Bulletin 360 May 1942

HAY CROP SILAGE

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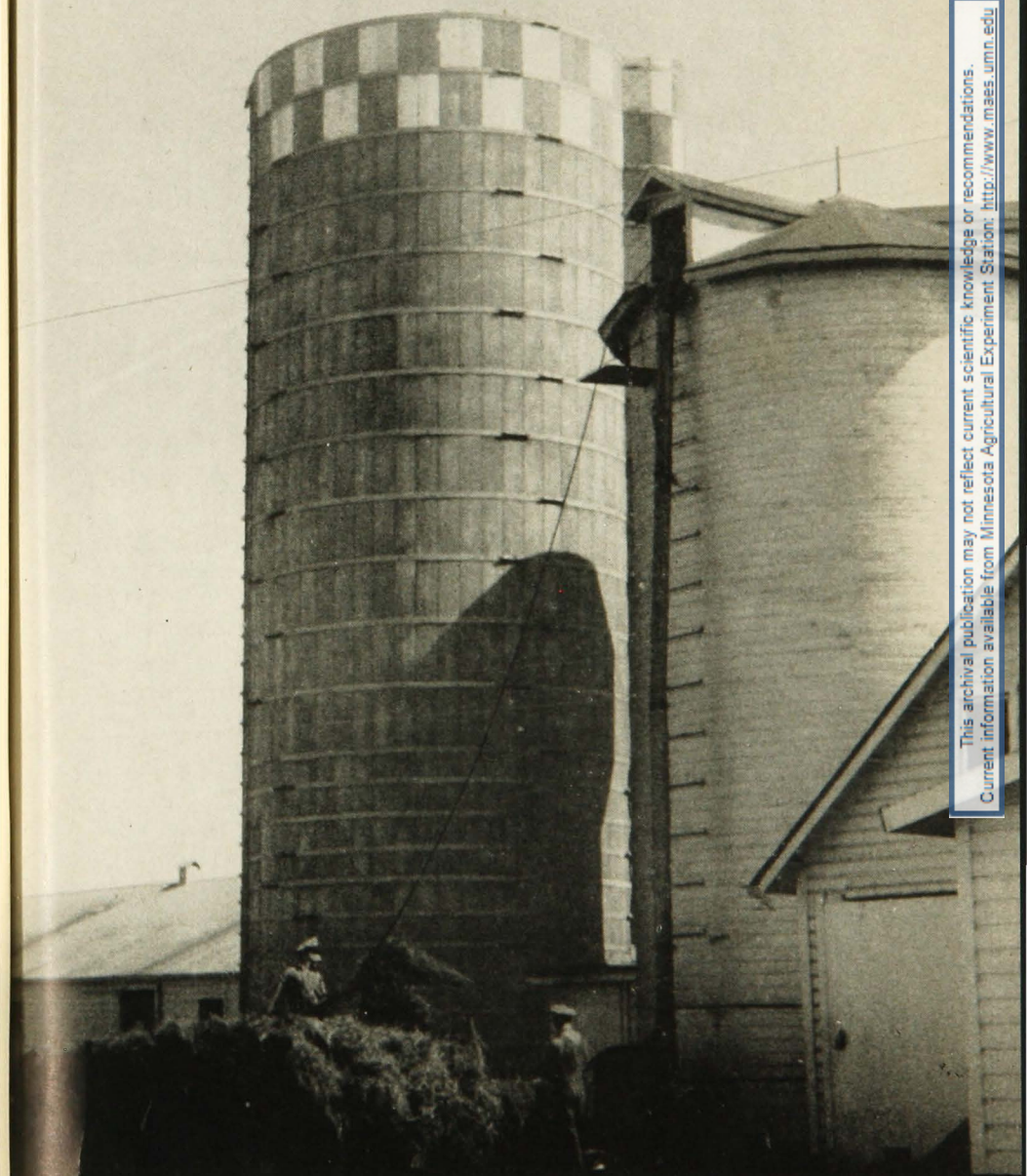

AGRICULTURAL EXPERIMENT STATION—UNIVERSITY OF MINNESOTA

Hay Crop Silage

1. Almost any feed of high moisture content may be preserved as silage.

2. The feeding value of the silage will depend upon the feeding value of the fresh material and the conditions under which it is ensiled.

3. Good silage may be made from hay crops when weather conditions do not permit curing as hay.

4. Under certain conditions crops such as sweet clover which do not make good hay may be ensiled to good advantage.

5. The quality of hay crop silage may be improved by addition of preservatives such as molasses, acid, or ground corn.

6. Regulation of the moisture content of the green material ensiled is important, even when preservatives are used.

7. Try hay crop silage in a small way and with present equipment before embarking on an extensive program of ensiling grasses or legumes. This experience may help to avoid expensive mistakes.

Accepted for publication January 27, 1942

Hay Crop Silage

N. N. Allen and J. B. Fitch

DURING THE PAST four or five years there has been a great deal of interest in the practice of ensiling crops ordinarily harvested and cured as dry hay. This type of silage is most commonly referred to as "grass silage," although "hay crop silage" is probably to be preferred as a general term since the legumes are more commonly used than the true grasses.

While the ensiling of green hay crops is new to most Minnesota farmers, it is a practice which has been followed for centuries in Europe where green feeds have been stored in underground pits or earth covered stacks. Because of its abundance and palatability, corn has been the leading silage crop in this country with other coarse forage crops such as sorghums or sunflowers used to some extent in sections not well adapted to corn.

