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INDUSTRY - UNIVERSITY SILAGE CONFERENCE

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UNIVERSITY OF MINNESOTA
INSTITUTE OF AGRICULTURE
ST PAUL, MINNESOTA

JANUARY 13, 1959
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MINNESOTA CONCRETE SILO ASSOCIATION

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INSTITUTE OF AGRICULTURE ST. PAUL 1 MINNESOTA

PROGRAM

Industry-University Silage Conference

Institute of Agriculture, University of Minnesota

St. Paul

Agronomy Building. . . . . Room 202

Chairman. . . Dennis Ryan, Extension Agricultural Engineer

.m.		
9:30	Registration	
0:00	Welcome.	T.H. Fenske, Dean, Institute of Agriculture
0:10	What is Silage?.	R.A. Briggs, Agronomy
0:40	Making and Storing Silage	C.K. Otis, Agricultural Engineering
1:10	Economics of Silage in a. . . . . Farm Program	Ermond Hartmans, Extension Economist in Farm Management
UNCH	Block and Bridle.	Beef Barbecue

Chairman. . . Ralph Wayne, Extension Dairyman

.m.		
1:30	Panel.	Feeding Silage to Livestock

Moderator. . R.E. Jacobs . . Extension Animal Husbandman

Dairy. .	John Donker. . .	Dairy Husbandry
Beef . .	Olaf Kolari. . .	Animal Husbandry
Sheep. .	R.M. Jordan. .	Animal Husbandry
Hogs . .	R.J. Meade. . .	Animal Husbandry

2:45	NO_2 Gas Production.	J.V. Scaletti, Animal Husbandry
3:00	Evaluation of Silage	William F. Hueg, Jr., Extension Agronomist
3:30	Future and Opportunities. . . . . in Silage	R.A. Briggs, Agronomy
4:00	Coffee and Adjournment	

WHAT IS SILAGE?

Rodney A. Briggs*

Silage is a moist preserved feed. To make quality silage we must understand the processes involved in its production. The fundamentals of silage are the same for corn, grass, or legumes. Adjustments may be necessary, however, to insure quality silage.

Generally we could consider that silage is a fermented material. Fermentation is brought about by the action of bacteria, in the absence of air, on sugars contained within the plant or added in the form of a carbohydrate preservative. The development of sufficient acid by fermentation to inhibit further bacterial action gives us the finished product, stable silage.

This procedure of bacterial fermentation is altered in the case of the addition of mineral acids or sodium metabisulfite.

Legumes, unlike corn, are low in sugars and high in protein. This lack of fermentable sugars favors an improper fermentation and the desirable acid formation is stopped before an acidity sufficiently high to inhibit further bacterial action has been reached and butyric acid is formed and putrefaction may take place.

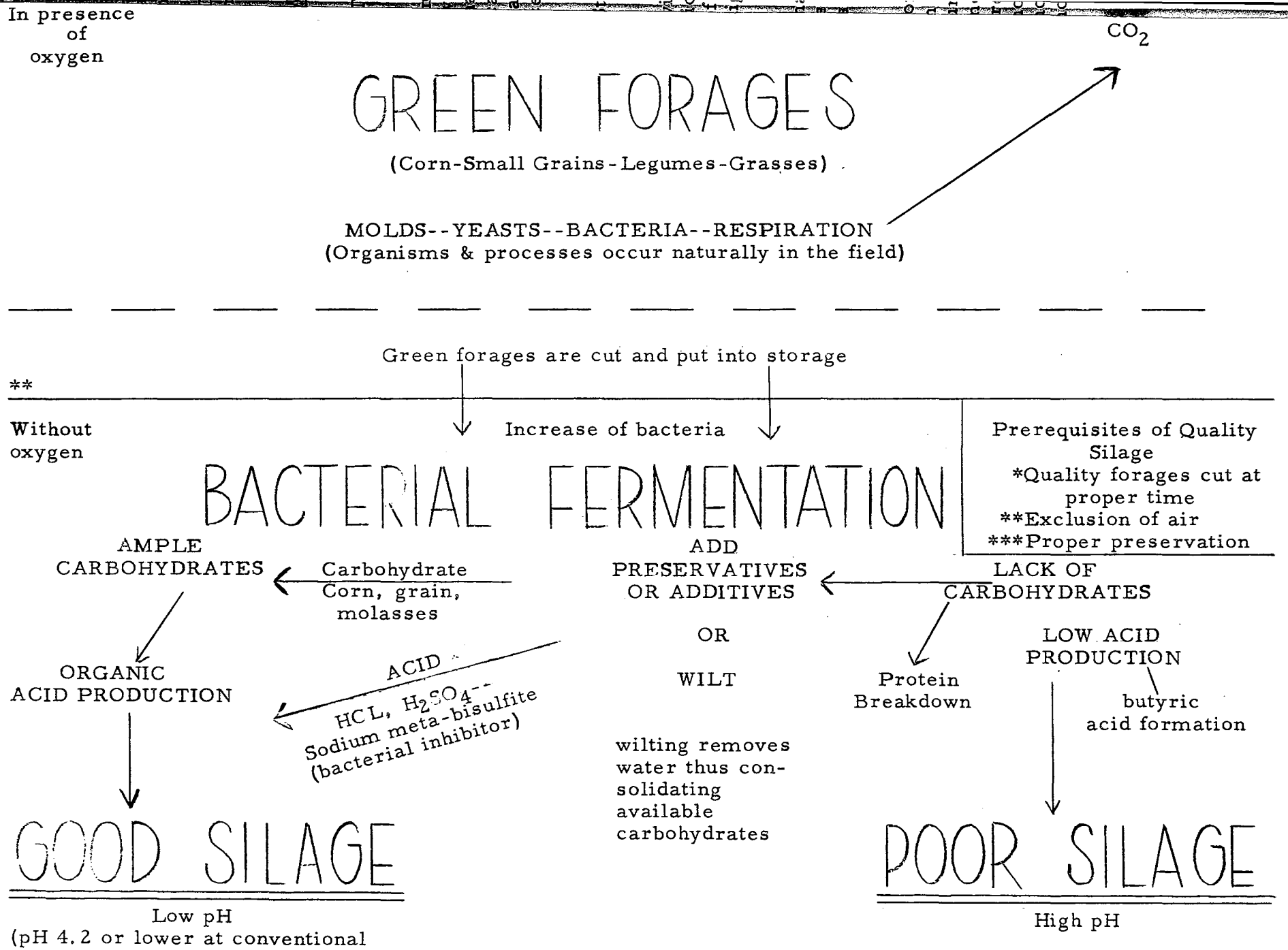
	AVAILABLE CARBOHYDRATES	CRUDE PROTEIN
Corn	Very High	Poor
Oats	High	Fair
Grass	Good	Medium
Grass-legume	Medium	Good
Legume-grass	Fair	High
Legume	Poor	Very High

