield, 1955	0.37	5.2
Wheat + 60 lb. molasses per ton	0.06	17.5
Sudan + 60 lb. molasses per ton	0.56	8.2
Corn, 60 bu. yield, 1955	0.51	2.0

It is obvious from the above table that both the nitrate and carotene contents of silage may vary widely, depending somewhat on the stage of maturity. The less mature plants will be higher in carotene but will tend to be higher in nitrate also.

The nitrogen content of the soil will have a direct relation to the nitrate content of the plant usually, but it has little or no effect on carotene. High nitrogen fertilization will increase the yield of corn silage, but one must guard against a level that will cause nitrate toxicity in the silage.

Silage Good For Heifers

Silage is excellent for growing heifers but they should be started on a small quantity and the amount increased gradually. Usually it should be fed with dry roughage. The feeding of limited amounts of silage may begin when heifers are four to six months of age.

Silage in Dairy Feeding Plan

High quality roughages possessing the physical and chemical characteristics associated with palatability and high content of feed nutrients, such as are grown on fertile soils during a favorable growing season, when supplemented with a suitable grain mix containing about 20

percent of mill feeds, oil meals, or both, usually supply adequate amounts of all vitamins and minerals except salt, required by dairy cattle, with 70 percent of the nutrients from the roughage. Silage provides a succulent, palatable, high quality dairy roughage at low cost. It increases milk production, puts more color and vitamins into the milk, is good drouth insurance, and makes it possible to keep more animals. It permits the maximum use of land.

Silage Serves On Wide Livestock Front

Silage can be very excellent or very poor feed. Whether it is good or bad depends largely upon the species, the condition of the plant when it was cut for silage, and the curing techniques. Each of the variety of silage-producing plants could be put into one of the following groups:

- Group I —silage made from corn, sorgo and milo.
- Group II —grass silage from small grain and similar plants.
- Group III—legume silage.

Assuming that all the above silages were cut and cured equally well, silage from corn has the highest value per ton. To put other silages on an equal basis would require the following additions: sorgo and milo silages will usually require the addition of one half pound corn or its equivalent daily for each 100 pounds live weight of cattle; grass silage and legume silage will require even a trifle more grain.

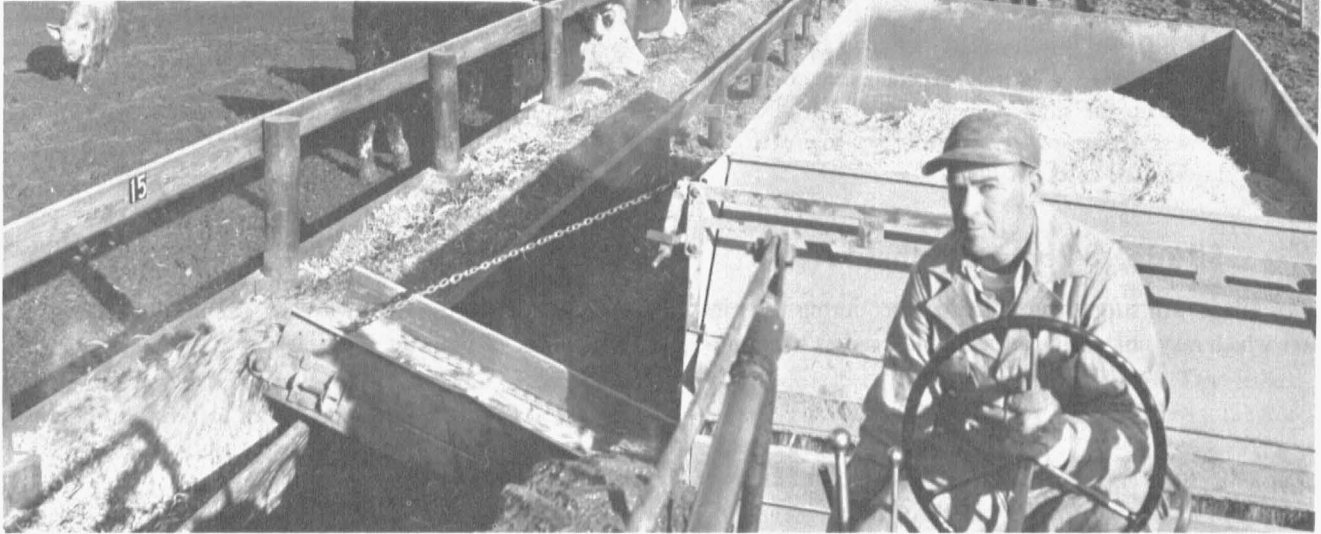
Legume silage, is, of course, higher in protein than corn silage; so is grass silage. Legume silage, in many cases, requires no protein supplementation, grass silage a small amount and corn silage a larger allowance of protein concentrate supplementation.