In practically every early American publication on silage mention is made of legumes and grasses as silage crops, and specific recommendations on methods of handling are made in many cases. Green pea vines from which the peas have been shelled for canning are commonly ensiled by piling in large, rectangular stacks, and despite the relatively large amount of decomposition and heating in these slowly built stacks the resulting silage is valued highly as a dairy cow feed.

Recent Interest

The national program of soil conservation, by encouraging growing of more legumes and less corn, has undoubtedly contributed to the revival of interest in hay crop silage. The use of preservative agents has helped to insure silage of good quality, although this is by no means a new practice. The Kansas Experiment Station[1] in 1917 reported extensive experiments in which molasses, ground corn, sorghum stover, straw, and green rye were successfully used with green alfalfa. Various preservatives had been used experimentally and reported even previous to that time by different stations.

Through their advertising, manufacturers of equipment and preservative materials have been very active in bringing the advantages of ensiling hay crops to the attention of livestock producers during recent years.

Extent of Practice

Ensiling of hay crops is more generally practiced in the New England states and in the Pacific Northwest than in the corn belt. It has been difficult to secure accurate information on the extent to which this type of silage is being used in Minnesota, but apparently only a small percentage of our dairymen are actually ensiling hay

[1] Reed, O. E., and Fitch, J. B. Alfalfa Silage. Kansas Agr. Expt. Sta., Bul. 217. 1917.

crops although many are seriously considering the advisability of adopting this method.

MAKING A DECISION

Before deciding whether or not to ensile hay crops, each operator should consider carefully the advantages and disadvantages under his own conditions. Beyond doubt there are some who might profitably make this a regular part of the farm program, while others would find it advantageous to ensile part of the hay crop only under certain conditions. In some cases there is little to be gained under any circumstances.

Advantages of Ensiling

1. *Permits saving the crop regardless of weather.*
   a. Reduces or eliminates loss due to unfavorable curing conditions.
   b. Permits harvesting to proceed on schedule, avoiding interference with other farm work.
   c. Permits removal of first crop at the time most favorable to growth of second crop.
2. *Eliminates or greatly reduces loss of leaves,* which contain a very high percentage of the nutrients of the plant.
3. *Permits better use of crops not well adapted to curing as hay.* In Minnesota this is particularly applicable to sweet clover and reed canary grass, which are often difficult to cure as hay.
4. *The Vitamin A value and color are retained more effectively than in hay* with consequent improvement in Vitamin A content and yellow color of the milk. There is also some evidence that the plant pigments help to prevent development of objectionable flavors in milk.
5. *Requires less storage space* per pound of dry matter than dry hay even when baled or chopped.
6. *Silage presents no problem of fire hazard,* but unless it entirely replaces dry hay there is little actual reduction of fire risk.
7. *Requires less labor for feeding.* This is a questionable claim, for, while the bulk of silage per pound of dry matter is less than of hay, the weight is about three times as great.
8. *Provides green feed which may be fed during the short pasture periods* of late summer, leaving the silo available for the regular filling of corn silage in the fall.
9. *Supplies more protein than corn silage.* This may be an important factor if low-protein hay is used. However, with legume hay of good quality, supplying protein needs is not a difficult problem, even with corn silage.

Disadvantages of Ensiling

1. *Higher cost of nutrients in silage.* Due to the high moisture content of the green crops, the tonnage which must be handled is almost three times as great as when dried for hay. This results in a higher cost per pound of dry matter. If a large acreage is being ensiled, this higher cost can be partially offset by purchase of special equipment. Estimates from the Division of Agricultural Economics of the University of Minnesota show probable costs of harvesting an acre of alfalfa as silage, including cost of 65 pounds of molasses per ton, to be about 80 per cent greater than harvesting as dry hay. The cost of the molasses accounts for almost two thirds of this added expense, the remainder being for additional labor and equipment.
2. *Lack of palatability.* Many users report that their cows do not like legume or grass silages as well as corn silage. This is partially borne out by experimental work, but there appears to be no serious difficulty in

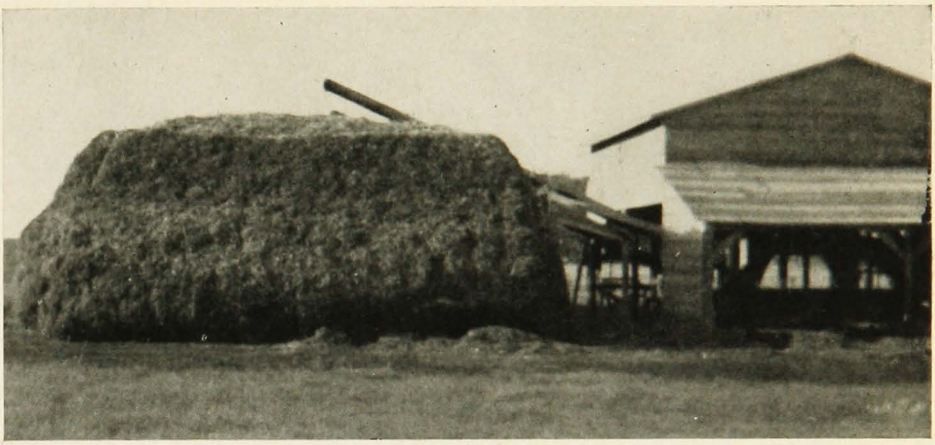

FIG. 1. PEA VINE STACK SILAGE IS A FORM OF LEGUME SILAGE COMMONLY USED FOR DAIRY HERDS IN THE VICINITY OF PEA HULLERS. ORDINARILY NO PRESERVATIVE AGENT IS USED

getting the cows to consume amounts as great as would ordinarily be fed.

