ABSTRACT OF THESIS

NUTRIENT CONSERVATION

AS

INFLUENCED BY TYPE OF SILAGE PREPARATION

Submitted by

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In partial fulfillment of the requirements

for the Degree of Master of Science

Colorado A. & M. College

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ABSTRACT OF THESIS

Two experiments were conducted to determine the effect of method of silage preparation on nutrient conservation, and to show the economic value of each method of preparation by using the silages in a fattening ration. Silages were prepared from alfalfa, corn, beet tops, and potatoes. The first feeding trial utilized low grain - high roughage rations, while during the second trial high grain - low roughage feeds were fed.

Preservation of carotene and protein was definitely enhanced by ensiling. Fifteen to 56 per cent more of the original carotene was saved during harvest, and up to 72 per cent more was retained during storage up to approximately 150 days. Ordinarily, the peak of silage feeding is reached before this time. After 150 days or more of storage, carotene content of silages, except that preserved with phosphoric acid, declined to levels equal to or below the stacked hays. Beet top silage retained 27.51 per cent more carotene than did stacked, dried tops. Although beet top silage kept very well during the winter months, spoilage was considerable with the approach of warm weather. Third cutting alfalfa contained the highest initial quantity of carotene with second and first cutting following in decreasing order. In general, ensiling of alfalfa resulted in a greater retention of crude protein than was observed in stacked hays. Preservation with phosphoric acid appeared to be the best method of nutrient

NUTRIENT LOSSES DURING HARVESTING

Feeding Trial	Kind of Silage	Crude Protein		Carotene		Ash		Calcium		Phosphorus	
		Hay	Silage	Hay	Silage	Hay	Silage	Hay	Silage	Hay	Silage
		%	%	%	%	%	%	%	%	%	%
1	Alfalfa-corn	14.53	6.59	57.32	22.18	4.94	4.91	18.36	9.58	12.37	9.54
1	Alfalfa-corn	16.97	5.56	83.94	28.17	4.97	-4.20	18.89	4.44	8.75	-1.67
1	Beet top	-----	4.68	-----	37.82	----	-2.94	-----	20.59	----	10.94
1	Corn	-----	2.35	-----	13.40	----	-4.01	-----	13.00	----	0.43
2	Alfalfa (Unpreserved)	0.17	9.55	46.87	22.69	1.32	1.74	6.07	0.74	37.18	14.08
2	Alfalfa-corn	0.45	0.30	37.57	27.90	2.94	1.72	13.11	3.42	2.44	13.01
2	Alfalfa-acid	3.50	1.48	24.76	9.62	13.63	-0.57	17.51	-1.97	34.35	-51.91

1/. Alfalfa-corn silage prepared from first cutting alfalfa; and 2/ prepared from second cutting.

NUTRIENT LOSSES DURING STORAGE

Feeding Trial	Kind of Silage	Crude Protein		Carotene		Ash		Calcium		Phosphorus	
		Hay	Silage	Hay	Silage	Hay	Silage	Hay	Silage	Hay	Silage
		%	%	%	%	%	%	%	%	%	%
1	Alfalfa-corn 1/	6.23	17.42	52.94	60.75	-10.94	-58.39	3.40	-12.09	13.71	-2.34
1	Alfalfa-corn 2/	4.60	3.64	0.00	71.76	-15.10	-23.82	-6.12	- 5.10	1.83	0.00
1	Beet top	----	6.66	----	50.23	-----	-12.59	----	- 0.55	---	-2.92
1	Corn	----	2.03	----	19.05	-----	- 1.04	----	-13.92	---	3.06
2	Alfalfa (Unpreserved)	6.86	11.48	47.75	42.08	3.63	-16.17	-1.92	0.50	-8.05	1.68
2	Alfalfa-corn	9.50	10.70	26.11	37.16	4.43	- 7.98	6.09	- 3.29	12.92	-13.08
2	Alfalfa-acid	16.36	9.95	11.50	6.38	9.34	-21.21	1.53	-38.13	0.00	-23.37
2	Potato-corn fodder	----	3.39	-----	----	----	- 2.19	----	16.08	----	5.66
2	Potato-alfalfa hay	----	8.51	-----	----	----	- 5.04	----	12.05	----	9.29

1/. Alfalfa-corn silage prepared from first cutting alfalfa; and 2/ prepared from second cutting.

conservation in these experiments.

During harvest, alfalfa silages retained from 6 to 20 per cent more calcium and 11 to 86 per cent more phosphorus than did sun-cured hays from similar cutting. The ash content of all silages increased during storage.

Potato-alfalfa hay, potato-corn fodder, beet top, and corn silages appeared to be more relished by the animals than were the alfalfa silages used in the feeding trials. Steers preferred the potato-alfalfa hay silage to the potato-corn fodder silage. When the steers were fed a higher grain level, the lots fed alfalfa silages prepared by different methods made better gains than did the control lot. There were no appreciable differences between lots of steers in selling price per hundred pounds live weight, shrink to market, dressing percentage, carcass grades or liver condemnation. Using the current feed prices, the cost to produce one hundred pounds of beef in both trials was highest for the lots which received the different alfalfa silages.

T H E S I S

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Submitted by

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In partial fulfillment of the requirements

for the Degree of Master of Science

Colorado A. & M. College

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COLORADO AGRICULTURAL AND MECHANICAL COLLEGE

August 9, 1945

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY Johnny Matsushima

ENTITLED NUTRIENT CONSERVATION AS INFLUENCED BY TYPE OF SILAGE PREPARATION

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

MAJORING IN ANIMAL HUSBANDRY

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Permission to publish this thesis or any part of it must be obtained from the Dean of the Graduate School.

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INTRODUCTION

Colorado farmers are vitally interested in the conservation of nutrients in their high quality livestock feeds. The state's high rank as a producer of cattle and sheep depends largely on home grown feeds, among which alfalfa, sugar beets, and potatoes are outstanding crops. A large proportion of these crops is utilized by livestock. However, lack of information concerning correct methods of preparation and storage of such crops, or their by-products, has resulted in considerable loss of valuable nutrients and reduced utilization of the feeds.

The use of alfalfa for silage has not been practiced extensively in high altitude sections, such as Colorado, where the rainfall is limited. The common method of preparation is to sun-cure the hay and store it in stacks. Some feeders have made alfalfa silage, but were disappointed in the results. Because alfalfa contains appreciable protein and relatively low carbohydrate, special treatment is necessary for proper preservation of this forage as a silage. In order to overcome the difficulties of improper fermentation, it has been necessary to use different preservatives and different methods of preparation. Molasses, cereal grains, and mineral acids are some of the commonly used preserving agents. In more recent years, the wilting method for the preparation of legume silage has been developed because of scarcity and cost of preserving agents.

Different methods of utilizing beet tops, including the silage process, have been used. A common method is to pile the tops and pasture them in the field. The main disadvantage in this practice is the loss of valuable nutrients through trampling and shattering of leaves by the animals. To prevent such losses there has developed a new procedure wherein the beet tops are hauled to a location near the feedlot and stacked for future use as silage.