Calves Gain Best On Corn Silage

Let us look at the uses of corn silage for farm livestock. Since it is a roughage it can be used best by ruminants. It may, if desired, make up the entire roughage for cattle and sheep. The greatest return from corn silage is attained when it is fed to calves so that they gain 1¼ to 1¾ pounds daily. To make 100 pound gain in tests conducted by the Missouri Agricultural Experiment Station, 500 pound calves required 1500 pounds of silage and 100 pounds of protein concentrate and the necessary minerals. Cost of gain was held to a minimum. When fed to yearling cattle the efficiency was not quite as great, that is about 2000 pounds silage and 100 pounds protein concentrate.

Silage -- For the Beef Breeding Herd

This self unloading wagon not only feeds silage but will mix grain or even molasses with the silage and place it in the fence line bunks. It is not even necessary to get into the lots with the cattle. A paved slab 12 feet wide on the cattle side stabilizes the lot. Pasture is available mostly for a clean bedding down area.



SILAGE IS AN EXCELLENT FEED for the beef breeding herd. It is moist and succulent and tends to stimulate the milk flow and keep the digestive system well regulated. Including some silage in the winter ration of cows having fall or winter calves is a good practice.

Corn silage combines grain and roughage in about the right proportion for cows nursing calves and its high yield per acre enables the cowman to winter a considerable number from a limited acreage, if necessary.

Corn Silage in the Ration

Corn silage, because of its corn content, is usually considered a higher cost feed than straws, stovers, mixed hays or other coarse roughages. For this reason it is usually fed to grade beef cows in limited amounts along with some cheap dry roughage which is fed according to the appetite.

If the supply of silage available is limited, other roughage may be fed during the early part of the winter and the corn silage should not be included in the ration until the cows start to calve. Feeding a limited amount of good quality legume hay or protein supplement is also desirable with corn silage.

A satisfactory ration for the average size beef cow would be 35 to 40 pounds of corn silage and five to six pounds of legume hay per day. Fifty pounds of corn silage and 1½ pounds of soybean, cottonseed or linseed meal would also make a good ration for cows with winter calves. Sorghum silage may be substituted for the corn silage in these rations.

Mixed grass and legume silage and small grain silages are silages that may be available. They are usually very satisfactory for wintering beef cows. Including a small amount of dry hay in the ration is desirable when mixed grass and legume silage is used.

Used To Fatten Cattle

Silage may also be used to fatten cattle. Usually additional grain feeding is required to finish cattle to the grade of choice. Low grade—medium or less—cattle may sometimes be finished to the grade that such cattle warrant by feeding only high quality corn silage supplemented properly with protein concentrate and minerals or legume hay. In some cases silage may replace hay completely if supplemented properly, in others a combination of the two seems best.

Sheep Utilize Silage

Sheep also can utilize silage to good advantage. In tests conducted at the Missouri Agricultural Experiment Station bred ewes were wintered on corn silage as the only roughage. It was supplemented with soybean meal, .3 pounds per head daily and minerals provided by steamed bone meal and salt. The results were excellent. The lamb crop averaged nearly 1.6 lambs per ewe and they had an abundant supply of milk for their lambs. Corn and milo silage may also be used to fatten lambs, however, the rate of gain is lower than when the ration is more concentrated through using grain. Top quality silage is essential.

Feeding Silage To Hogs

THE USE OF SILAGE FOR HOGS is limited to older animals that are being maintained, or for those where small gains will be satisfactory. The most practical use of silage is for sows during pregestation and gestation. Mature sows can make better use of silage than can gilts.

Many farmers feed more energy than the sows actually need during gestation and the sows become too fat. Feeding silage is a good way to reduce the energy intake and to keep the sows from getting too fat. Reducing the fatness of the sow results in better sow performance and decreased costs per pig.

Silage A Pasture Substitute

Silage will supply nutritional factors during the winter which may not otherwise be supplied unless the farmer

is feeding a well balanced ration. In this respect, silage is considered as a substitute for pasture.

Silage must be of high quality so as to be palatable. The consumption of silage will be increased if it is fed in large flat bottomed troughs and the protein supplement and grain are spread over the top. Moldy silage should never be fed to sows.

Feeding silage to the average size swine herd cannot be justified unless it is available and fed to other livestock.

Silage alone is not a well balanced ration and it must be supplemented with protein, minerals and possibly vitamins. Additional grain needs to be added to grass silage for both sows and gilts. Grain may also need to be added to corn silage with the amount depending on the amount of grain in the silage.