Table 1 -- Availability of carbohydrates to supply natural sugars for silage fermentation, each cut at proper stage of growth.

Following is a schematic drawing of the silage process. These, and like materials, preserve silage by inhibiting bacterial activity.

In general, we can handle green material from the field in two different ways -- as direct cut (fresh green material) or partially dried (wilted). Because of basic differences between these two types of silages, they shall be considered separately.

*Associate Professor, Agronomy and Plant Genetics, University of Minnesota, St. Paul



A Schematic Drawing of the Silage Process

RAB/Jan. 1959

Direct Cut, Fresh Material

Our immature grasses and legumes are low in carbohydrates needed to promote favorable bacterial action effectively in the grass-silage process. Therefore, under conditions of high-moisture, direct-cut green material, a preservative is needed to direct the biological processes in the right direction. There are two types of preservatives on the market today which can be used: (a) sugars or other fermentable carbohydrates such as molasses or ground grains that aid fermentation, and (b) chemicals such as sulfur dioxide, sodium metabisulfite or mineral acids which inhibit fermentation. Dry preservatives or hay will also aid in lowering the moisture content if added to high moisture material.

Wilted Grass

Two different types of silage can be produced when using grass wilted in the field. These types could be classified as cold pack and warm silages.

The basic difference between these two types depends on the regulation of oxygen. In cold silage the wilted grass is chopped and is quickly put into silo and packed extremely well and covered to exclude oxygen. European workers indicate that this type of wilted silage has some definite drawbacks: If dry matter content is too low (below 35 percent), there can be a build-up of putrefactive fermentation, and if dry matter content is too high (above 50 percent), it is next to impossible to pack sufficiently well to exclude air, except when oxygen can be controlled.

Structures that can effectively regulate the oxygen supply can make good cold silage. Structures such as the glass-lined silos and plastic bags fit into this category.

If wilted silage is very gradually packed in loose layers and stacks, the temperature will rise. If the temperature rises rapidly, all bacterial action is stopped. This is a difficult procedure to insure even temperature rise throughout the green material. Losses of feed value are high, much of the energy is lost as heat, and there is a decrease in the digestibility of protein as well as high losses as protein.

Wilting silages to a 60 to 70 percent moisture level is a prerequisite for successfully making good wilted silage. Various authors have reported that the biologically active surface is not within the plant material, but at the surface. By controlling moisture content there is sufficient concentration of carbohydrates to insure proper fermentation.

As our productive improved grasses and legumes approach maturity, their dry-matter content increases. When cut at the proper stage of growth, our legumes are generally within a 70 to 80 percent moisture range, while the grasses are between 65 and 75 percent moisture. Many farmers take advantage of this loss of moisture by growing mixtures of legumes and grasses and cutting at early bloom stage or slightly later, as carbohydrate content increases with age. When this is done little wilting is required as the standing crop has a moisture level desirable for making grass silage. It is important, however, that no outside moisture such as rain or dew is left on the plant, as that can add to a higher than desirable moisture content.

Most wilted silages in this area have been a combination of these two silage types with an in-between silage produced. There is not sufficient heat rise to inhibit bacterial action and oxygen is not completely excluded to form a cold pack. Hence the potential loss of feed value may be great.

What then are the prerequisites or requirements for making a high quality silage? These requirements include a complex of factors including time of cutting, moisture control, length of cutting, proper fermentation, and control of oxygen.

R.B. Shepherd, formerly with the Bureau of Dairy Industry, U.S.D.A., has indicated that high moisture silage is robbing farmers of tons of good feed each year. High moisture material in conventional storage structures leads to high dry matter loss in seepage juice. His studies indicated losses as high as 10 percent of the total dry matter can be found in very high moisture material when put into a silo. Reduction of moisture content to 60 to 70 percent is desirable. However, when we approach 60 percent moisture content, the danger of poor packing and allowing oxygen to reach the silage is increased. Extra precautions must be taken to insure that oxygen is excluded. This can be accomplished by extra packing and shorter chopping or moldy, heated silage will be the result.

The first prerequisite in the production of quality silage is to harvest our forages when the nutritive value is high. As the plant matures there are great changes in the chemical composition and nutritive value of the plant. The crude protein content of alfalfa cut in the prebloom stage may be over 23 percent on a dry basis, but rapidly decreases to less than 14 percent when harvested at the seed stage. At the same time, crude fiber content can increase from 25 percent to over 35 percent. You can't get better quality out of a silo than you put into it in the first place. Corn silage with high ear content is also of higher quality than low ear content corn.

With a second prerequisite of oxygen control and a third prerequisite of proper fermentation the silo serves both as a processing as well as a storage structure. Where oxygen can be controlled, moisture content can be effectively lowered to approximately 40 percent before putting into a structure for processing. This stage insures that the maximum moisture loss has taken place but before leaves start to shatter. When a crusher or conditioner is used, the moisture could be reduced further, to approximately 30 percent.

Silage is not difficult to make, but knowledge of its processes will aid in its widespread use. We need more intensification and understanding to help us realize the potential value of our forages and allow us to farm to day as we will in the future.