Present war-time conditions have demanded a strong market for potatoes. Only a small quantity has been undisposed. In certain years, however, cyclic trends in market demands brought about by overproduction in relation to human consumption will, according to past experience, create a surplus which can be used as livestock feed. The potato crop is one that must be utilized immediately, and in such an emergency, may be fed to livestock in different forms. Raw and cooked potatoes have been fed to swine and cattle with satisfactory results (11). The literature presents little information, however, concerning potato silage, particularly as to methods of preparation and the value of such silage in a fattening ration.

The research presented in this thesis represents a phase of a long-time project in feed preservation now being conducted by the Colorado Agricultural Experiment Station. The specific objectives with which the writer has been concerned are; (1) the effect of method of silage preparation on nutrient

conservation; and (2) the economic value of each method of preparation as determined by the use of the silages in a fattening ration.

REVIEW OF THE LITERATURE

The making of silages from alfalfa, corn fodder, beet tops, or potatoes is not a recent development in the preservation of feeds for livestock. Although it is not known just when the practice started, the literature indicates that silage was prepared centuries ago in northern Europe. The construction of the first silo in the United States has been credited to F. Morris, of Maryland, in 1876 (26).

Green corn fodder, sugar beet tops, and potato tubers contain appreciable carbohydrate. Therefore, acids develop quickly after ensiling and eliminate the necessity of adding preservatives for proper fermentation. The composition of these materials has been reported by several workers and is shown in Table I.

Table No. I. Chemical Composition of Fresh Silage Materials.

	Percentage on Dry Matter Basis					
Green Material	Crude Protein	Crude Fiber	Crude Fat	N.F.E.	Mineral	Source of Information
Corn fodder	7.51	25.19	3.38	58.27	5.64	(26)
Sugar beet tops	18.33	13.89	1.53	44.03	22.22	(15)
Alfalfa	14.04	34.21	2.63	41.23	7.89	(26)
Potatoes	10.38	1.89	.47	82.08	5.19	(18)

Although the carbohydrate content of alfalfa is somewhat low for proper enzymatic action, certain investigators (2), (4), (8), (27) state that no preservative is necessary if the dry matter content is properly adjusted prior to ensiling. These workers point out that the alfalfa should contain not less than 25 per cent of dry matter. Woodward (25) found that the moisture content of chopped material going into silage should not be higher than 68 per cent.

Experiments at the Pennsylvania Experiment Station by Stone and coworkers (21) indicate that untreated alfalfa silage was nearly equal in quality to that treated with molasses. Alfalfa preserved with 200 pounds of corn-and-cob meal per ton yielded the best results. When 18 pounds of phosphoric acid was added to each ton of alfalfa, the quality of silage was as good as that treated with corn-and-cob meal (Table II).

Table No. II. Analyses of Alfalfa Silages, Dry Weight Basis.

Treatment	Bacteria Per Gram	Moisture	pH	Sugar	Carotene Per Gram	Quality
	Millions	%		%	Micrograms	
None	1.20	75.4	4.53	1.3	34	Poor ?
None	63.00	75.5	5.02	0.3	102	Very poor "
Wilted	67.00	68.1	4.45	0.8	89	Good "
200 # corn & cob meal	170.00	72.1	3.85	2.1	139	Excellent "
80 # molasses	110.00	76.1	3.95	0.9	140	Good "
18 # phosphoric acid	4.50	75.9	3.94	1.4	60	Excellent ?

Various studies have been performed to determine the effect of ensiling on the composition of forage crops (1), (3), (22), (23), (27). The published data indicate that results are not closely related because of different kinds and amounts of

preserving agents used; varying chemical composition of different green forage samples effected by stage of development and maturity, dry matter content, mixture of various grasses and legumes, etc., and seasonal variation in composition.

Many investigators have turned to silage preparation as a means for saving forage crops frequently damaged by unfavorable weather conditions at harvest time (13) (27). From the standpoint of nutrient conservation, much emphasis has been placed on the greater carotene retention in silages as compared to sun-cured hays. Vermont workers (5) found that A. I. V. silages retained 78%, phosphoric acid treated silage 43%, molasses silage 22%, and unpreserved silage 18% of the original carotene content. Sun-cured hays retained only 12 per cent. Camburn, Ellenberger, Newlander, and Jones (4) reported that sun-cured hays suffered greater losses than did silages in all nutrients except nitrogen-free extract, in which case fermentation induced considerable loss in the silages. Morrison (12) pointed out that even under the most favorable conditions, losses of nutrients are about 5 per cent greater when the corn crop is cured as dry fodder than when it is ensiled.

Alfalfa silage is used frequently in dairy cattle rations because it serves as a succulent feed during the winter months when pasture grass is not available. During six years, the Wisconsin Experiment Station (3) found no pronounced increase in milk production when legume silage was compared with good corn silage in winter dairy rations. However, the milk produced on

an alfalfa silage ration was richer in color than that produced when the cows received a corn silage ration. The average results for five years showed that total vitamin A content of milk was about 50% greater when the cows were fed an alfalfa silage ration than when fed a corn silage ration.

Three feeding trials conducted at the Pennsylvania Station (28) indicated that alfalfa-molasses silage was slightly superior to U. S. No. 3 grade alfalfa hay but no better than corn silage for fattening steers (Table III).

Table No. III. A 3-year Average of Feeding Tests Using Alfalfa-molasses Silage. 1937-1940. (Pennsylvania Station).

168-day Feeding Period	Average Daily Gain	Cost Per Cwt. Gain	Selling Price Less Marketing Cost	Dressing Per Cent (Warm Weight)
Lot 1 - Corn silage	2.18	8.76	8.95	60.3
Lot 2 - Alfalfa-mol. silage	2.15	8.62	8.92	60.0
Lot 3 - Alfalfa hay	2.06	9.02	8.95	59.8

Good and Garigus (7) performed a similar experiment at the Kentucky Experiment Station. During a 70-day feeding period one lot of steers received shelled corn and U. S. No. 1 grade alfalfa hay, while another lot received shelled corn and alfalfa molasses silage. The average daily gain per head was 2.48 pounds for the alfalfa hay fed lot and 2.09 pounds for the alfalfa-molasses silage lot. It was found when repeating the experiment that steers fed on alfalfa-molasses silage gained more than those receiving alfalfa hay. Each lot gained 2.04 and 1.82 pounds respectively. However, the steers fed alfalfa hay had a higher

dressing per cent when slaughtered.

Potatoes are a succulent carbonaceous feed like corn silage. Because of high water content it is necessary to ensile potatoes with other dry material to insure good results. Morton and Osland (14) reported a good quality silage when 18 per cent by weight of dry corn fodder was mixed with 82 per cent cull potatoes. However, in Germany Brandt and Kraemer 1/ found that steaming changes the physical qualities of the starch enclosed in potato cells. Moreover, the crystallized starch formed by steaming absorbs free moisture enclosed in the cells so that the steamed product has the consistency of a thick paste without any free liquid. These investigators found that steamed potato silage lasts for long periods and total loss of nutrients is limited to about 10 per cent. Williams (24) found very little nutrient loss in the same type of silage made in England.

Voltz 2/ reported that milk cows fed steamed potatoes yield little milk, although when fed raw or as steamed silage the milk yield was good. The reason for these results, according to the German workers, was that the cows utilized all the gelatinized starch of the steamed potatoes in forming meat and body fat.