Silage in Crop Planning

ADVANTAGES OF SILAGE in crop production management include:

1. Better stands of grasses and legumes following small grains.

2. Remove crop earlier, get succeeding crop in more timely, or permit double cropping, helps preserve stands of legumes in meadows and increases annual yield.

3. Harvesting more total digestible nutrients per acre, releasing acres for other uses. Particularly valuable on small farms and may be valuable in the future from the standpoint of the Nation's food supply.

4. In years or months of plenty, surplus forage, such as silage, can be stored very efficiently for use in times of shortage—a way to utilize more effectively our fluctuating supply of forage growth.

Taking the general accepted saving of an increase of 50 percent of total digestible nutrients for the corn and

sorghum crops when made into silage, as compared to harvesting the grain and dry forage, would give a hay equivalent of 247,000 tons saved annually.

A U.S.D.A. experiment at Beltsville, Md., reported by the Bureau of Dairy Industry, gives the following comparisons on nutrients conserved from the growing crop as hay and in different types of silage structures.

LOSSES IN PERCENT

Crop Storage	Fer-				Total
	Field	men- tation	Seep- age	Spoil- age	
Hay-with rain	35	5	-	-	40
Hay-with no rain	22	3	-	-	25
Grass silage-Stack	2	11	7	12	32
Grass silage-Trench Silo	2	10	7	6	25
Grass silage-Upright Silo	2	9	7	3	21
Grass silage-Gas tight Silo	2	9	7	-	18
Grass silage-Gas tight Silo (wilted to 46% moisture)	8	3	-	-	11

Silage Yields High Hay Equivalent

AN AVERAGE NUTRIENT LOSS of 35 percent in hay making in Missouri is probably not an excessive estimate, considering the amount of hay completely ruined and never stored, and the amount that is rained upon before storage. A high estimate of 25 percent nutrient loss on the average in silage would mean that the grass silage

now being made gives a saving of an additional 25,500 tons of hay equivalent—making a total feed saving from silage of 272,000 tons of hay equivalent annually. Better ensilaging procedures could increase these savings. Still further savings with silage compared to hay are realized during feeding operations.

A study several years back by C. L. Day, Agricultural Engineering Department, showed that the average cost of harvesting and storing three tons of row crop silage

was about the same as for one ton of hay. Harvesting and storing three tons of grass silage cost about 1/3 more.

Variety and Fertilization Affects Silage Produced

A PRELIMINARY TEST conducted in 1952 suggests that variety and fertilization may influence greatly the

quantity and quality of silage produced. A study of the following table will prove interesting:

	DRY WEIGHT IN POUNDS PER ACRE				
	Ears	Stalks	Ears and Stalks	Protein	% Protein
Hybrid:					
U.S. 13	5047	3765	8812	489	5.54
Dixie 17	5257	6553	11810	590	4.99
Nitrogen Level:					
None	2954	3471	6425	285	4.43
120 lb.	5817	5780	11597	667	5.75

Some varieties may produce more tonnage but a lower proportion of grains than others.

Heavy fertilization may increase not only tonnage but also the proportion of grain and protein in the roughage. The quantity and quality of silage produced by sorghums probably varies in a manner similar to that of

corn with respect to variety and fertilization. Dry stalked vs. sweet stalked varieties affect palatability in the sorghums.

The table below shows the silage yield of small grains from a test in 1955. These were cut in the early to medium dough stage.

	Date of Harvest	% Moisture When Cut	Tons/Acre Silage at 68% Moisture	Pounds/Acre of Grain When Ripe
B-400 Barley	May 14	73	5.2	2074 (43.2 bu.)
Pawnee Wheat	May 19	68	6.9	2940 (49.0 bu.)
Vigo Wheat	May 28	67	8.5	2766 (46.1 bu.)
Balboa Rye	May 7	71	6.9	
Tetra Petkus Rye	May 29	71	9.3	
O-205 Oats	June 9	77	6.3	2416 (75.5 bu.)

Here an economical method was worked out to pour concrete fence line bunks. 2 1/2 cubic yards of concrete poured 20 lineal feet of bunk. 24 feet of reusable forms were used to pour about 800 feet of bunk on this farm.