3. *Silage contains little Vitamin D.* If silage replaces all or a large part of the hay, the cow's principal source of Vitamin D is cut off since sun-cured hay ordinarily supplies most of her needs for this vitamin during the winter months. This may more than offset the benefits of improved preservation of carotene, which is the cow's source of Vitamin A.

EARLY EXPERIMENTAL WORK

Work with legume silage at Minnesota started in 1924 when sweet clover was ensiled with the idea of finding a more satisfactory use for this crop than curing as hay. Using four small experimental silos of about 1000 pounds capacity, comparisons were made of sweet clover cut at an early bud stage and ensiled without wilting, cut at the same stage and wilted five hours, cut at one-half bloom stage and wilted five hours, and cut at an early seed stage and wilted four hours. The quality of the silage as judged by odor, taste, and color was improved by reducing the moisture content before ensiling. Cows seemed to like the silage, but did not consume it as readily as corn silage. The silos were again filled in 1926, 1928, and 1930. In all cases satisfactory silage resulted without preservatives.

PRESERVATIVES

While the use of preservatives is not new, during the past decade a great deal of attention has been given to improvement of the keeping qualities of silage by use of added preservative agents. Silage is ordinarily preserved from complete decomposition by acids developed by fermentation of the carbohydrates of the ensiled material. If sufficient amounts of readily fermented carbohydrates are available, this takes place rapidly and sufficient acid is developed to check further bacterial decomposition. The air is replaced by carbon dioxide which further prevents organism growth. The commonly used preservatives depend primarily upon one of three principles for effectiveness:

1. Addition of acid to produce a degree of acidity unfavorable to growth of organisms.

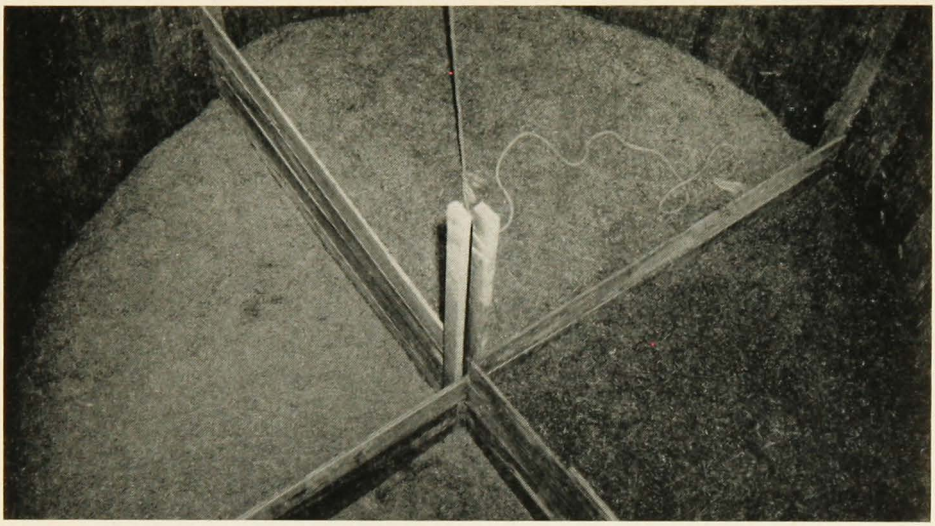

FIG. 2. ARRANGEMENT OF THE DIVIDING PARTITIONS IN EXPERIMENTAL SILO

2. Addition of easily fermented carbohydrates for production of acid by bacterial action.

3. Addition of cultures of bacteria to bring about the desired fermentation from carbohydrates present in the ensiled material.

Even when preservatives are used, the importance of such factors as moisture control to prevent excessive loss of juices and to create conditions favoring development of good silage should be recognized.

Acid Method

For the acid method, two processes have been used widely. The first to be extensively used was the A.I.V. method, using a mixture of concentrated sulfuric and hydrochloric acids which is diluted and added to the silage to secure the desired degree of acidity. This method was developed and patented by a Finnish worker, A. I. Virtanen.

In America phosphoric acid has been much more popular. It has the advantages of low price, ease and safety of handling in wood or metal containers, and of contributing to phosphorus needs of animals and soil. In addition, it does not appear to come under the protection of the Virtanen patent, obviating the payment of royalties.

Fermentable Carbohydrates

Many materials have been used to increase the content of easily fermented substances in the silage. Mixture of legumes with good silage crops such as corn or sorghums has long been advocated, but in many cases is not practical because the crops are not ready at the same time. Dried forage from such crops has also been used quite extensively. Green cereal grains have been ensiled with legumes to improve the keeping qualities. Addition of ground corn or other starchy grains, used by Reed and Fitch[2] in 1917, is now being advocated quite extensively. Milk and

[2] Reed, O. E., and Fitch, J. B. Alfalfa Silage. Kansas Agr. Expt. Sta., Bul. 217. 1917.

milk products have been used to some extent. Because of their high moisture content, fluid milk or whey has not proved very satisfactory. Concentrated milk or whey is relatively expensive.