1/. Quoted from War Food Administration mimeographed report entitled "Recommendations for Utilization of Surplus Potatoes by Steaming and Ensiling" by Dr. Karl Brandt, agricultural economist, who came to this country from Germany, and Mr. Joseph Kraemer, former general overseer for management of farms operated by the Land Bank of Berlin.

2/. Quoted from same report by Brandt and Kraemer in which they referred to Voltz's data published in the Hearings at the German Economics Inquiry Commission, 1927, Volume 5 and 6.

They point out that the fattening qualities of potato silage find most profitable use in fattening of hogs and beef cattle. Osland (17) found that potato-corn fodder silage showed very little waste and proved to be a palatable feed, but raw potatoes ensiled alone yielded a product which was extremely difficult to handle at feeding time. Potatoes fed in livestock rations are generally comparable to good corn silage (11).

Edwards (6) observed the smallest loss of nutrients in piled dried beet tops and 50 per cent less loss of nutrients in beet top silage when compared to stacked dried tops. Heidebrecht (9) in comparing the carotene content of beet tops during storage, found that sheltered dried tops, piled tops, and tops spread in rows retained considerably more of the nutrient than either stack or trench silage. Edwards (6) reported that beet tops as silage showed the lowest percentage of waste, which consisted of spoilage on top of the silo.

In England, Oldershaw (16) found that beet top silage is relished by most classes of stock, provided it is fed in mid-winter, and if a little time is given the animals to get used to it. Osland, Maynard, and Morton (18) obtained fairly good results by short time preliminary feeding of beet top silage to steers. The silage proved impractical when fed for the entire feeding period. Jones (10) pointed out that beet top silage is not a balanced ration, therefore it needs to be supplemented. Beet tops have been reported to have a very loosening effect which can be controlled by supplementary feeding of lime (20).

MATERIALS AND METHODS

Silage Preparation:

Alfalfa silages were prepared from hays of first, second, and third cuttings except in 1943-44 when no silage was made from the third cutting due to lack of storage facilities. Each cutting was made before the bloom stage. One-half of the alfalfa at each cutting was used for silage and the other half was sun-cured and stacked as hay. After mowing, the alfalfa used for silage was bunched immediately in windrows with a side-delivery rake. Within four to six hours after mowing, the hay was picked up from the windrows and cut into one inch lengths with a mechanical chopper and elevated into a following adjacent truck by means of which the material was hauled to trench silos. Because no mechanical chopper was available for the 1943-44 experiment, the green material was ensiled without chopping. The date of harvest and preserving agents used for each cutting are shown in the following table:

Table IV. Date of Ensiling and Preservatives Used.

Feeding Trial	Cutting	Date Ensiled	Preservative	
			Kind	Amount Per Ton
1	First	June 23, 1943	Ground corn	150 pounds
1	Second	August 3, 1943	Ground corn	100 pounds
2	First	June 24, 1944	None	None
2	Second	August 3, 1944	Ground corn	90 pounds
2	Third	September 21, 1944	Phosphoric acid	1 gallon

The ground corn was spread in thin alternate layers between approximately six inches of alfalfa. The phosphoric acid, commercially known as "Phosilage", was sprinkled over the chopped material as it was unloaded from the truck.

Beet top silage was prepared from beet tops grown near Fort Collins, and were hauled in from the field within 24 hours after topping and stacked next to the feed lot.

Potato-alfalfa hay silage (4 parts raw potato and 1 part alfalfa hay by weight) and potato-corn fodder silage (4 parts raw potato and 1 part dry corn fodder by weight) were prepared about the middle of May, 1944. Components of each silage were put through an ensilage cutter together and blown into a trench silo. The potatoes used in the preparation of both silages were surplus commodity product shipped in from Oklahoma. The quality of the dry corn fodder and alfalfa hay used in the mixture was of fair grade. The corn fodder had been in shocks all winter long prior to ensiling.

Corn silages used as standards of comparison in the two years' trials were prepared from corn grown on the College Farm. The fodder was cut during the dough stage. To the 1944-45 silage water was added to aid in packing immediately after the silo was filled.

Chemical Analyses:

In order to determine the nutrient losses of the forages during storage, samples were taken from each of the fresh materials, again when ensiled or stacked, and at intervals of 30 to 60 days for the different silages and hays. All the samples were analyzed for dry matter, crude protein, ash, calcium and phosphorus. Carotene was determined in all samples except the potato silages. A sample of each of the potato silages was

analyzed for carotene at the beginning of the ensiling period. The carotene content was so low that further sampling was discontinued.

All analyses were conducted in the Animal Nutrition Laboratories according to methods accepted by the American Association of Agricultural Chemists.

Experimental Animals:

The 1943-44 feeding experiment entailed the use of thirty-six good-to-choice quality, grade Hereford, yearling, steers that averaged 790 pounds in weight. Sixty Hereford yearling steers of the same quality that averaged 760 pounds live weight were used for the 1944-45 trial. The average of three consecutive weights taken at the beginning and at the end of each experimental period were used respectively as the initial and final steer weights. Single daily weights were taken every 28 days to permit a periodic comparison of gains produced by each lot and between lots. Group weights every fourteen days following the individual weighing were taken in 1943-44 trial. The steers were allowed their morning feed of grain and free access to water prior to weighing, but silages were fed after weighing. All weights were taken at 10:00 A. M. on each weigh day.

Allotment Factors:

The factors of weight, type, condition, color, and origin (in 1943-44 experiment only) were considered in alloting steers in order to reduce to a minimum variations between lots.

Feeds Used:

Feeds other than silages fed to the animals were as follows:

Corn	U. S. No. 1 Grade	Ground medium fine
Barley	U. S. No. 2 Grade	Steam rolled
Alfalfa hay	U. S. No. 2 Grade	First and second cuttings
Cottonseed meal	41 % Crude Protein	

Rations Fed:

Average Daily Ration - 1943-44*

Lot Number	1	2	3	4
Amount per head:	Lbs.	Lbs.	Lbs.	Lbs.
Ground corn	3.03	3.29	3.24	3.06
Rolled barley	3.03	3.29	3.24	3.06
Corn silage	23.86			
Alfalfa-corn silage		22.92		
Beet top silage			27.13	
Dried beet tops				9.54
Alfalfa hay	6.23	4.66	4.64	8.59
Mineral	.033	.037	.053	.053
Salt	.022	.027	.013	.038

* Cited from Colorado Farm Bulletin, Volume VI, Number 4. 1944.

Average Daily Ration - 1944-45 *

Lot Number	1	2	3	4	5	6
Amount per head:	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Ground corn	14.46	15.06	15.03	14.62	14.46	14.81
Cottonseed meal	.96	.99	.99	.97	.96	.98
Corn silage	4.37					
Alfalfa silage		4.37				
Alfalfa-corn silage			4.37			
Alfalfa-acid silage				4.35		
Potato-corn fodder silage					4.27	
Potato-alfalfa hay silage						4.35
Alfalfa hay	3.76	4.20	3.92	4.33	3.72	4.03
Mineral	.032	.034	.030	.051	.032	.029
Salt	.029	.024	.025	.035	.021	.024

* Cited from Colorado Farm Bulletin, Volume VII, Number 4. 1945.