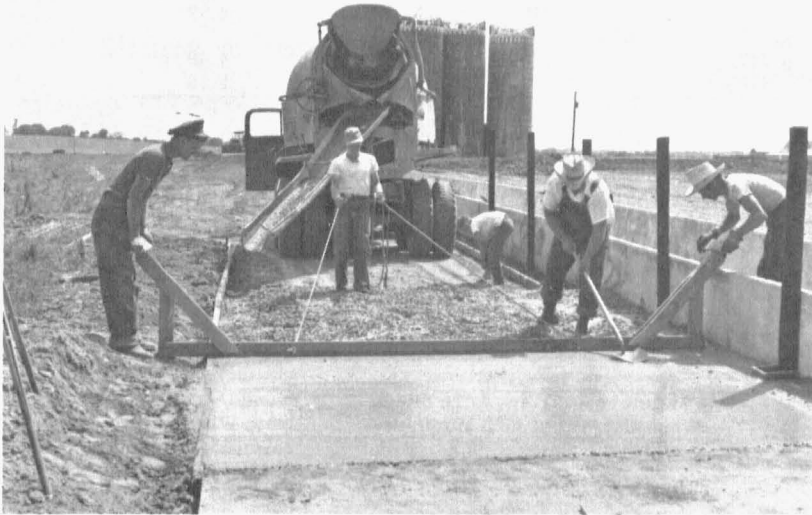
Crops Have Differences

Kinds and varieties of crops differ in date of harvest, yield, and composition.

Nitrogen fertilization of grains and grasses not only influences yield and chemical composition, but also the

moisture content at a given stage of maturity, all of which are important in the quantity and quality of the feed preserved.

In one test 35 pounds per acre of nitrogen increased the silage yield of wheat and oats by about two tons per acre.



A concrete slab 12' wide 4" thick and with thickened edges was poured to stabilize platform where livestock stood to eat silage. One cubic yard of concrete poured about 6' of this 12' platform.

FOR MANY YEARS IMPROVEMENT of silos has consisted of finding a better wall treatment, adding a roof, putting in more reinforcement, or planning a simpler method of erection for upright type silos.

Important as these may be for durability, appearance, economy, or safety, real challenges are to perfect a self-feeding method, to devise a mechanism for removal of silage, and to find economical ways to store, preserve, and handle large amounts of grass silage. Research and development in the University of Missouri, College of Agriculture's agricultural engineering department have been directed to meet these challenges.

The horizontal silo lends itself to these improvements. Silos in this category range from a simple unsupported stack to the permanent concrete above-ground or below-ground silos. The stack provides low cost storage at a sacrifice of silage quality.

One step better than this is the below-ground unlined trench which does give some sidewall protection against spoilage, but still can be considered as only a

temporary structure. The permanent horizontal silo, either above-ground or below-ground, with permanent-type floor and walls, fits in well with a long-time silage-feeding program.

Emphasize The Practical

Horizontal silos will serve present-day farming operations best if they are economical and completely functional. To be completely functional they must be conveniently located, designed for minimum losses, and constructed for durability and long service. They should be adapted also for self-feeding or for efficient feeding by use of mechanical equipment.

Thousands of temporary unlined trench silos have been constructed during the last few years. Many of these have been placed in inconvenient locations because the terrain near the feedlots was not suitable.

On some farmsteads where a sloping terrain with adequate drainage is available near the feedlots a trench-type permanent silo can be constructed economically. In many cases, however, above-ground construction will be required.

Kind of Silo You Need

Pressures on Walls

The design and construction of economical and practical above-ground horizontal silos have created somewhat of a problem, since self-supporting walls are necessary.

Until 1953 and 1954 when the initial research work was done at Missouri on silage pressures in horizontal silos, there was little design information available. Information on lateral stresses and overturning moments on silo walls during and after the packing of silage was needed.

From these data, pilasters, poles, posts and other lateral supports could be designed and an estimate of unit pressures established for the design of the planks and panels between the supporting members. Tests were conducted during the years 1953-55 to determine this needed design information.

Data for both long and short cut grasses and legumes at various moisture contents were obtained and have been reported in Agricultural Engineering Journal papers forming the basis of a bulletin now in preparation.

Conclusions drawn from the studies:

1. Maximum unit lateral pressures of 125 to 150 pounds per square foot will occur temporarily at a depth of from one to two feet below the silage surface during the filling operation.
2. At depths below the two-foot level of silage the unit lateral pressures relax to approximately 100 pounds per square foot.
3. A single-unit pressure curve for the total depth of silage changes constantly during the silo-filling operation but soon after the silo is filled becomes practically a vertical pressure curve of about 100 pounds per square foot from the two-foot depth, from the top, down to the six-foot depth.
4. The average concentrated lateral loads caused by the packing tractor ranged from 135 to 190 pounds at the silage surface. The horizontal load on the silo wall two feet below the surface is not affected appreciably by the tractor.
5. A lateral concentrated load of 200 pounds at the surface caused by the packing tractor, is justifiable for design purposes.