MAKING AND STORING SILAGE

C. K. Otis*

Raw Material

Direct cut high moisture content 73% - 80%
Wilted cut 70% or below
Effect of moisture content on density and losses
Effect of maturity on density and losses
Effect of length of cut on density and losses

Additives (preservatives)

Molasses appears to speed up release of juice
Other additives being used

Method of Filling

Distribution important

Effect on pH
Effect on silo stability

Juice Flow

Hydrograph of juice flow
Need for good bottom drain

Capping Silage Surface

Airtight film
Weighting surface

Feeding from Surface

Rate of removal to avoid spoilage
Mechanical unloaders

*Professor, Department of Agricultural Engineering, University of Minnesota, St. Paul

THE ECONOMICS OF SILAGE IN THE FARM BUSINESS

E. Hartmans*

The primary objectives of making silage can be summarized as follows:

1) To decrease the losses incurred in harvesting forage crops.
2) To increase the total feed production of forage and grain crops and consequently the total output of animal products per acre.
3) To increase the net profit per acre.
4) To increase the net income to the farm family.

In discussions on silage the first two objectives are mentioned most commonly, thereby implying that the net profit per acre and net income to the farm family is automatically obtained. This is quite incorrect. The fact that more TDN is obtained per acre or even that more milk or meat is produced per acre does not necessarily mean that this results in more net income (the final and critical measure) to the farm family.

This discussion aims at taking a critical look at silage as to its capacity for increasing the net income position of the farmer.

In order to do this most intelligently, I want to divide my discussion into three different parts. These will deal with:

1) Silage made of exclusive forage crops such as legumes and grasses, as compared to harvesting these crops as hay.
2) Silage made of crops that can be harvested either as grain or forage.
3) Silage versus pasturing.

I. Forage Crops

Conventional hay making methods incur relatively large harvesting losses. Table 1 shows the results of a USDA study:

Table 1 - Harvest Loss - Field and Storage of Hay

	Field Cured		Barn Cured
	Rain	No Rain	No Heat
Hours in Swath and Windrow	108	54	20
Percent Loss of: Leaves	61	38	28
Dry Matter	37	21	19
Protein	46	28	24
Carotene	99	97	94

*Associate Professor and Extension Economist in Farm Management, University of Minnesota, St. Paul.

From the above table it is obvious that field losses of most field-cured hay are enerally around 30 percent of the dry matter. Losses in harvesting the crops for iiage can be cut down to 5 percent with timely cut forage. However, losses of storage nd preservation are higher in silage than in hay. The type of structure and the content o which a good fermentation process takes place will influence the storage losses to a reat extent. In the following table a covered upright silo is chosen for comparison:

Table 2 - Losses in Hay and Silage Making

	Field Cured Hay	Barn Cured Hay	Silage
	Percent loss of dry matter		
Harvesting	25	15	5
Storage	5	5	10
Total field to feed	30	20	15

These data indicate that more feed can be raised by making silage rather than mak- g hay. However, it should be kept in mind that more storage cost is required and more bor in the handling of it.

Table 3 gives a comparison of harvesting 100 tons of hay as compared to 300 tons of lage, assuming a 3 ton standing hay yield or 9 tons of silage for a 30-cow unit per year:

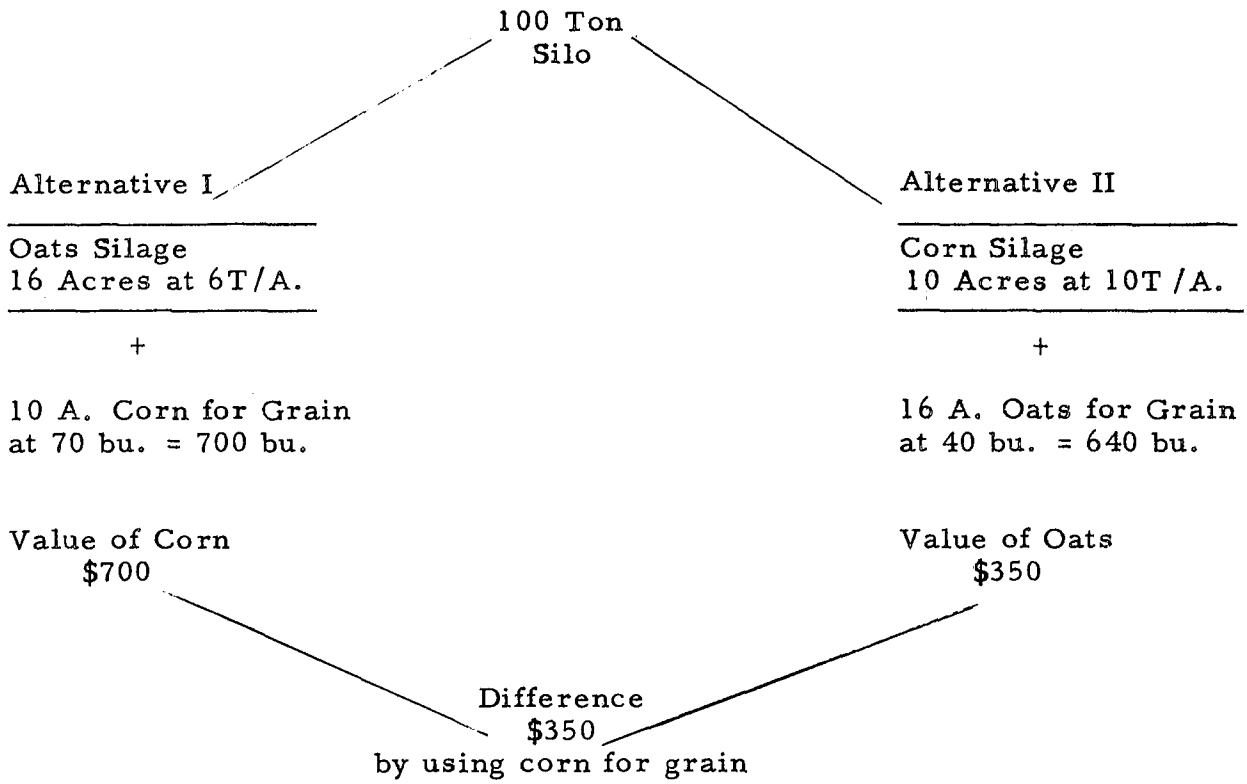
Table 3	Field Cured	Barn Cured	Silage
Acres required	47.6	41.6	39.2
Added returns over field cured:			
Extra cornland	----	$360	$504
Grain saving	----	180	180
Protein saving	----	240	240
Extra milk	----	90	90
Total added returns		$870	$1,014
Extra Costs (structure, equipment)	----	230	200
Extra Net Return (excl. labor)		$640	$814
Extra Labor		---	300 hrs.