Method of Feeding:

Grain was fed twice daily, promptly at 7:00 A. M. and at 4:00 P. M. The silages and alfalfa hay were fed once daily at 10:00 A. M. and 1:00 P. M. respectively. Mineral block and stock salt were self-fed.

Feeding was increased to full feed as quickly as possible. The 1943-44 experiment was started using one pound of grain per head daily. At the one-hundred fiftieth day, this amount was gradually increased to 7.5 pounds per head daily, and maintained at that level to the end of the feeding period. The amount of silage fed to each lot was adjusted according to the dry matter content of the silages. All lots were started with 45 pounds total or five pounds per head daily. The quantity fed daily per animal was gradually increased until lot 1 received 17.5 pounds of corn silage, lot 2 - 20 pounds alfalfa-corn silage, lot 3 - 22.5 pounds beet top silage, and lot 4 - 15 pounds of dried beet tops. At the end of approximately 150 days feeding, silage intake was reduced over 50 per cent because of the increase in grain. In the 1944-45 experiment, the steers were started on two pounds of grain mixture and one pound of cottonseed meal per head daily. When on full feed at 150 days, the steers were receiving 18 pounds of grain mixture and one pound of cottonseed meal. Two pounds of silage was gradually increased until they reached a maximum of four pounds per head daily. The amounts of hay fed to each lot were kept as nearly alike as possible. A truck-load of hay was weighed into each bunk and a certain quantity of it was fed each day.

EXPERIMENTAL RESULTS

Nutrient Conservation:

Carotene: Of all the nutrients studied in this research, carotene appeared to show consistently the greatest decline during storage. Also the greatest difference between hay and silage values were shown for carotene. Preservation of this nutrient was definitely enhanced by ensiling (Plates I and II and Table VII). In most cases, during the first 200 days of storage, silages retained more carotene than did the hays. Silage treated with phosphoric acid suffered the smallest loss. In general, the addition of preservatives definitely increased the retention of carotene. Unpreserved silage showed the smallest retention of carotene. Woodward and Shepherd (27) obtained similar results with the same kinds of silages using molasses instead of ground corn as a preservative. Observations by Perkins and associates (19) also indicate that acid treatment of silage is an effective and dependable method, under most conditions, for the carotene preservation of crops.

Silages consistently showed smaller loss of carotene during harvesting (Table VI). Fifteen to 56 per cent more of the original carotene was saved during harvest by putting the hay into silage. The greatest carotene destruction in the cured hays was during the time between cutting and stacking. After stacking, the carotene loss was less and the decline was more gradual.

Variations in carotene loss in different cuttings was probably due to the different lengths of time the hays were left in cocks in the field. Second and third cutting hays showed tremendous losses (Plate I) because of remaining in cocks six days before stacking. The second cutting suffered additional weathering by a slight rain on the third day after it was mowed. Carotene losses were small for both the silage and hay from third cutting alfalfa, 1944, (Table VI). Cloudy weather prevailed during the entire harvest period and consequently the destruction of carotene was not appreciable. Third cutting alfalfa contained the highest initial quantity of carotene (Plates I and II) with second and first cutting following in decreasing order, except in 1943 when third cutting yielded less than did second cutting. This was probably due to a heavy frost a few days before the third cutting hay was mowed.

Table V. Initial Nutrient Composition at Harvesting of Materials Used for Silage Studies.*

Year	Material	Dry Matter	Crude** Protein	Carotene	Ash	Calcium	Phosphorus
				Per Gram of Dry Matter			
		%	%	Gamma	Mgms.	Mgms.	Mgms.
1943-44	Alfalfa, 1st. C.	18.36	20.65	239	84.90	12.53	2.83
1944-45	Alfalfa, 1st. C.	19.39	17.91	335	89.31	12.20	2.17
1943-44	Alfalfa, 2nd. C.	18.39	18.33	355	85.40	11.49	2.40
1944-45	Alfalfa, 2nd. C.	19.12	19.87	362	86.27	12.18	2.46
1943-44	Alfalfa, 3rd. C.	22.01#	18.32	322	103.23	11.99	1.86
1944-45	Alfalfa, 3rd. C.	15.69	18.87	416	97.68	12.68	2.62
1943-44	Beet tops	21.18	8.98	349	169.14	9.18	1.92
1943-44	Corn fodder	23.46	8.08	97	48.17	2.23	2.30
1944-45	Corn fodder	23.49	8.19	161	56.90	2.22	2.03
1944-45	Potatoes	22.72	8.31	---	62.42	0.58	2.27

* Except for potatoes which had been in storage several months prior to ensiling.
** Calculated on dry matter basis.
\# A heavy frost was responsible for the high dry matter content.

TABLE VI. NUTRIENT LOSSES DURING HARVESTING

Feeding Trial	Kind of Silage	Crude Protein		Carotene		Ash		Calcium		Phosphorus	
		Hay %	Silage %	Hay %	Silage %	Hay %	Silage %	Hay %	Silage %	Hay %	Silage %
1	Alfalfa-corn 1/	14.53	6.59	57.32	22.18	4.94	4.91	18.36	9.58	12.37	9.54
1	Alfalfa-corn 2/	16.97	5.56	83.94	28.17	4.97	-4.20	18.89	4.44	8.75	-1.67
1	Beet top	-----	4.68	-----	37.82	----	-2.94	-----	20.59	----	10.94
1	Corn	-----	2.35	-----	13.40	----	-4.01	-----	13.00	----	0.43
2	Alfalfa (Unpreserved)	0.17	9.55	46.87	22.69	1.32	1.74	6.07	0.74	37.18	14.08
2	Alfalfa-corn	0.45	0.30	37.57	27.90	2.94	1.72	13.11	3.42	2.44	13.01
2	Alfalfa-acid	3.50	1.48	24.76	9.62	13.63	-0.57	17.51	-1.97	34.35	-51.91

1/. Alfalfa-corn silage prepared from first cutting hay; and 2/ prepared from second cutting.