Molasses, which has probably been most extensively used, is almost ideal for this purpose. It has a very high content of sugar, the most readily fermented carbohydrate; and it is relatively low in cost although it has the disadvantage of requiring a cash outlay since it is not produced on the farm. Dried molasses is now being used to some extent. It has the advantage of being more convenient to handle than liquid molasses, but it is much more expensive if evaluated on the basis of its sugar content.

Bacterial Cultures

Because of the great abundance of acid-forming bacteria under conditions such as those encountered in ensiling legumes or grasses, it is highly improbable that lack of proper organisms would be a factor in preservation of silage. Cultures of bacteria similar to the "starter" used by the buttermaker are being sold, however, for the purpose of preserving silage.

RECENT WORK

In 1938, 1939, and 1940 at the Minnesota Experiment Station, experiments have been carried out to compare the merits of various methods for preservation of legume silage. A wood stave silo, 16 feet in diameter and 36 feet high, was divided into four compartments by means of cross partitions of 7/8-inch pine shiplap as shown in figure 2. This arrangement permitted comparison of four methods of treatment in the same silo and under essentially identical conditions. Since the four sections were filled simultaneously with alternate loads of material from

Table 1. Legumes Ensiled in Divided Silo

Compartment	Green material—pounds	Treatment per ton green material
Alfalfa 1938		
1	26,685	No preservative
2	28,330	75 lbs. molasses
3	26,885	A.I.V. process—sulfuric and hydrochloric acids
4	30,900	133 lbs. ground corn
Alfalfa 1939		
1	24,350	No preservative
2	23,350	75 lbs. molasses
3	24,510	25 lbs. 75 per cent phosphoric acid
4	22,900	133 lbs. wheat straw
Sweet Clover 1939		
1	14,995	No preservative
2	13,245	75 lbs. molasses
3	17,030	25 lbs. 75 per cent phosphoric acid
4	8,525	133 lbs. wheat straw
Alfalfa 1940		
1	23,553	No preservative
2	26,225	75 lbs. molasses
3	29,295	15 lbs. 75 per cent phosphoric acid
4	23,220	133 lbs. ground corn
Sweet Clover 1940		
1	16,510	No preservative
2	12,760	75 lbs. molasses
3	12,970	15 lbs. 75 per cent phosphoric acid
4	11,620	*Silogerm (Bacterial culture)

* Supplied through courtesy of The Silogerm Co., Bloomfield, N. J.

the same field, conditions were practically identical except for the preservative used.

In 1938 only alfalfa was used. This was cut when about one fourth in bloom, raked into windrows immediately, and ensiled with no reduction of moisture other than that incidental to lying in the windrow before it was loaded. This, even for the last loads, was not sufficient to wilt the green material before it reached the silo.

The same arrangements and procedures were followed in 1939 and 1940 except for differences in preservatives as noted in table 1. Sweet clover, as well as alfalfa, was available. The alfalfa was ensiled first and covered with tarred felt. The sweet clover was then ensiled on top of the alfalfa. In 1939 the sweet clover was cut with a grain binder for more convenient handling of the tall growth. It was in an early bloom stage. In 1940 a field harvester was used for part of the sweet clover, the chopped material being delivered into wagons and hauled to the silo where it was elevated with a fly-wheel type of ensilage cutter. The remainder was cut with a grain binder as in

Table 2. Comparative Feeding Value of Legume Silages Preserved by Different Methods*

	Actual moisture	Composition on 75 per cent moisture basis	
		Digestible protein	Total digestible nutrients
	per cent	per cent	per cent
Alfalfa, 1938			
Ensiled alone	82.12	2.98	13.65
Ground corn, 133 lbs. per ton	71.33	3.24	14.73
Molasses, 75 lbs. per ton	76.11	3.70	14.55
A.I.V. acid mixture	77.18	3.47	14.54
Alfalfa, 1939			
Freshly cut alfalfa	83.69	3.31	13.15
Ensiled alone	74.71	2.92	13.75
Straw, 133 lbs. per ton	60.51	3.10	14.03
Molasses, 75 lbs. per ton	72.89	3.44	14.40
75 per cent phosphoric acid, 25 lbs. per ton	73.90	2.56	12.97
Alfalfa, 1940			
Freshly cut alfalfa	75.72	3.40	13.25
Ensiled alone	78.43	2.96	13.58
Ground corn, 133 lbs. per ton	69.95	3.48	14.10
Molasses, 75 lbs. per ton	73.92	3.29	14.31
Phosphoric acid, 15 lbs. per ton	76.12	3.23	14.03
Sweet Clover, 1939			
Freshly cut sweet clover	77.82	3.26	14.24
Ensiled alone	83.02	2.93	14.88
Straw, 133 lbs. per ton	85.03	2.23	14.15
Molasses, 75 lbs. per ton	77.38	3.13	15.31
75 per cent phosphoric acid, 15 lbs. per ton	74.41	3.86	15.33
Sweet Clover, 1940			
Freshly cut sweet clover	87.01	4.33	13.55
Ensiled alone	82.69	2.90	15.10
Bacterial culture and salt	79.92	3.10	13.89
Molasses, 75 lbs. per ton	79.19	3.29	14.50
75 per cent phosphoric acid, 15 lbs. per ton	81.23	3.40	14.11
Ensiled alone†	86.55	2.67	13.95
Straw, 133 lbs. per ton†	81.89	2.67	13.64
Dried skim milk, 20 lbs. per ton†	84.10	3.50	14.57
Salt, 40 lbs. per ton†	82.80	3.10	12.75

* Estimated from the composition as determined by chemical analysis, using coefficients of digestibility for sweet clover silage from Morrison, "Feeds and Feeding," Twentieth Edition.