This unquestionably illustrates the economic significance of both barn curing and silage making of good forage mixtures. Because of some additional nutritional benefits of feeding a combination of hay and silage, both silage making and barn curing have outstanding economic advantages in a good forage handling program. Taking the first crop for silage and the second crop for hay appears to be fitting into the farm business best.

II. Grain Crops

The two principal crops to be considered are corn and oats. When more forage is needed for the livestock program beyond what is furnished by the exclusive forage crops, oats should be given careful consideration as a silage crop before using corn. This assumes that oats are already part of the cropping program. The reason for this is given in the following comparison:

Figure I.

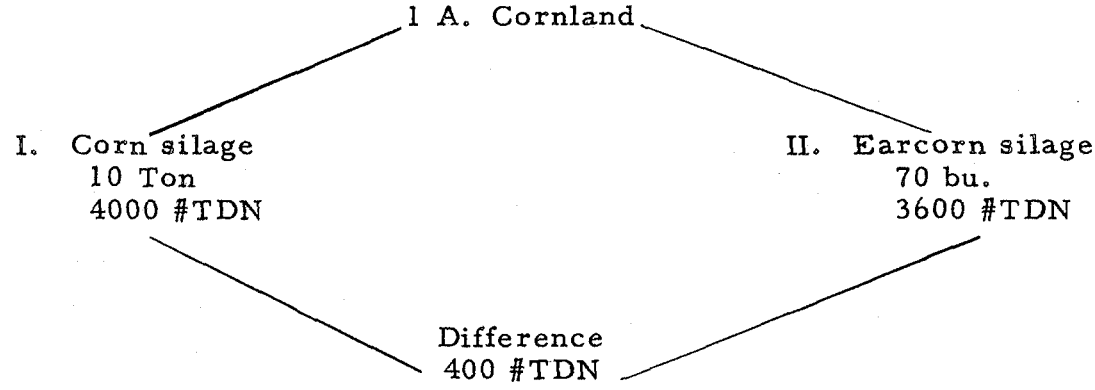


This indicates that oat silage can have up to $350 per ton less feed value than corn silage and the farmer should still consider this crop before taking corn for silage. Or, putting it another way, when corn and oat silage are compared in feed trials, under the above conditions of 40 bu. oats and 70 bu. corn, corn silage should be charged $3.50 more per ton than oat silage, in order to determine which feed gives the most economic returns. Proper timing of cutting the oats for silage is extremely important. Some additional benefits of oat silage such as weed control and effect on new-seeding may be important.

Corn is generally used as a silage crop in both dairy and cattle feeding programs, here, because of inadequate size of dairy business, more forage is needed than can be rnished by the forage and oats crop in the rotation. The farmer is justified in putting is corn in the silo. This pertains primarily to relatively small farms. On larger farms r on farms with a cattle feeding program a real question must be raised with regard to tting up corn silage; particularly, with the introduction of ear corn and shelled corn lage.

Figure II will show a comparison of taking 1 A. of corn land for silage as compared harvesting it as ear corn silage:

igure II.



The extra 400# of TDN are obtained with extra harvesting and storage cost of approximately $20. Or the extra TDN is obtained at a cost of $5-per 100# of TDN. Corn r grain can be purchased at $1.00 per bu. or at a cost of $2.00 per 100# TDN. In dition, considerably more labor is required in handling the corn silage. Even when rn silage would produce 800 lbs. more TDN than ear corn silage, the farmer would ill not be justified in harvesting the whole plant rather than the ear alone. The declin- g price of corn and the increasing cost of farm operation have caused this situation.

This conclusion is generally true for cattle feeders wherever corn reaches physiogical maturity. Before dairymen expand their dairy operation with corn silage, they ould consider alternative uses of their corn land through other livestock. Corn land rvested as grain and put through hogs or feeder cattle has a considerably higher inme potential per hour.

Silage versus Pasture

Recently a lot of emphasis has been placed on feeding dairy cattle in the yard the ar around either with silage or daily cut forage rather than by pasturing.

The University of Wisconsin has recently completed a study of the various summer eding methods and although the study shows that more TDN and more milk per acre can produced by silage feeding the year around as compared to soilage or ration-a-day graz- g, the cost of the extra TDN is so high that it is not advisable as a general farm practice.

FEEDING SILAGE TO DAIRY CATTLE

J. D. Donker*

Silage--feed with greater amounts of included moisture than those feeds stored in the dry form--has some advantages as well as disadvantages when fed to dairy cattle.

I shall not dwell on the advantages and disadvantages of making and storing feedstuffs as silage; rather, I shall consider is as a feedstuff compared to other materials from a feeding viewpoint.

Silage has long held a prominent place among feedstuffs fed dairy cattle of all ages and classifications. As a succulent feed, it supplies some of the water needed to digest and metabolize the feeds eaten. This quality of silage is still of great importance on farms which do not have individual drinking cups for milking animals. Silage is generally highly palatable and a combination of silage with other feeds generally allows more forage to be consumed and thus concentrates are saved. There is generally much less waste when silage is fed than when dry loose hay is fed, especially in bunk feeding. Silage is not dusty and as such has an advantage over many dry feeds.