PLATE I

CAROTENE CONTENT
of ALFALFA SILAGE AND HAY, 1943-44

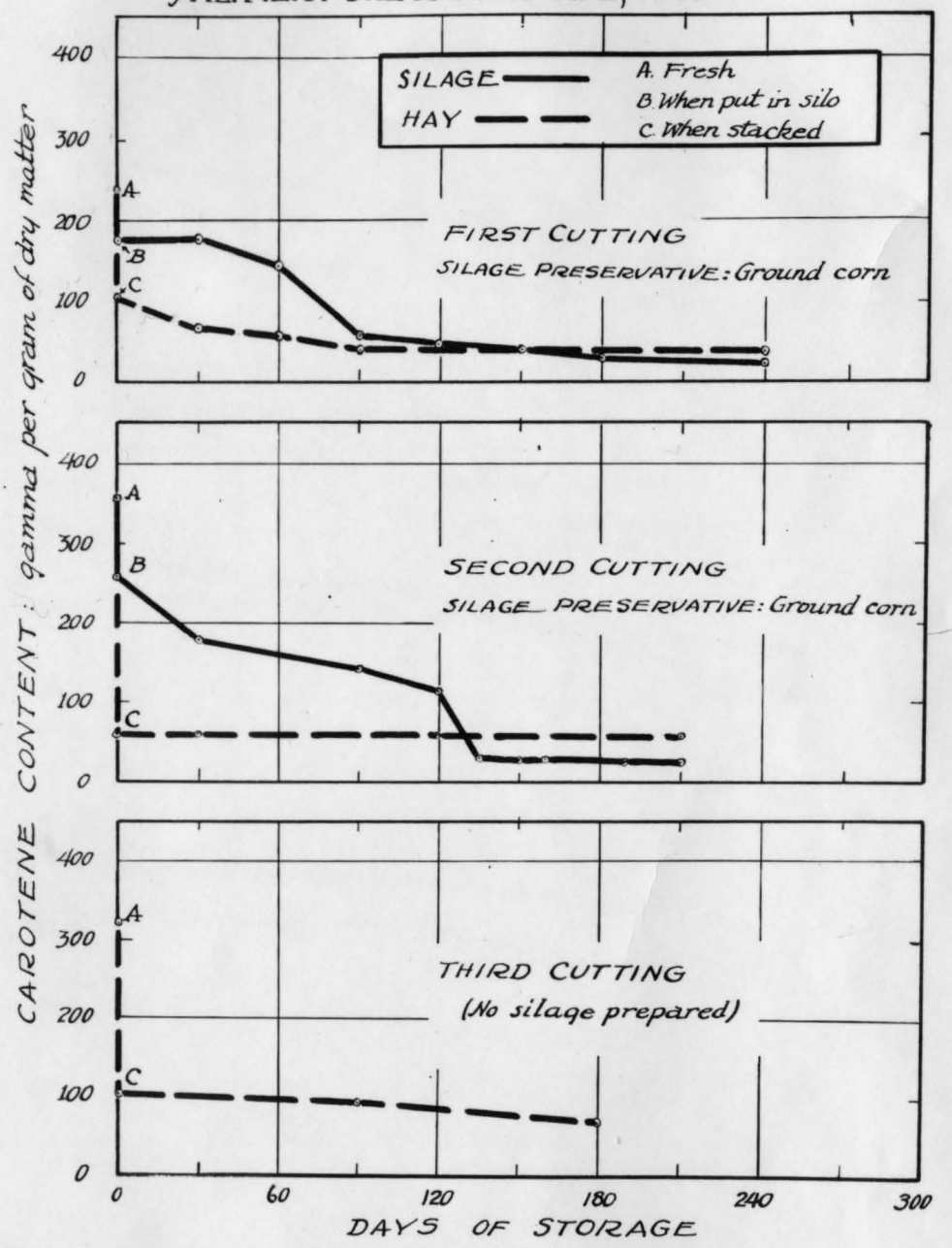
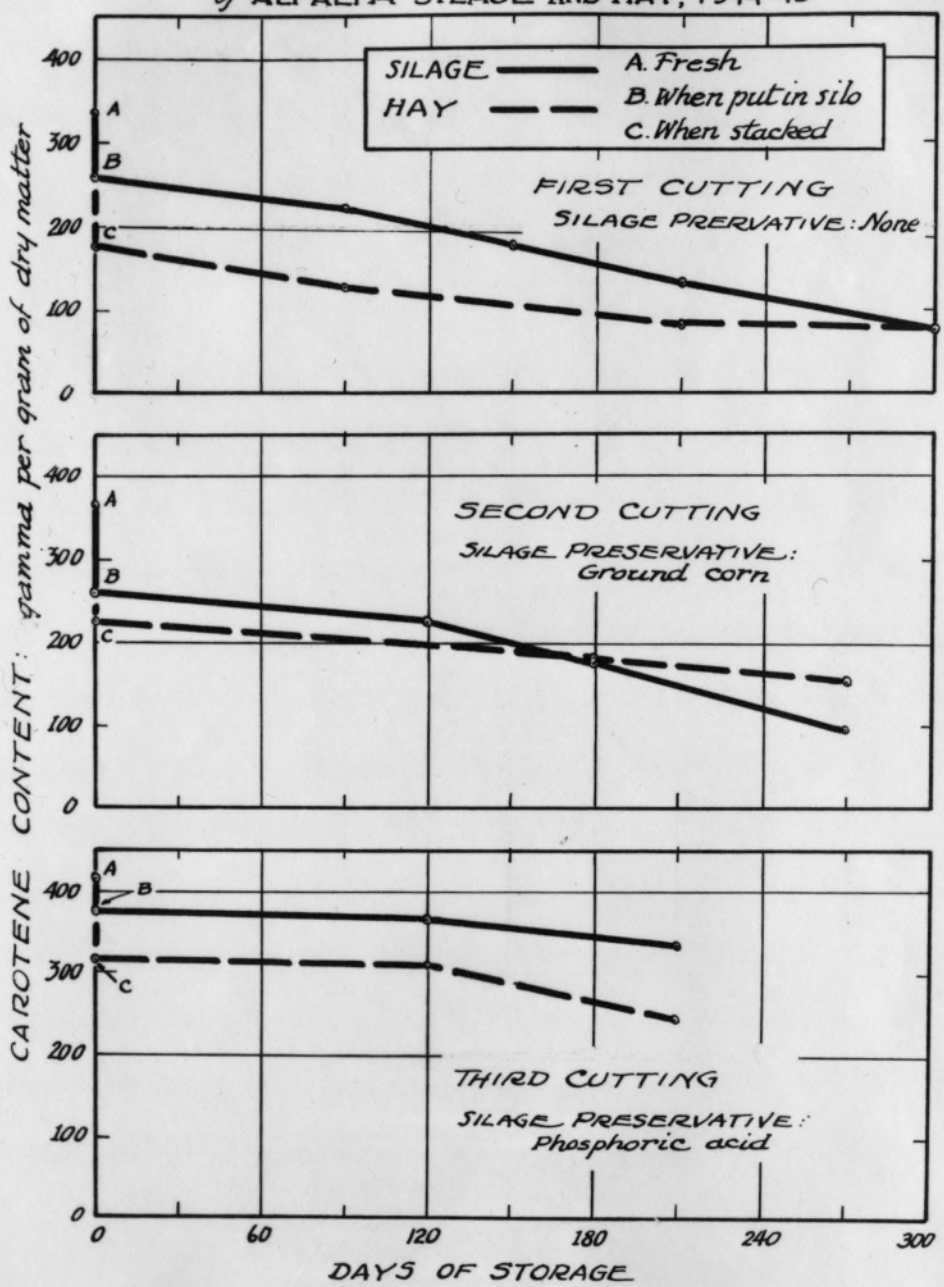


PLATE II

CAROTENE CONTENT

of ALFALFA SILAGE AND HAY, 1944-45



Beet top silage retained 27.51 per cent more carotene than did the stacked, dried tops (Plate III). Again the greatest carotene loss occurred immediately between topping and stacking. Another appreciable loss, perhaps due to fermentation changes, occurred during the first 30 days after the silage was prepared.

Corn silages suffered little carotene loss. According to the curves shown in Plate III, the greatest loss occurred during harvest.