† These samples are from small experimental silos holding about one-half ton. All others are from large silo with cross partitions.

1939. The clover was in the bud stage with very few blossoms showing. The amounts ensiled and preservatives used during the three years are shown in table 1.

In 1940 four small experimental silos were filled with sweet clover from the same source as that used in the large silo. In addition to a check lot, ensiled alone, salt at the rate of 40 pounds per ton was used in one silo, dried skim milk at the rate of 20 pounds per ton in the third, and chopped straw at the rate of 133 pounds per ton in the fourth.

The silos were opened and feeding was begun each year about two months after filling. The amounts of silage available were not sufficient for extensive feeding trials to determine the relative value of the different types of silage for milk production. Experience has indicated, however, that the composition of a feed is a good index of its feeding value, provided it is sufficiently palatable to be eaten in the desired amounts. Samples of the fresh material at the time of ensiling and of the silage when fed were analyzed. The results are given in table 2. These have been calculated to a 75 per cent moisture basis and are given in the familiar terms of digestible protein and total digestible nutrients. Coefficients of digestibility for sweet clover silage from Morrison, "Feeds and Feeding," Twentieth Edition, were used in the calculations.

Palatability Trials

For comparing palatability, four groups of cows, as nearly alike as possible as to breed, age, and stage of lactation, were used. The plan of feeding for these groups is shown in table 3.

This plan was followed during each of the three years. The length of the periods was planned according to the amount of silage available. The cows were fed U. S. No. 1 alfalfa hay at the rate of one pound daily per hundred pounds body weight and sufficient concentrates to maintain their weight and production. In 1938 the cows were given only as much silage as they would clean up entirely and the average consumption was essentially the same for all lots of silage. However, it was found that by allowing them to leave a few pounds they would consume much more; so during 1939 and 1940 they were allowed to leave a small amount which was weighed back to determine the amount actually consumed.

The amounts eaten and dry matter content of each type of silage are shown in figures 3 and 4.

Comparative Composition and Consumption

The differences in composition of the silages preserved by different methods are so small that we would expect little difference in feeding value. In general appearance, all lots of silage were of good quality, free from mold, and with no evidence of decomposition beyond that normally occurring in the ensiling process. As judged by general observations on color, odor, and taste, it is doubtful if any lot would have been consistently chosen as superior to others from the same source of green material. When fed to the cows, however, there was a marked difference in favor of

Table 3. Plan of Feeding Used in Palatability Trials

	Period 1	Period 2	Period 3	Period 4
*Group 1	Lot 1	Lot 2	Lot 3	Lot 4
Group 2	Lot 2	Lot 3	Lot 4	Lot 1
Group 3	Lot 3	Lot 4	Lot 1	Lot 2
Group 4	Lot 4	Lot 1	Lot 2	Lot 3

* Group refers to the cows used and lot to the silage fed.

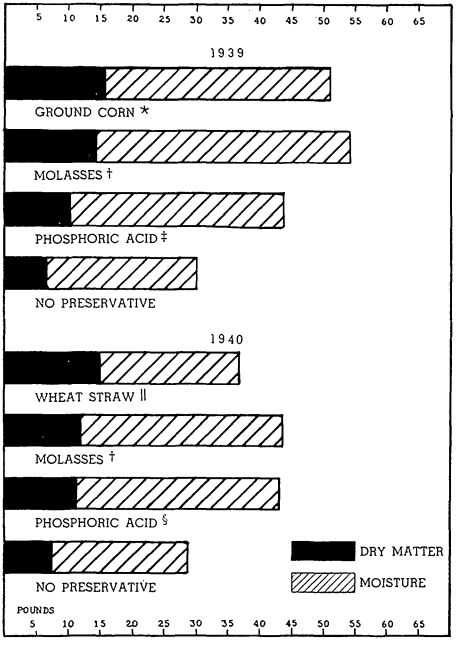

FIG. 3. AVERAGE DAILY CONSUMPTION OF ALFALFA SILAGE. 1939, AVERAGE FOR 40 COWS; 1940, AVERAGE FOR 39 COWS. SILAGE ENSILED WITH:

* 133 pounds of ground shelled corn per ton

† 75 pounds of molasses per ton

‡ 15 pounds of 75 per cent phosphoric acid per ton

§ 25 pounds of 75 per cent phosphoric acid per ton

|| 133 pounds of wheat straw per ton

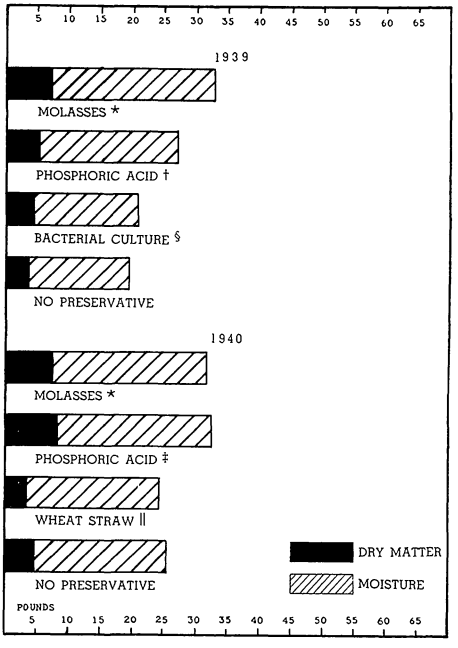

FIG. 4. AVERAGE DAILY CONSUMPTION OF SWEET CLOVER SILAGE. 1939, AVERAGE FOR 40 COWS; 1940, AVERAGE FOR 42 COWS. SILAGE ENSILED WITH:

* 75 pounds of molasses per ton

† 15 pounds of 75 per cent phosphoric acid per ton

‡ 25 pounds of 75 per cent phosphoric acid per ton

§ Bacterial culture and .08 ounces lactose and 20 pounds of salt per ton

|| 133 pounds of wheat straw per ton

some preservatives. The average consumption of alfalfa silage was much higher than of sweet clover silage. In 1939 corn silage was available at the close of the alfalfa silage feeding period. When the cows were changed to corn silage, their average consumption was higher than for any type of alfalfa or sweet clover silage.