Many silage feeding setups are completely mechanized, thus saving time and effort in feeding. The quality of the milk from silage-fed cows generally has a higher carotene and vitamin A content than hay-fed cows. The vitamin A provided by silage is important to the health of the cow and prospective offspring. Ensiling is the most effective way to preserve carotene in forage.

The performance of dairy cattle, which are fed silage, depends on the quality of the materials. Examples can be cited of good performance and also others of very poor performance. Our opinions of what consitutes acceptable silage often do not coincide with bossy's viewpoint. This difficulty occurs more often with hay crop silage than with corn silage.

There are some disadvantages of feeding silage to cattle also. The water that is included in silage makes handling expensive and hard work. While silage is not dusty, it may have an odor which can be easily picked up by the milk. The acids in silage have an undesirable effect on concrete mangers. In winter, silage might freeze and there is great difficulty in handling it. The rate of feeding silage must be considered in conjunction with environmental temperatures in order that undesirable fermentations do not precede the feeding of the silage.

The question of how much silage to feed to what animals is dictated by supplies of other feeds. Large Holstein cows can well use up to or over 75 pounds daily of corn silage.

There is sometimes difficulty when switching from corn silage to grass silage in that milk production drops. One must remember that good corn silage has a higher concentration of energy on a dry matter basis than any other forage material because of the ears of corn. The bacterial fermentation in the rumen does not adjust overnight as a ration might. Considerable time might be required before a new ration would be utilized as adequately as one to which the cows were adjusted. It is well to remember that it is never wise to change rations abruptly with milking dairy cows.

*Associate Professor, Department of Dairy Husbandry, University of Minnesota, St. Paul

SILAGE FOR SHEEP

R. M. Jordan*

Lamb feeders and farm flock owners do not use silages as extensively as beef producers. This is due to the relatively small tonnage to be fed daily. In addition there are many "old wives' tales" about silage as a feed for sheep. Those producers who have mastered the labor and spoilage problem have learned that silage has a valuable place in most sheep feeding schemes.

Corn silage, oat silage or grass-legume silage may be used as the major source of roughage for either fattening lambs or wintering ewes. However, silages have definite limitations. They are bulky and therefore there is a limit to how much sheep can eat and still consume sufficient nutrients for their daily requirements. Depending upon the type of crop the silage is made from, it may be an inadequate source of protein, calcium and energy for sheep. Methods of correcting the deficiency will be presented. Regardless of the type of silage being fed, the addition of some dry hay to the ration enhances the value of the silage for sheep considerably.

Ensiled ground ear corn or ensiled ground shell corn is an excellent fattening feed for sheep. On a dry matter basis it has the same value as "dry" corn.

Results of feeding silages to fattening lambs, wintering ewes and lactating ewes will be discussed.

*Associate Professor, Department of Animal Husbandry, University of Minnesota, St. Paul

ALFALFA HAY, ALFALFA SILAGE, AND CORN SILAGE FOR FATTENING LAMBS

	Jan., Feb., Mar., 1952			Oct., Nov., Dec., 1953		
	Alfalfa Hay Lot I	Alfalfa Silage Lot II	Corn Silage Lot III	Alfalfa Hay Lot I	Alfalfa Silage Lot II	Corn Silage Lot III
Number of lambs	22	22	21	25	24	25
Days fed	70	70	70	86	86	86
Average initial weight, lbs.	82.0	81.5	79.5	67.7	65.2	66.0
Average final weight, lbs.	109.0	116.9	113.8	103.4	104.2	104.0
Average gain per lamb, lbs.	27.0	35.4	34.3	35.7	39.0	38.0
Average daily gain, lbs.	0.40	0.50	0.49	0.42	0.45	0.44
Death loss	0	1	0	0	1	0
Average daily feed consumed, lbs.						
Grain	1.39	1.50	1.45	1.55	1.48	1.4
Hay	1.35	0.73	0.71	1.45	0.52	0.4
Silage	-----	2.44	2.30	-----	2.40	2.3
Protein Supplement	0.1	0.1	0.1	0.1	0.1	0.1
Feed per 100 lbs. gain, lbs.						
Grain	361.4	297.6	296.7	373.5	326.7	337.1
Hay	349.5	144.6	145.7	349.4	114.8	108.6
Silage	-----	483.2	470.1	-----	529.8	540.1
Protein Supplement	24.8	19.7	20.0	24.1	22.1	22.6

Oat Silage versus Corn Silage
With and Without Hay

Lot No. (Ten lambs per lot)		Lot 3 Oat Silage Shelled Corn Pelleted SOM	Lot 4 Corn Silage Shelled Corn Pelleted SOM	Lot 5 Alfalfa Hay Oat Silage Shelled Corn Pelleted SOM	Lot 6 Alfalfa Hay Corn Silage Shelled Corn Pelleted SOM
Initial Weight		75.0	74.5	75.1	74.4
Final Weight of lamb		94.9	94.0	99.2	99.0
Average gain per lamb		19.9	19.5	24.1	24.6
Average daily gain		.219	.214	.265	.270
	Alfalfa Hay			.50	.50
Average	Oat Silage	2.70		2.14	
Daily	Corn Silage		2.69		2.07
Ration	Shelled Corn	1.05	.99	1.07	1 06
	Pelleted Soybean Oil Meal	.30	.30	.20	.20
	Alfalfa Hay			187.6	184.1
Feed	Oat Silage	1233.2		809.9	
Per cwt.	Shelled Corn	480.6	464.5	404.4	392.1
Gain	Corn Silage		1255.3		765.9
	Pelleted Soybean Oil Meal	137.2	139.1	75.0	73.0
Feed Cost per cwt. gain		19.44	20.15	16.30	16.05

Summary of results from feeding rations with various proportions of legume hay and corn silage (11.0% total protein)