Construction Materials

Above-ground horizontal silos have been designed with tilt-up concrete wall panels and pilasters, concrete blocks, and with pressure treated poles and plank walls. A silo has been constructed on the Agricultural Engineering Farm using all of these materials so that the durability of the materials and their effects on silage quality can be observed. Results will be reported as they become available.

Filling the Horizontal Silo

Maximum assurance of minimum top surface spoilage on horizontal silos can best be provided during the filling operation. Forage should not be overly mature and should have a moisture content above 65 percent on the wet basis.

The forage material must be continuously packed in the silo during the filling operation with a heavy farm tractor. Each load of silage should be spread evenly in the silo to permit effective packing. The packing tractor should be operated for an hour each morning prior to the placement of any new forage in the silo.

A self-unloading wagon is an excellent way to spread the silage evenly, and a wagon of this type can have many uses around a livestock farm.

Feeding From Horizontal Silos

The horizontal silo lends itself readily to self-feeding techniques, to removal of silage with a tractor and scoop and to hand pitching.

A Missouri survey found that an average of 50 minutes per ton was required to hand pitch silage from horizontal silos into trailers or trucks and transfer it into feed bunks by hand.



Corn silage fed to 500 pound steer calves during the winter of 1957 produced excellent results when supplemented with soybean meal and a salt-bonemeal mixture. A ton of silage supplemented with 140 pounds of soybean meal produced 158 pounds of gain per ton of silage fed. In this case a 10 ton yield of silage produced 1580 pounds of beef per acre; a 15 ton yield produced 2,370 pounds per acre and a 20 ton yield, 3,160 pounds per acre.

One hand pitching operation can be eliminated by pitching directly into a portable bunk. Observations indicate that the tractor and scoop is the most efficient way to remove silage mechanically from horizontal silos.

Many scoops leave the face of the unfed silage loosened and ragged, and a fairly high rate of silage removal is needed to keep spoilage to a minimum. Silage can be loaded into wagons, trailers, or trucks, from horizontal silos at a rate of from 300 to 400 pounds per minute and directly into feed bunks at a rate of 260 pounds per minute. Time for the latter type of operation is directly related to the distance between the feed bunks and the silo.

Removal of the silage from the silo is generally only about half of the job of feeding it. The other half of the operation consists of placing the silage where it is to be eaten. This operation can be done by hand or mechanized in one of three different ways: (1) self-unloading wagons, (2) feed bunks conveyors or (3) carrier systems over the feed bunk.

Hand pitching of silage from wagons into feed lot bunks requires about 30 minutes per ton. Self unloading wagons will unload at a rate of about one ton in 15 minutes.

Self-Feeding Silo Economical

Self-feeding silage from a horizontal silo requires a minimum of labor on the part of the operator, but does require good management for maximum satisfaction. In the first place, *proper planning* for a self-feeding operation

is necessary. The relative amounts of hay and silage stored must be balanced properly so the livestock may self-feed both throughout the feeding season with a minimum of rationing of either.

The width of silo must be designed to allow from four to six inches of silo width per head of livestock. This provides sufficient feeding space when the cattle have access to the silage 24 hours per day. At a rate of consumption of 40 to 50 pounds per animal, this removes silage from the exposed surface at from four to six inches per day. This is fast enough to eliminate spoilage from exposure.

Self-Feeder Labor Requirements

The *labor requirements* of self-feeding are for (1) movement of the feeding gates, (2) removal of top surface spoilage and (3) removal of manure from the silo. Movement of feeding gate must be controlled by the operator to force the livestock to eat the silage that falls down in front of the gate. This may need to be done only every third or fourth day.

It may be done with a large crowbar or with the tractor. The removal of spoilage is a hand operation that would normally be done at the time the feeding gate is moved. This may or may not be of significance depending upon the amount of surface spoilage. Cleaning of the silo is an operation that can readily be done with a tractor and blade so that labor and time requirements of this job are minimum.



Here is a good type silage self feeding rack. Cattle stand on platform making further anchoring unnecessary. When livestock can no longer reach silage it is simple matter to scoot racks forward.

Self-Feeding Gates

There are two basic designs of self-feeding frame-type gates including the self-supporting and the suspended. A third method uses electrically charged wires to control feeding. The frame-type gates must be sturdy as the animal exerts considerable pressure on them attempting to reach fresh silage.

The self-supporting type gate with the platform has been found to be very rigid and successful where other types of self-supporting gates have not held up much more than one season without considerable repair. They should be designed to fit the silo. If the silo is more than 12 feet wide, two sections should be used.

In a suspended-type gate the top bar, which rides on the silo wall, must be sufficiently strong to support

the gate itself and also the pressures exerted by the cattle.