Crude Protein: In general, ensiling of alfalfa resulted in a greater retention of crude protein than was observed in the stacked hays. This could have been due to less shattering of leaves in the silage preparation. Less fermentation, because of the addition of acid, was probably responsible for the protein retention in alfalfa-acid silage (Table VII). Alfalfa silage preserved with ground corn also showed a comparable retention, although in this case some protein was added in the corn. Unpreserved alfalfa silage showed greatest protein loss, while corn silage and potato-corn fodder silage lost very small amounts. Table X indicates increases of crude protein and ash content in stacked, dried, beet tops, no doubt owing to an increasing proportion of crowns through the shattering and loss of leaves, and accumulation of dirt with subsequent sampling.

Ash: The ash content of all silages increased during storage, likely resulting from a decline in carbonaceous material lost in fermentation.

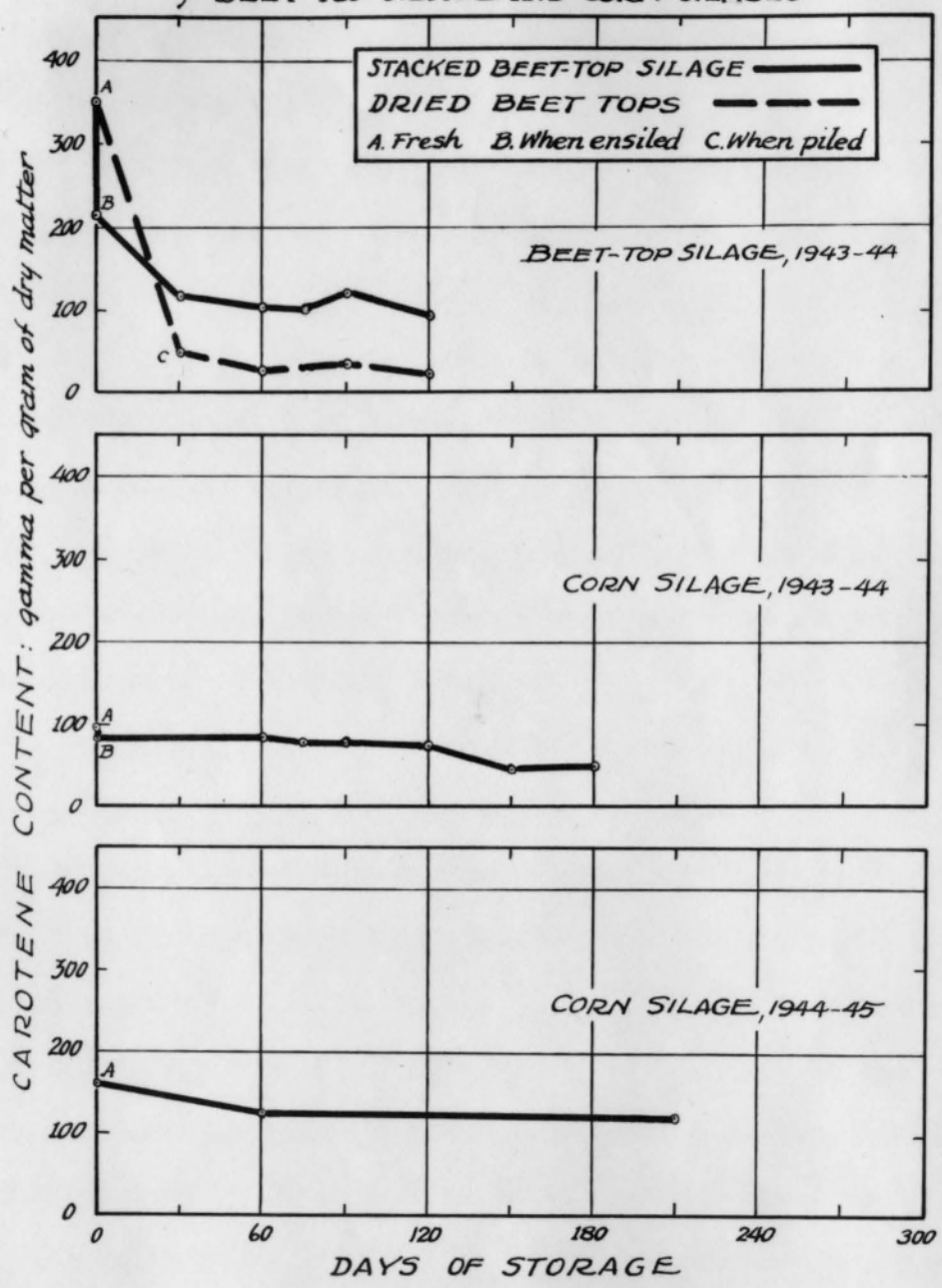
TABLE VII. NUTRIENT LOSSES DURING STORAGE

Feeding Trial	Kind of Silage	Crude Protein		Carotene		Ash		Calcium		Phosphorus	
		Hay %	Silage %	Hay %	Silage %	Hay %	Silage %	Hay %	Silage %	Hay %	Silage %
1	Alfalfa-corn 1/	6.23	17.42	52.94	60.75	-10.94	-58.39	3.40	-12.09	13.71	-2.34
1	Alfalfa-corn 2/	4.60	3.64	0.00	71.76	-15.10	-23.82	-6.12	- 5.10	1.83	0.00
1	Beet top	----	6.66	----	50.23	-----	-12.59	----	- 0.55	----	-2.92
1	Corn	----	2.03	----	19.05	-----	- 1.04	----	-13.92	----	3.06
2	Alfalfa (Unpreserved)	6.86	11.48	47.75	42.08	3.63	-16.17	-1.92	0.50	-8.05	1.68
2	Alfalfa-corn	9.50	10.70	26.11	37.16	4.43	- 7.98	6.09	- 3.29	12.92	-13.08
2	Alfalfa-acid	16.36	9.95	11.50	6.38	9.34	-21.21	1.53	-38.13	0.00	-23.37
2	Potato-corn fodder	----	3.39	-----	----	----	2.19	----	16.08	----	5.66
2	Potato-alfalfa hay	----	8.51	-----	----	----	- 5.04	----	12.05	----	9.29

1/. Alfalfa-corn silage prepared from first cutting hay; and 2/ prepared from second cutting hay.

PLATE III

CAROTENE CONTENT
of BEET-TOP SILAGE AND CORN SILAGES



Calcium and Phosphorus: During harvest, alfalfa silages retained from 6 to 20 per cent more calcium and 11 to 86 per cent more phosphorus than did the sun-cured hays from similar cuttings (Table VI). The losses of these nutrients shown by the stacked hays was perhaps due mainly to shattering of leaves. Table VII shows that silages also retained more calcium and phosphorus than the sun-cured hays during storage. The addition of preservatives perhaps increased the mineral content of the silages slightly. The addition of phosphoric acid certainly increased the phosphorus content of the alfalfa-acid silage. Calcium and phosphorus losses in corn silages were very small. Tables XVI and XVII indicate fluctuations of these minerals during storage in the potato-corn fodder and potato-alfalfa hay silages. Such variations were undoubtedly caused by sampling errors.