Year	Lot. No.	No. of lambs	Av. Daily Gain (lbs.)	Feed Cost per Cwt. Gain
Average daily ration (pounds): - shelled corn 1.01, linseed meal 0.16, hay 0.26, corn silage 3.29, ground limestone 0.02, and free access to salt.				
1946-7	VII	20	.342	$15.75
1947-8	IV	12	.327	22.03
1948-9	IV	12	.317	16.42
Average (1)			.331	17.65
Average daily ration (pounds): - shelled corn 1.03, linseed meal 0.09, hay 0.66, corn silage 2.55, ground limestone 0.01, and free access to salt.				
1946-7	VI	20	.357	$16.01
1947-8	III	11.2	.310	22.16
1948-9	III	12	.280	17.58
Average (1)			.323	18.04
Average daily ration (pounds): - shelled corn 1.05, linseed meal 0.008*, hay 1.11, corn silage 1.33, and free access to salt.				
1946-7	V	20	.319	$17.59
1947-8	V	12	.276	23.37
1948-9	V	12	.267	19.24
Average (1)			.293	19.62

(1) weighted average

* Linseed meal fed at the rate of 0.06 pound oer lamb daily in lot V for 30 days at the beginning of the 1948-49 trial and at the rate of 0.05 pound per lamb daily for the last 42 days of the 1947-48 trial.

These lambs averaged 56.8 pounds at the beginning of the experiment and were fed for an average of 124 days. The average final weights were 96.8, 96.6, and 92.5 pounds, respectively, for the lots fed 0.26, 0.66, and 1.11 pounds of hay.

COMPARISON OF ALFALFA HAY AND ALFALFA SILAGE FOR PREGNANT EWES

	Lot 1 Alfalfa Hay	Lot 2 Alfalfa Silage
Number of ewes	20	20
Days fed	126	126
Average initial weight, lbs.	170.9	170.9
Average final weight, lbs.	203.7	184.9
Average gain per ewe, lbs.	32.8	14.0
Death loss	0	0
Average fleece weight, lbs.	11.45	9.57
Lambing percent		
Ewes bred	165	130
Ewes lambing	174	173
Average birth weight, lbs.		
Single	12.4	11.2
Twins	9.6	8.6
Weaning percent	120	95
Average rate gain first 35 days, lbs.	.51	.45
Average daily feed consumed		
Grain (last 30 days), lbs.	.5	.5
Roughage, lbs.	3.9	9.8

SILAGES FOR BEEF CATTLE

O. E. Kolari*

The use of silage in beef cattle programs is usually looked upon as an economical and efficinet method of feeding. A great number of trials have been conducted with the various silages and perhaps no individual silage program is best for all feeders. Cattle feeding is unique in that a number of systems of feeding various kinds of cattle have evolved. The kind of silage feeding program to be used on any given farm depends on a number of factors such as size or age of cattle, grade of cattle, speed of fattening desired availability and relative price of grains and silages, etc.

Silage research with beef cattle was initiated in 1953 as a part of the Beef-Grassland Program at the Rosemount Station. In silage studies with wintering steer calves at Rosemount, the over-all objective has been to winter the cattle to gain at about one pound, or slightly over, per head daily. Alfalfa, alfalfa-brome, grass, corn, pea vine and oat silages have been fed.

Results of these trials during the past years have indicated that alfalfa-brome or grass silage has about 80% of the feeding value of corn silage. Oat and pea vine silages have about the same or slightly lower value than alfalfa-brome silage.

Alfalfa silage has been fed in various combinations with corn silage. The value of such combinations appeared to be related to the amount of corn silage fed.

Preservatives have been added to alfalfa-brome silage and their effects tested by feeding trials with wintering steer calves. Molasses (100#/T), sodium meta-bisulfite (8#/T), ear corn (150 and 300#/T) and beet pulp (150#/T) have been used. None of these treatments has been outstanding in increasing gains and decreasing costs of production.

These trials have shown that alfalfa-brome hay has as good or even better feed valu than alfalfa-brome silage for wintering steer calves.

Wintering calves lack the capacity to eat ample grass silage or hay to make gains o one pound or over per head daily. It is not unusual to find that calves will lose body weig when fed grass silage only. It will require approximately 20 pounds of silage, 3 pounds o ear corn and 3 pounds of hay per steer per day to provide the necessary gain. With this type of feeding program, cost of gain may be approximately 15 cents per pound of gain wh silage quality is good and silage losses are minimal.

Cattle seem to relish some dry roughage when fed high silage rations. The addition of small amounts of hay or dry corn cobs to either grass silage or corn stover silage has proven beneficial in trials conducted at Iowa. Less corn was needed to produce the same or equivalent gain when dry roughage was fed simultaneously with the silage.

A recent and interesting development in silage feeding is the "all-in-one" silage. I this method 40% of the total silage weight is corn added at ensiling time. Results of these trials (Illinois) with high energy treatment of alfalfa and oat silage when the silage is put show that these silages compare favorably with corn silage. They concluded that the high

*Assistant Professor, Department of Animal Husbandry, University of Minnesota, St. Pa

alue corn silage holds is due to its grain content and high tonnage per acre. The supplemental feeding of 1 lb. or protein per head daily with oat and corn silage in these rials proved to be beneficial. Calves adjusted quickly to the high level of corn contained n the silage when they were full-fed the first day.

Studies at the Illinois Station have shown that a forage or pasture crop yields more otal digestible nutrients when harvested as silage when compared to pasture feeding or eding as hay. In one of their trials fattening steers full-fed ear corn with alfalfa silage ained 2.41 pounds per head daily, compared to 2.09 pounds for cattle full-fed ear corn n pasture. They calculated that one acre of alfalfa yielding 8 tons of silage would provide ilage for 6.4 steers. One acre of comparable pasture would provide forage for 2.4 steers. he pasture cattle consumed less corn in this 114 day trial. Purdue trials indicated that ne acre of forage put up as grass silage produced 500 pounds of beef per acre. The amount f cattle gain produced from an acre of (1) corn silage, (2) ear corn, (3) hay silage was reently tested at the Illinois Station. The total area of crops fed nedessary to produce 100 ounds of beef with yearling steers was (1) 0.17, (2) 0.25, and (3) 0.25 acres, respectively, r the above feeding programs. Daily gains and carcass grades were the best in the ear orn group.