Must Fit Silo's Shape

This type of gate must be designed to fit the shape of the silo quite closely. It is necessary to anchor the top bar on the walls at each position throughout the feeding season and have the bottom bar of the gate fit closely enough to the silo floor to eliminate riding up over the silage.

All frame type gates must be provided with at least a 12-inch solid plank at the bottom to prevent excessive waste of silage.

The "hotwire" feeding gate has been used successfully by some feeders, however, the height of the wire and its movement requires careful management.

Planning Ahead in Improving Silage



We'll be hearing more about "chore tractors" because they are necessary to make this type of labor saving livestock handling unit possible. Silos and paved lots need to be cleaned every few days and this chore tractor makes this possible from the tractor seat.

LITTLE IS KNOWN ABOUT the fundamental processing of silage making—what goes on, or what should go on, in the fermentation process to make the best silage. What is known has been developed largely by the "trial and error" technique. More knowledge of the fundamental processes of chemistry, bacteriology, and plant physiology involved it appears might open up the field for practical developments that could result in top quality silage all of the time at lowest cost.

This work would involve more information on the following:

- a. The sequence of chemical and biological changes during fermentation and storage.
- b. What nutrients the microorganisms act on, and what fermentation products are produced under different conditions. This would include types of bacteria in the fermentation process and their differences during the different stages of silage making.
- c. Chemical and physical studies to determine the effect of varying plant structure and composition on pre-

servation processes and losses during fermentation and storage.

d. Information on the changes in protein and non-protein nitrogen including the formation of poisonous nitrates and nitrites.

e. Knowledge of vitamin, mineral and possibly antibiotic losses and changes.

f. Information on the sum of all these effects on the losses from the silo and their effect on nutrient value of the silage.

Such fundamental knowledge would enable the plant breeder to develop crops for silage quality as well as quantity, and would be a base for developing most efficient fertilizing and crop production practices. It would aid in developing harvesting, storing, and feeding practices that would provide the most feed nutrients at the lowest cost.

Problems that need study:

- a. Quality of silages produced:
 1. From various crops at different moisture contents and stages of maturity.
 2. With and without the use of preservatives, and
 3. Stored in horizontal, upright, and gas tight silos.

Quality is expressed finally by animal performance and involves palatability, nutritive quality, and water content as affecting consumption and production.

b. Types of storage—costs and returns. Comparisons of conventional types with gas-tight silos, and the use of plastic films to provide gas-tight storage.

The full possibilities of gas-tight storage need investigation. If relatively cheap, gas-tight storage could be developed, all indications are that this process could revolutionize forage processing and assist greatly in mechanization of feeding operations.

c. Costs of different types of harvesting and storage operations.

d. Effectiveness and practicability of various types of covers for horizontal silos.