With both sweet clover and alfalfa, the palatability was greatly increased by preservation with molasses or acid. Ground corn was also very effective in increasing the palatability of alfalfa silage. Since the corn contributed about one fifth of the total dry matter of the silage, the presence of the corn as well as any improvement in preservation would be expected to contribute to the palatability. Any unfermented molasses, likewise, would be expected to contribute to greater palatability of the molasses-preserved silage, although in no case was the odor or taste of molasses observed in the silage.

Straw itself is not very palatable and in this case contributed about one fifth of the dry matter of the silage to which it was added. It did not improve the quality greatly as indicated by amount

eaten. Likewise the bacterial culture failed to improve the silage.

When a direct comparison was made between legume silage and good corn silage in 1939, the corn silage was found to be more palatable. This bears out the opinion quite general among corn belt dairymen who have used legume silage that it is less palatable than good corn silage.

In comparing the silage made without added preservative, to that made with various preservatives, no attempt was made to improve the quality by reducing the moisture as is commonly recommended. The material ensiled ranged from 75 to 87 per cent moisture.

Despite a moisture content above that considered optimum for making silage without added preservative, in no case did the silage spoil and in every case silage of good appearance resulted. The preservative properties of many substances have undoubtedly been overrated because of the belief that legumes will spoil if ensiled without added preservatives. Even green sweet clover containing 87 per cent moisture, ensiled in small experimental silos with watertight bottoms, came out as bright colored, clean smelling silage although the silage in the lower half of the silo was entirely submerged in juice.

1941 Results

In 1941 the divided silo was again filled, two compartments with legumes alone, one with 133 pounds of ground corn per ton of green material, and one with 75 pounds of molasses per ton. The green material ensiled consisted of 78 tons of alfalfa and 19 tons of sweet clover. The alfalfa was covered with tarred felt and the sweet clover placed on top. The material used in 1941 was well wilted when ensiled.

The sweet clover was fed out three months after the silo was filled. The alfalfa was fed nine months after filling. The relatively shallow layer of sweet clover had heated, producing a dark, nonacid silage relished by the cows but of very poor quality as judged by the usual standards for good silage. The alfalfa was in better condition.

The lots to which ground corn had been added were in the poorest condition with considerable spoilage and mold, particularly in spots where there was a greater than average concentration of corn. This was undoubtedly caused by the lower moisture content due to the presence of the dry corn.

The alfalfa silage to which molasses was added seemed to be in slightly better condition than the lots ensiled alone. Here again moisture may have been the deciding factor since the diluted molasses added over 100 pounds of moisture per ton. No advantage was noted in sweet clover silage.

In comparing palatability of the different lots, 133 pounds of ground corn per ton of silage was added as fed to one of the two lots of silage made without added preservative. Over a six-day period 11 cows, fed the sweet clover silage made without preservatives, consumed an average of 47.3 pounds per day; 10 cows, fed the molasses silage, averaged 42.9 pounds per day; 10 cows, fed silage with ground corn added when ensiled, averaged 48.1 pounds per day; and 10 cows, fed the silage made without preservative but with ground corn added when fed, averaged 47.7 pounds per day. The small differences in consumption may well have been due to individual differences in animals since the limited amount of silage did not permit a change of feed within groups.

The alfalfa silage was fed to 42 cows using the general plan indicated in table 3. The average daily consumption of the silage without preservative was 34.2 pounds. Of that ensiled without preservative but with ground corn added when fed, the average daily consumption was 35.5 pounds as compared to 33.7 pounds of the silage to which

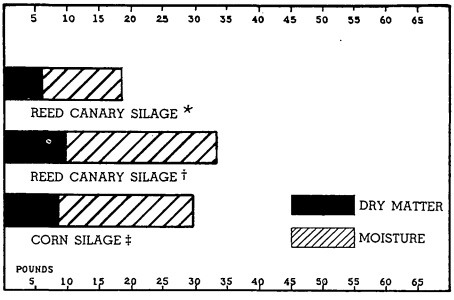

FIG. 5. AVERAGE DAILY CONSUMPTION FOR SIX COWS OF REED CANARY GRASS SILAGE COMPARED WITH CORN SILAGE

* Mature grass ensiled with 75 pounds of molasses per ton

† Ensiled when about one half headed with 15 pounds of 75 per cent phosphoric acid per ton

‡ Well eared, ensiled when grains were well dented

ground corn was added when ensiled. The average daily consumption of molasses silage was 39.7 pounds per ton.

These results emphasize the fact that danger of actual loss by spoilage is greatest in silage of low moisture content and that added preservative agents are not effective if the moisture content is too low. Dry materials such as ground grain or dry forage crops actually increase the spoilage risk under such conditions.