A number of cattle feeding trials have been conducted comparing sorghum silage to orn silage. Results of these trials generally show corn silage superior to sorghum silage. Sorghum silage contains less grain than corn silage on a unit weight basis and therefore cattle gains are usually increased more by feeding corn or grain in addition to sorghum ilage, than in addition to corn silage. Purdue researchers calculated that 11.3 tons of orn silage per acre contained the equivalent of 70 bushels of corn and 17.75 tons of sorhum silage per acre contained 40 bushels of grain.

Considerable interest has been shown recently in high moisture corn for cattle feedg. Results of Iowa and Purdue experiments show that 9-10% less corn on a dry matter asis is required per unit gain when high moisture corn is fed. Average daily gains have ot differed much between high and low moisture corns. However, it does appear that the y matter intake of the corn in slightly reduced when the corn fed is high moisture corn. his observation has also been noted when comparing the dry matter intake of cattle fed ilages containing varying amounts of dry matter. Dry matter intake has usually been gher when the dry matter content of the silage has been higher.

Cattle will eat about 5-6 pounds of silage per 100 pounds of liveweight when the cattle e on a full-feed of silage. With high levels of silage feeding about one ton of silage will required per 100 pounds of liveweight gain. As the amount of grain fed to silage fed cattle increased the amount of silage consumed is decreased. The most desirable amount of lage to feed is dependent on a number of factors as has been previously pointed out. The fluence of level of silage fed upon daily gains and carcass grade was investigated at the osemount Station during the past year. A group of yearling steers (64) weighing about 780 unds and a group of heifers (64) weighing 520 pounds at the start of the trials were fed rying levels of corn silage. Results of these two trials indicated that high corn silage eding decreased gains. Results of the average daily gains of the cattle follow:

Kind	No silage	1/3 silage	2/3 silage	Full-fed silage
Steers	2.53	2.57	2.42	2.29
Heifers	2.18	2.16	2.08	2.03
Average	2.35	2.37	2.25	2.16

A similar type of experiment was conducted by Illinois last year. Their results showed tle difference in the gains made by steers. However, results of their heifer trial agree th the above.

SILAGE IN SWINE PRODUCTION

R. J. MEADE*

Swine, because of their simple stomach, are usually fed moderate to high energy rations which will promote rapid and efficient gains. Thus, it does not appear that silages of the roughage category fit into the swine program to any extent. However, it must be recognized that all hogs are not being finished for market and that in the case of the brood sow, where only moderate gains are desired, the silages may be used to advantage.

If silages are to be used in the feeding of pregnant sows and gilts, the nutrient deficiencies of the silages must be corrected. For example, well-eared and well-matured corn silage is deficient in quantity and quality of protein, minerals, vitamin D and many of the B vitamins, including vitamin B_{12}.

Workers at the Iowa Station (J. Animal Sci., 16(1957):600) reported the results of an experiment in which they fed pregnant sows and gilts 12 pounds of corn silage per head daily supplemented with a 20 percent protein "corn silage balancer" which was fed at two levels of intake. This corn silage balancer was formulated to contain adequate amounts of protein, minerals and vitamins to correct the nutrient deficiencies of the corn silage. They reported that when the silage balancer was fed at a low level (2.50 and 2.75 pounds per head daily to sows and gilts respectively) during the first two-thirds of the gestation period, and at a high level (3.75 and 4.55 pounds per head daily to sows and gilts, respectively) during the last third of the gestation, the sows and gilts produced 1.41 and 1.54 more pigs per litter, respectively, than did sows and gilts which were fed 2.95 and 3.2 pounds, respectively, of balancer per head daily throughout the gestation period. Additional details of this study by the Iowa workers will be presented.

Workers at the Purdue Station (Mimeo. A.H. -152, 1955) reported that sows fed corn silage rations averaged 0.3 to 1.3 more pigs per litter at 8 weeks than did sows fed the conventional control ration. Feed costs per sow were reduced by from 16 to 20 percent through the use of corn silage. However, the sows fed the corn silage rations were not given as much T.D.N. as were the sows fed the control ration. In 1956 (Mimeo A.H. -180) the Purdue workers reported that the feeding of corn silage to brood sows during the gestation period resulted in (1) 25% lower feed costs, (2) 1 to 3 more pigs per litter at farrowing time, (3) an increase in percentage of pigs weaned and (4) 2 to 3 more pigs per litter at weaning. In this particular experiment these workers investigated the influence of various levels of supplementation of corn silage rations for pregnant sows. The Purdue group has conducted additional work with corn silage in brood sow rations an the results of such work as well as more detailed information on the above mentioned reports will be presented.

In none of the above mentioned reports has cost analysis data been presented to ind cate whether the use of corn silage in the feeding program will increase, or decrease, th labor requirement in caring for brood sows. Likewise, no data is given regarding the ty of enterprise in which a corn silage feeding program might best be followed in the feedin and management of the brood sow herd.

The results of two experiments conducted at the Purdue Station to determine the va of high-moisture ensiled shelled corn for growing-finishing swine (Mimeo. A.H. -183, 19 Mimeo. A.H. -244, 1958) will also be discussed.

*Associate Professor, Department of Animal Husbandry, University of Minnesota, St. P

NO_2 GAS PRODUCTION

J. V. Scaletti*

Laboratory silos have been utilized in a study of the evolution of oxides of nitrogen from ensiled oats, alfalfa and corn obtained at varying conditions of growth, maturity, moisture content, nitrogen fertilizer levels and preservatives. The effect of these conditions on the evolution of oxides of nitrogen has been observed.

*Assistant Professor, Department of Animal Husbandry, University of Minnesota, St. Paul

EVALUATION OF SILAGE

William F. Hueg, Jr.*

The role of silage as a farm-produced feed has long been recognized by livestock farmers. However, with many years of silage making experience, too many farmers have variable results from year to year. Perhaps much of this variability has come about simply because the farmer has not understood the mechanics of silage productions. He has paid too little attention to the details that result in good silage, and all too often has failed to recognize the factors involved those years when a good silage product was made, making it difficult if not impossible to duplicate the results year after year.