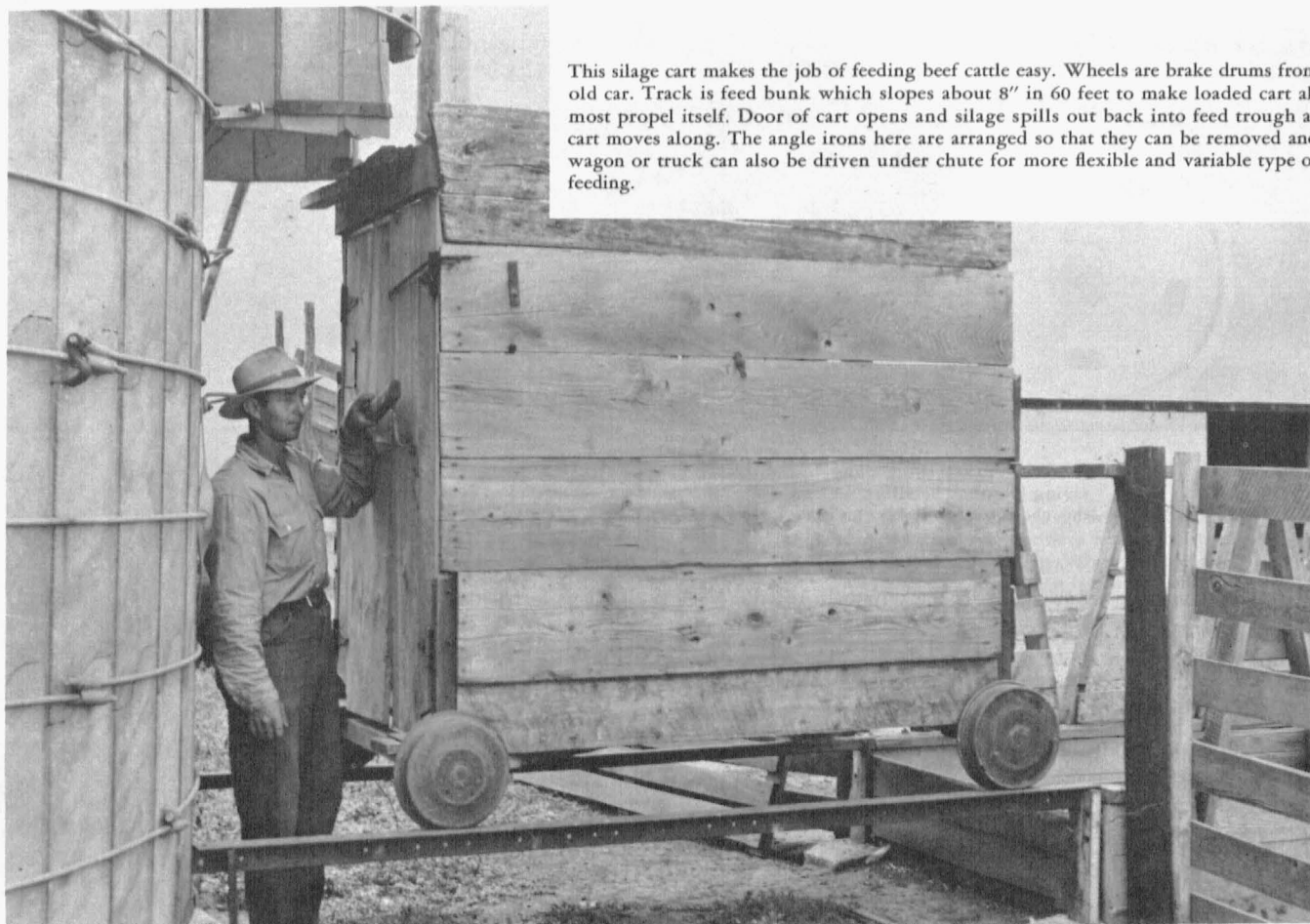
e. Loss of nutrients from "feeding face" of silage under summer conditions.

f. Spoilage and nutrient loss of silage made in spring as compared to that made in fall.

g. Fertilization, and cropping practices for silage production.

h. Cropping systems best related to silage production, storage and handling under different conditions.

i. Testing and breeding crop varieties better suited for silage needs.



This silage cart makes the job of feeding beef cattle easy. Wheels are brake drums from old car. Track is feed bunk which slopes about 8" in 60 feet to make loaded cart almost propel itself. Door of cart opens and silage spills out back into feed trough as cart moves along. The angle irons here are arranged so that they can be removed and wagon or truck can also be driven under chute for more flexible and variable type of feeding.

Recent Silage Research at Other Stations

(FROM USDA FARM PAPER LETTER)

Trench Silage Costs Less—It costs \$5.18 to harvest, store, and feed a ton of silage when an upright silo is used, compared with \$3.93 with a trench silo, according to a cooperative study by the USDA and the Alabama Experiment Station on 71 Alabama farms. Spoilage was 2.3 percent greater, however, with the trench silo. The biggest item of cost, harvesting, was found to vary by type of machine and type of silo used. For trench silos, it cost \$2.12 per ton with field forage harvesters and \$2.94 with binders, including some use of mowers. The cost of feeding from upright silos was found to be 96 cents a ton, compared with \$1.23 for trench silos.