REED CANARY GRASS SILAGE

Through the courtesy of Northland Farms, Anoka, Minnesota, it was possible in 1938 to make some observations on reed canary grass silage. One lot of canary grass ensiled before fully headed out with the addition of 15 pounds of phosphoric acid per ton, and another lot ensiled when almost mature with 75 pounds of molasses per ton were available.

Six cows at the University Farm were used in a palatability trial with these lots of reed canary grass silage. They were fed alfalfa hay at the rate of one pound per hundred pounds body weight and a constant amount of grain according to their milk production. They were then fed as much silage as they would eat. They received the molasses silage during the first 25 days, the phosphoric acid silage during the next 36 days, then corn silage of good quality under the same plan of feeding for the following 10 days. The average amounts eaten daily are shown in figure 5. Almost twice as much of the early cut phosphoric acid silage was eaten as of the mature molasses silage. This was probably due more to the stage at which the canary grass was cut than to the preservative used. They con-

Table 4. Feeding Value of Reed Canary Grass Silage*

Lot†	Composition on 75 per cent moisture basis	
	Digestible protein	Total digestible nutrients
	per cent	per cent
1. Mature grass. Preserved with 75 lbs. molasses per ton	.99	14.18
2. Ensiled when about one third headed. Preserved with 15 lbs. phosphoric acid per ton	1.91	13.69
3. Ensiled when about one third headed. (No preservative)	1.35	13.77
4. Ensiled when about one third headed. 75 lbs. molasses per ton	1.37	13.73
5. Ensiled when about one third headed. 15 lbs. phosphoric acid per ton	1.49	13.50
6. Ensiled when about one third headed. A.I.V. acid mixture	1.69	13.44
7. Ensiled when about one third headed. Fresh grass as ensiled	2.53	12.38

* Estimated from the composition as determined by chemical analysis, using coefficients of digestibility for Sudan grass-silage from Morrison, "Feeds and Feeding," Twentieth Edition.

† Lots 1 and 2 were used in palatability comparisons; Lots 3, 4, 5, and 6 were ensiled in small experimental silos; Lot 7 was freshly cut grass used for Lots 3-6, inclusive.

sumed slightly less corn silage during the last ten days, suggesting that the early cut canary grass silage compares very favorably with corn silage in palatability. See table 4 for analyses of samples from these silage lots.

During the summer of 1938, three small experimental silos with a capacity of about one half ton each were filled with freshly cut reed canary grass, harvested when one third of the heads were showing. No preservative was added to one lot, molasses at the rate of 75 pounds per ton was added to the second, phosphoric acid at 15 pounds per ton to the third, and the A.I.V. mixture of acids to the fourth. The silos were opened two months after filling. The amount of spoilage on top was approximately the same for each silo, and all lots were in excellent condition.

While the material available did not permit a very satisfactory comparison of preservatives or other factors, this work showed that silage of good quality and quite palatable may be made from reed canary grass, and that the earlier cut grass made much better silage than that which had matured. With more mature canary grass, preservatives should not be needed, but with the immature grass they might improve the quality of the silage in a manner similar to that with legumes and with other young grasses.

Making and Feeding Hay Crop Silage

HAY CROPS should be cut for silage at the stage at which they make the best hay. Reduction of moisture by wilting slightly helps prevent excessive loss of nutrients by seepage of juice. Excessive moisture also slows up the development of the proper degree of acidity for optimum preservation. Greater amounts of preservative are required if moisture content is unnecessarily high, and filling costs are increased due to the greater tonnage of green material. The material, however, should not be too dry as actual spoil-

FIG. 6. NEVER OVERLOAD WAGON WITH GREEN CROPS. THIS PHOTOGRAPH SHOWS A TON OF GREEN ALFALFA ON AN 8- BY 14-FOOT RACK

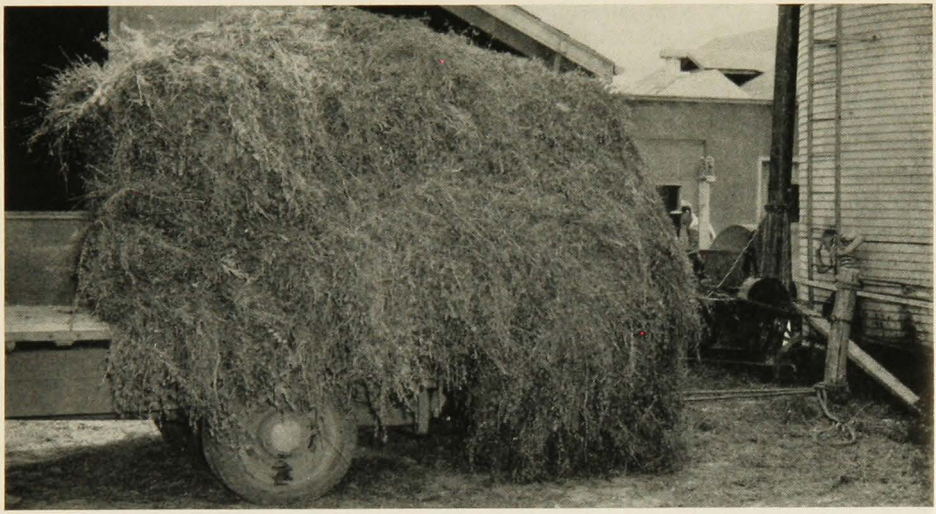

FIG. 7. THE LOAD MAY BE SLID OFF WITHOUT TANGLING BY USE OF A HEAVY ROPE PLACED LIKE A SLING UNDER THE GREEN MATERIAL. THE ROPE IS ANCHORED TO A HEAVY POST AND THE TRUCK OR WAGON IS DRIVEN SLOWLY FORWARD

age is likely to result. A moisture content of 65 to 75 per cent is usually recommended.