Part of the dilemma has been that the farmer did not recognize the important quality factors which determine whether his silage will be a valuable feed or a stinking mass. In addition, there has been little agreement on the part of those in the field of agronomy and animal nutrition to set up standards which make it possible to evaluate silage as a feed.

Sensory evaluation--by taste, color, odor and feel--has been widely used with success in evaluation of food for human consumption. The standards for hay evaluation reflect to a relatively high degree the chemical value of the hay, and to a degree, its feed value. It would be supposed that such standards could be modified and adapted in the evaluation of silages.

The scorecard developed by the National Silage Evaluation Committee has brought together, in short, concise statements, those characteristics which can be evaluated organaliptically. At the same time, the descriptive terms used have been so described that the farmer, reviewing such an evaluation of his silage, can readily visualize and relate the cause and effect as expressed in his silage sample.

An educational program was set up in Minnesota in 1956 under the direction of Rodney Briggs, then Extension Agronomist, to survey by sampling the quality of silage being produced on Minnesota farms. This was accomplished by scheduling a silage show during Farm and Home Week. To date, 777 samples have been evaluated under this program.

Each entry was accompanied by a detailed information blank as attached. Each sample was evaluated against the score card. A copy of the silage evaluation was returned to each entering farmer for his information. In all publicity regarding the show, the educational values derived from the evaluation were stressed, rather than competiti

After reviewing this number of silage samples, one begins to find definite relationships between specific handling and storage practices, and the resultant quality of silage. High quality silage is dependent on many factors, all of which can be controlled to some degree by good management. There are, however, two major requirements for the silage process: 1) the elimination of air; 2) a proper fermentation.

1. The silo is a processing structure , as well as a storage structure. To produce high quality silage, it must be airtight. Over 60 percent of the silage made in trenches, bunkers or stacks was scored fair or poor, while in conventional upright silos, only 36 percent was scored fair or poor.

*Assistant Professor and Extension Agronomist, University of Minnesota, St. Paul

2. A primary requirement for a proper fermentation is a good supply of sugars or fermentable carbohydrates. Because corn has a good supply of sugar when harvested at the mid-dent stages, we normally get a proper fermentation.

Conversely, forage grasses and legumes are high in protein and low in the necessary carbohydrates, which makes a proper fermentation difficult or impossible to achieve. In addition, high moisture content aggravates the difficulty of getting a proper fermentation. Therefore, when using early cut grasses and legumes, it is desirable always to use a preservative.

a. Ninety percent of all the corn samples were harvested from the early to late dent stages. Only 37 percent of these samples scored fair or poor. However, those samples cut when in the immature milk stages were only scored fair or poor.

b. The same relationship held with oat silage samples. Sixty percent of those samples cut in the late milk to late dough stage were scored excellent or good. However, those samples cut in the early milk stage were allowed to wilt, and were scored good. Minnesota recommends cutting oats in the late milk to early dough stage.

c. Of the grass silage samples, 36 percent contained 90-100 percent legume. Two-thirds of the grass silage samples are being harvested at the early stages of growth. Approximately half of the grass silage samples had preservatives added, of which 60 percent were chemical, and 40 percent carbohydrate preservatives.

d. Where preservatives were used in the recommended amounts, 31 percent of the grass silage samples were scored excellent, and 38 percent were scored good. Where preservatoves were used in less than recommended rates, only 45 percent of the samples were scored excellent or good.

1959
FOURTH ANNUAL MINNESOTA SILAGE SHOW
CONTEST AND EXHIBIT
FARM AND HOME WEEK - JANUARY 15 & 16, 1959
DAIRY BARN - ST. PAUL CAMPUS
UNIVERSITY OF MINNESOTA

ENTRY BLANK (Please fill out as completely as possible)

1. Name_____ Address_____ County_____

2. Type of silage: Corn_____ Alfalfa_____ Other (Name)_____

3. Composition of Silage

Legume %		Grass %	
Alfalfa	____	Brome	____
Clover	____	Timothy	____
Mixed	____	Mixed	____
Other	____	Other	____

4. Harvesting & Preservation

If Wilted, How Long?		Preservative Used (if any)	
Direct cut	____	Kind	____
1 hour or less	____	Amount per ton of green material	____
2 - 4 hours	____	How applied	____
4 - 6 hours	____		
6 or more hours	____		

5. State of Maturity at Cutting

Corn		Small Grain		Legume		Grass	
Immature	____	Immature	____	Immature	____	Prehead	____
Milk	____	Early milk	____	Early bloom	____	Heading	____
Early dent	____	Late milk	____	Late bloom	____	Flowering	____
3/4 dent	____	Early dough	____	Seed stage	____	Seed	____
Late dent	____	Late dough	____	Mature	____	Mature	____
Drying	____						

6. What Kind of Weather When Filled

Bright sunshine	____
Overcast or cloudy	____
Raining	____

7. Type of Storage

		Tons	
Upright silo	____	Capacity	____
Trench	____	Capacity	____
Horizontal (Bunker)	____	Capacity	____
Stack	____	Capacity	____
Glass lined	____	Capacity	____

8. If feeding, is it palatable?_____

9. Do you use a plastic cap to cover silage? Yes____ No ____

10. Have you ever seen a gas at the base of your silo? Yes____ No ____
Have you ever found dead birds or animals at the base of your silo? Yes____ No____
Have you ever noticed an unusual odor while filling the silo? Yes____ No ____

11. What type field chopper: conventional____ or flail ____

The sample should be approximately 1 quart. Place the sample in a plastic freezer bag or a mason jar. Try to remove air from the sample. Frozen samples are desirable. Bring or send samples to "Silage Show", 103 Agronomy Building, Institute of Agriculture, University of Minnesota, St. Paul 1, Minnesota any time during the week of January 12 to 16 (Farm and Home Week). You can bring a sample directly to the Dairy Barn on January 15 or 16. No samples will be returned; but a scoring and an evaluation of the silage will be returned to each exhibitor.