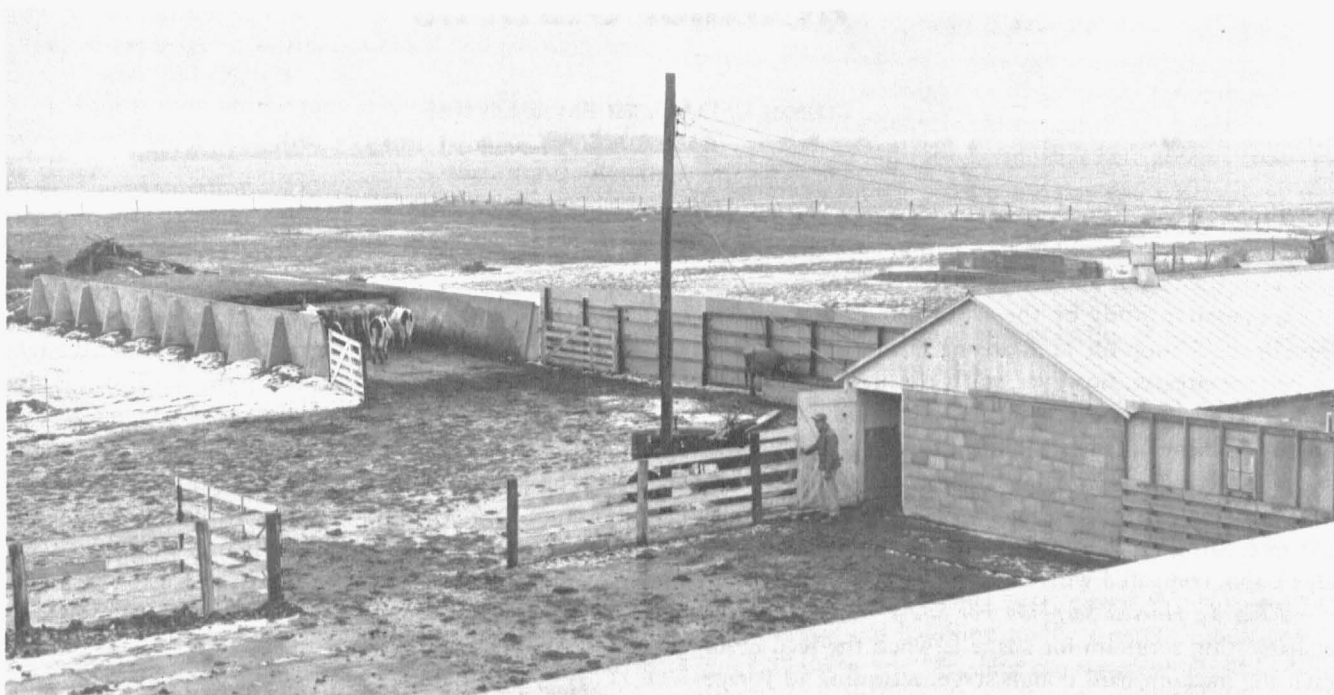
When To Harvest Sorghum For Silage—The best stage for harvesting sorghum for silage is when the seed heads reach the medium hard dough stage, according to Forage Crop Specialist Carl Hittle of the University of Illinois. If sorghum silage is made when the plants are less mature, too much acid develops, Hittle says, giving strong flavor and odor. On the other hand, if sorghum is allowed to mature much beyond the hard dough stage, the grain will get too hard and will tend to pass right through an animal without being digested.

Corn Silage OK For Brood Sows—A recent report from Purdue University, based on three years of research there, shows that corn silage can be fed to brood sows during gestation with satisfactory results. The experiments showed that the feeding of good quality corn silage, 1.5 pounds of a high quality protein, and minerals free choice, resulted in a 20-percent reduction in feed costs, an increase of 1.4 to 2.0 more pigs per sow at farrowing, and an increase of 0.3 to 1.3 more pigs per litter at weaning.

Late Sorghum OK For Ensilage—Late plantings of sorghum that do not mature before a killing frost can be made into fairly good ensilage, according to Extension Agronomist J. C. Swinbank at the University of Nebraska. It should be dried out somewhat before ensiling, though, he says. One way to tell whether the sorghum is dry enough or mature enough for silage is to twist a stalk with the hands. If a little juice is visible on the twisted cane, the moisture content is about right. Swinbank says immature sorghum that has been withered by drought can also be used for ensilage but it may be necessary to add water in order to make the forage pack well in the silo.

How To Guard Against Silo Filler's Disease—At silo-filling time there is the danger of "silo-filler's disease" caused by the poisonous gas-nitrogen dioxide that may form in fresh silage. USDA scientists suggest these precautions when filling all tower silos: Run the blower for 10 minutes before going into any partly filled silo and always keep the blower running while inside; watch out for irritating odors. Nitrogen dioxide is heavier than air and collects near the surface of the silage. The gas tends to settle in the silo chute and around the base of the silo; watch out for yellowish brown fumes because they are a sign of nitrogen-dioxide gas. If the silo is dark, use a flashlight; keep children and animals out of the silo and away from it during filling; after the silo is filled, wait at least a week before going inside and, if necessary, put up a temporary fence to keep children and farm animals away from it.

Silos need to be properly located for convenience. This above ground concrete tilt up wall silo is located adjacent concrete paved area. Here self feeding hay barn, self feeding silo, loafing barn and milking parlor are located as a compact unit. Lots are paved with 4" of concrete to keep livestock out of the mud. Buildings supplemented by windbreak fences give cattle protection from winter winds. Chores are reduced to a minimum because practically no hand handling of feed is necessary.



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You have "June in January" when silage is included in the feeding program. As pointed out in this bulletin, silage is a good substitute for pasture during the winter months. It is often referred to as "canned pasture," and may be fed the year around with beneficial results.