If the silo is being filled rapidly, the silage in the bottom may be somewhat drier, and juice from the upper part of the silo will wash down into this material. It is safer, however, to have the material too green than too dry. If the crop has become too dry, water should be added. Care should be taken to avoid mowing more material than can be ensiled the same day or in hot weather the same half-day.

A windrowing attachment on the cutter bar of the mower saves the raking operation and avoids some of the risk of picking up stones which might damage the silage cutter. A heavily constructed loader of the rake-bar type will handle the green material readily. Care must be taken not to overload the wagons or trucks. This green material is much heavier than dry hay. The wagons or trucks may be unloaded quickly by the arrangement shown in figure 7. This permits dumping the load at the cutter and keeping the hauling equipment in action. The crops may be cut with a grain binder and handled in bundles if desired. Field choppers are now available which deliver the chopped material into trucks or wagons, and it need only be elevated into the silo.

Difficulty is often encountered in elevating the green material into the silo. The cutter used should have good elevating capacity. A fan of at least four blades and driven at high speed is desirable. If the housing is adjustable, it should be taken up so that the clearance between the tips of the fan blades and the housing is not excessive. The knives should be kept sharp so that the chopping will require a minimum of power. A half inch or shorter cut is usually recommended.

Legume silages are heavy and exert greater pressure on the silo walls than corn silage. If the hoops of the silo are not strong, they should be replaced by heavier ones or additional bands should be placed around the lower por-

tion of the silo where pressure is greatest. In types of construction where the reinforcing is concealed in the joints, outside bands should be added as a safety measure if the silo is old. This is a wise precaution, even for corn.

The preservative may be added at the feed table, at the blower, or in the silo. Many cutters are now supplied with special pumps which will pump liquids at the desired rate either into the blower or directly into the silo. An elevated barrel or steel drum with a hose attached may be used to add the liquids by gravity, regulating the flow by hand or with a valve operated by the feed roller. The acid or molasses is usually diluted with water which gives a larger volume, making it easier to distribute evenly. In the case of molasses this dilution facilitates handling although many cutters are now equipped with pumps for handling undiluted molasses.

There is some evidence to indicate that less preservative is needed for silage that is to be fed within a short time after filling than for silage that will be stored for a long period. With ground corn which is now being recommended quite extensively in the corn belt, much more experimental work is needed before we can feel definite assurance as to its preservative value or the amounts needed. The corn greatly improves the palatability of the silage, and presumably any excess corn would not be wasted but would merely increase the feeding value of the silage. Other grains should serve as well as corn for preservation of silage. The ground grain is probably most easily added by constructing a hopper to discharge it into the blower. At least one machine which is now on the market has a grinder attached which will grind the grain directly into the blower.

FIG. 8. THE REINFORCING OF OLD SILOS SHOULD BE CHECKED CAREFULLY. ADD OUTSIDE BANDS IF NECESSARY. THIS SILO COLLAPSED DUE TO THE PRESSURE OF ALFALFA SILAGE

Table 5. Amounts of Preservative Usually Recommended

	Molasses (12 lbs. = 1 gallon)	75 per cent Phosphoric acid (13.2 lbs. = 1 gallon)	Ground corn or corn and cob meal
	Pounds	Pounds	Pounds
Corn, sorghums, sunflowers, etc.	None	None	None
Sudan grass and reed canary grass—well matured	0- 40	0-10	0- 75
Sudan grass, reed canary grass—immature	40- 60	10-15	75-150
Small grains—milk stage	40- 60	10-15	75-150
Meadow or pasture grasses	40- 60	10-15	75-150
Mixed legumes and grasses	60- 75	12-15	100-200
Alfalfa, sweet clover, red clover, etc.	75-100	15-25	150-200
Soybeans—beans well matured	75-100	15-25	150-200
Soybeans—beans very immature	100	15-30	150-250

Danger from Silo Gas

As a safety measure, it is advisable before entering the silo after being closed down overnight to operate the blower for a few minutes in order to blow out any accumulation of gas which might cause suffocation.

Feeding Legume Silage

The feeding value will depend upon the crop ensiled and the stage at which it was harvested. Ensiling is merely a method of storage and does not improve the nutritive value of the material ensiled. Silage from legumes or young grasses contains more protein than corn silage. With such silage, hay of low-protein content may be used to replace legume hay and corn silage. It is well to remember, however, that the moisture content of silage is very high and that about three pounds are required to replace one pound of hay from the same crop. It is advisable to limit the amount fed until the cows have become accustomed to this type of silage.

Feeding trials at several experiment stations have shown that the feeding value of legume silage is accurately indicated by its composition.

Trying Out the New Method

Beyond doubt, ensiling of hay crops has established a permanent place in the farming program. However, more experience is needed before recommending it too generally in this section. It might be well for those contemplating ensiling hay crops for the first time to try it out in a small way with present equipment before embarking on an extensive program involving investment in additional silos or equipment. The experience thus gained under home conditions will afford an opportunity to judge the merits of the silage more soundly and to plan the future operations more intelligently.

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