Dry Matter: Because the alfalfa was not chopped in preparing silages for the first feeding trial, adequate packing to exclude sufficient air for proper fermentation could not be obtained. Thus, the silages dried considerably. The dry matter content of unpreserved alfalfa silage (Table XII) and alfalfa-corn silage (Table XIII) decreased approximately 10 per cent during storage. A possible explanation for the gain in moisture might be that the trench silos were constructed in a pasture where the water table was very high, consequently allowing water to penetrate into the ensiled material. Or, the sampling error could have been partly responsible. In order to get a representative sample,

material was taken from the center (in depth) of the silos. The trench silo used for alfalfa-acid silage was located a little higher above the water table than the other two silos and consequently there was not as much increase in moisture. The addition of water after ensiling decreased the dry matter content 3.95 per cent in the corn silage (Table XV). The moisture loss in potato-corn fodder silage was small at first, but after 210 days of storage the dry matter increased rapidly. Such a change perhaps resulted from the warm weather following opening of the silo during the spring months in 1945. A moisture loss, averaging 4.65 per cent, also occurred in the potato-alfalfa hay silage during this season of the year. Because potato-corn fodder silage was composed of coarser material, there resulted a greater moisture loss. However, in both potato silages, an immediate establishment of desirable pH values led quickly to proper fermentation and held nutrient losses to a minimum.

Silage Utilization:

Beet top, corn, potato-corn fodder, and potato-alfalfa hay silages appeared to be relished by the animals used in the feeding trials. Table XX shows how the various silages were rated for palatability, color, and odor.

Table No. XX. Quality of the Silages.

Feeding Trial	Silage	Palatability	Color	Odor
1	Alfalfa-corn	Poor	Dark brown	Strong, putrefactive
2	Unpreserved alfalfa	Fair	Brown	Slightly butyric
2	Alfalfa-corn	Fair	Greenish-brown	Fair silage
2	Alfalfa-acid	Good	Yellowish-brown	Fair silage
1	Beet top	Very good	Yellowish-brown	Sweet silage
1	Corn	Excellent	Yellowish-green	Excellent silage
2	Corn	Excellent	Yellowish-green	Excellent silage
2	Potato-corn fodder	Excellent	Dark brown	Excellent silage
2	Potato-alfalfa hay	Excellent	Grayish-green	Excellent silage

No difficulty, except in the alfalfa silage lots, was experienced in getting the animals to eat the silages. In the 1943-44 trial, the steers would eat only a small amount of the alfalfa-corn silage because of an offensive odor and probably also lack of palatability. Greater preference was shown for the alfalfa-corn silage and the unpreserved alfalfa silage in the second trial than for the alfalfa-corn silage of the previous year. The animals seemed to like the acid preserved silage the best of the different alfalfa silages at

the beginning of the feeding period, and consequently made the best gains. However, during the latter half of the trial, a decline in rate of consumption of the acid silage was noticed, although the animals did clean up all they were fed by evening each day. The cause for this is unknown. No case of digestive disorder was observed.

Steers preferred the potato-alfalfa hay silage to the potato-corn fodder silage. Undoubtedly, this was due to loss of moisture from the potato-corn fodder silage because of its coarse texture. However, very little waste resulted from spoilage or during feeding.

Dried beet tops seemed to stimulate a greater appetite and cause less scouring than did the beet top silage, although the scouring was not serious in any case. Animals in both lots cleaned up the tops as soon as they were fed. The silage kept very nicely during the winter months, but when warm weather approached considerable spoilage occurred. It must be pointed out that none of the silages were fed in large enough quantities each day to prevent the spoilage and waste which otherwise could have been utilized.

Corn silages exhibited a rather sour odor when the silos were opened at the beginning of the feeding experiment. Perhaps, sufficient time had not elapsed for complete fermentation which later produced very agreeable odor. Only a short time was required for the steers to become accustomed to these silages.

Live Weight Gains: The first feeding trial utilized low grain-high roughage rations, while during the second trial high grain-low roughage feeds were fed. Under such conditions, live weight gains observed in the two trials cannot be compared directly. In the first trial, steers fed beet top silage and dried beet tops made the greatest gains (Table XXI). The control lot which received corn silage made the next best gains while the lot which received alfalfa silage gained the least. However, in the second trial when the animals were fed a higher grain level, the lots fed alfalfa silages prepared by different methods made better gains than did the control lot (Table XXII). Such differences were perhaps due to the change in quality of the silages. Lot No. 6, fed potato-alfalfa hay silage, made the best gains in the second test, and Lot No. 5 which received potato-corn fodder silage was the second highest in gains.

Economic Data: The feed cost to produce one hundred pounds of beef in both trials was highest for the lots which received the different alfalfa silages. However, the steers in all silage fed lots in the first trial sold for approximately the same price. Six silage fed lots in the second test sold for $17.20 per hundred pounds. From the financial standpoint, Lot No. 2 in the 1943-44 trial showed the highest, and Lot No. 3 the smallest loss. Steers in the 1944-45 trial fed unpreserved alfalfa silage and alfalfa-corn silage returned the least profit. Lot No. 4, fed alfalfa-acid silage yielded more profit than the corn silage fed lot and the two potato silage lots netted the most money.

Shipping and Slaughter Data: The corn silage fed lot in the 1943-44 trial showed the smallest shrink to market. No significant difference in dressing percentage was observed between the two trials. No appreciable difference between lots was shown in carcass grades. The two grades of carcasses in the first trial were good and choice, while in the second they were considered choice and prime. No livers were condemned in the alfalfa-corn silage and beet top silage lots in 1943-44. The percentage liver condemnation in 1944-45 was not significant.

Feed Replacement Values: Beet top silage, potato-alfalfa hay silage and potato-corn fodder silage gave higher feed replacement values than the standard (corn) silage as indicated in Table XIX (Appendix). Of course, it must be emphasized that replacement value as generally computed represents only the current and often unstable monetary value, certainly not the true nutritive value of a feed.

Alfalfa-corn silage in both trials and alfalfa-acid silage in the second trial gave two-thirds the feed replacement value and unpreserved alfalfa silage showed one-third the feeding value of standard corn silage. In the 1944-45 feeding trial, the addition of preservatives improved the quality of silages, and likewise increased the feed replacement value approximately 30 per cent over that of the untreated silage.

TABLE XXI. STEER FEEDING EXPERIMENT 1/

Nov. 9, 1943 to Mar. 28, 1944
(Data Averaged for One Steer)

	Lot Number	1	2	3	4
	Number of Steers	9	7	9	7
Steer Gains	Initial weight	786.9	817.1	793.6	817.5
	Final weight	1011.9	1017.5	1033.3	1055.0
	Total gain	225.0	200.4	239.7	237.5
	Daily gain	1.61	1.43	1.71	1.70
Feed Required Per Hundred Pound Gain		Lbs.	Lbs.	Lbs.	Lbs.
	Ground corn	188.50	229.70	189.10	180.10
	Rolled barley	188.50	229.70	189.10	180.10
	Corn silage	1484.70			
	Alfalfa silage		1601.50		
	Beet top silage			1584.7	
	Dried beet tops				562.10
	Alfalfa hay *	387.70	325.90	271.20	506.20
	Salt *	1.40	1.90	.80	2.20
	Mineral *	2.10	2.60	3.10	3.10
Economic Data	Feed cost per cwt. gain **	$ 18.39	22.65	14.95	15.84
	Selling price per cwt. (Denver)	15.45	15.50	15.50	15.45
	Return per steer	153.56	154.45	156.74	157.70
	Total expense	161.87	171.79	157.95	162.99
	Profit per steer	-8.31	-17.34	-1.21	-5.29
Shipping and Slaughter Data	Market weight	993.90	996.40	1017.80	1020.70
	% shrink to market	.06	1.41	.70	1.65
	Dressed weight (cold)	600.30	595.40	609.00	616.90
	Dressing per cent	60.40	59.80	59.80	60.40
	Government carcass grade:				
	Choice	5	2	4	4
	Good	4	5	5	3
	Inspection of livers:				
	Abscess	2	0	0	1
	Telangiectasis	1	0	0	1
	Sawdust	0	0	0	0

*Self-fed in all lots

**Feed costs used (ton basis): Ground corn, $49.00; rolled barley, $47.00; alfalfa hay, $19.00; mineral, $75; Salt, $15; alfalfa silage, $10.50; beet top silage $4.00; corn silage, $7.50; and dried beet tops, $8.00.

1/. Cited from Colorado Farm Bulletin, Volume VI, Number 4. July-August, 1944

TABLE XXII. STEER FEEDING EXPERIMENT 1/

Nov. 17, 1944 to May 31, 1945
(Data Averaged for One Steer)

	Lot Number	1	2	3	4	5	6
	Number of Steers	10	10	10	10	9	8
Steer Gains	Initial weight	761.83	761.17	761.17	759.17	773.33	743.75
	Final weight	1175.67	1183.50	1184.83	1177.67	1210.19	1208.33
	Total gain	413.83	422.33	423.67	418.50	436.85	464.58
	Daily gain	2.11	2.15	2.16	2.14	2.23	2.37
Feed Required Per One Hundred Pound Gain		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
	Ground corn	684.65	699.09	695.48	684.83	648.91	624.60
	Cottonseed meal	45.37	46.11	45.85	45.34	43.09	41.24
	Corn silage	206.85					
	Alfalfa silage		202.68				
	Alfalfa-corn silage			202.05			
	Alfalfa-acid silage				203.58		
	Potato-corn fodder silage					191.80	
	Potato-alfalfa hay silage						183.68
	Alfalfa hay *	178.09	194.99	181.51	202.75	166.98	170.11
	Mineral *	1.51	1.56	1.39	2.37	1.45	1.24
	Salt *	1.35	1.12	1.16	1.65	.96	1.03
Economic Data	Feed cost per cwt. gain **	$ 18.98	19.46	19.47	19.36	18.20	17.59
	Selling price per cwt. (Denver)	17.20	17.20	17.20	17.20	17.20	17.20
	Return per steer	194.62	197.20	197.11	197.11	200.67	199.95
	Total expense	192.49	196.22	196.53	194.73	195.18	193.40
	Profit per steer	2.13	0.98	0.58	2.38	5.49	6.55
Shipping and Slaughter Data	Market weight	1131.50	1146.50	1146.00	1146.00	1166.67	1162.50
	Per cent shrink to market	3.76	3.13	3.28	2.69	3.60	3.79
	Dressed weight (cold)	717.80	734.20	741.00	721.00	744.67	739.25
	Dressing per cent	63.44	64.04	64.66	62.91	63.83	63.59
	Government carcass grade:						
	Prime	4	4	5	2	4	4
	Choice	6	6	5	8	5	4
	Inspection of livers:						
	Abscess	2	0	1	2	1	0
	Telangiectasis	1	1	1	0	0	1
	Sawdust	0	0	0	0	0	1

* Self-fed in all lots.

** Feed costs used (ton basis): Ground corn, $44.00; cottonseed meal, $65.00; alfalfa hay, $18.00; mineral, $75.00; salt, $16.00; corn silage, $7.50; alfalfa silage, $7.50; alfalfa-corn silage, $9.80; alfalfa-acid silage, $8.80; potato-corn fodder silage, $10.00; and potato-alfalfa hay silage, $10.00.

1/. Cited from Colorado Farm Bulletin, Volume VII, Number 4. July-August, 1945.

SUMMARY AND CONCLUSIONS

Two experiments were conducted to determine the effect of method of silage preparation on nutrient conservation, and to show the economic value of each method of preparation by using the silages in a fattening ration. Silages were prepared from alfalfa, corn, beet tops, and potatoes. The first feeding trial utilized low grain - high roughage rations, while during the second trial high grain - low roughage feeds were fed.

Preservation of carotene and protein was definitely enhanced by ensiling. Fifteen to 56 per cent more of the original carotene was saved during harvest, and up to 72 per cent more was retained during storage up to approximately 150 days. Ordinarily, the peak of silage feeding is reached before this time. After 150 days or more of storage, carotene content of silages, except that preserved with phosphoric acid, declined to levels equal to or below the stacked hays. Beet top silage retained 27.51 per cent more carotene than did stacked, dried tops. Although beet top silage kept very well during the winter months, spoilage was considerable with the approach of warm weather. Third cutting alfalfa contained the highest initial quantity of carotene with second and first cutting following in decreasing order. In general, ensiling of alfalfa resulted in a greater retention of crude protein than was observed in stacked hays. Preservation with

phosphoric acid appeared to be the best method of nutrient conservation in these experiments.

During harvest, alfalfa silages retained from 6 to 20 per cent more calcium and 11 to 86 per cent more phosphorus than did sun-cured hays from similar cutting. The ash content of all silages increased during storage.

Potato-alfalfa hay, potato-corn fodder, beet top, and corn silages appeared to be more relished by the animals than were the alfalfa silages used in the feeding trials. Steers preferred the potato-alfalfa hay silage to the potato-corn fodder silage. When the steers were fed a higher grain level, the lots fed alfalfa silages prepared by different methods made better gains than did the control lot. There were no appreciable differences between lots of steers in selling price per hundred pounds live weight, shrink to market, dressing percentage, carcass grades or liver condemnation. Using the current feed prices, the cost to produce one hundred pounds of beef in both trials was highest for the lots which received the different alfalfa silages.

APPENDIX

TABLE VIII. NUTRIENT COMPOSITION OF ALFALFA-CORN SILAGE AND HAY

First Cutting - 1943-44

Period of Storage	Dry Matter		pH	Crude Protein		Carotene		Ash		Calcium		Phosphorus	
	Hay	Silage	Silage	Hay	Silage	Hay	Silage	Hay	Silage	Hay	Silage	Hay	Silage
	Per Cent			D.M. Basis Per Cent		Per Gram of Dry Matter Gamma			Milligrams				
When cut	18.36	18.36	----	20.65	20.65	239	239	84.90	84.90	12.53	12.53	2.83	2.83
When stacked or put in silo	76.34	39.83	----	17.65	19.29	102	186	80.71	80.73	10.23	11.33	2.48	2.56
30-days storage	91.32	30.87	----	16.14	18.23	65	174	76.38	99.65	9.76	13.98	2.16	2.09
60-days "	91.75	33.48	7.60	16.81	17.53	55	143	79.90	100.12	10.20	11.48	2.11	3.12
90-days "	90.91	29.87	7.58	16.84	15.26	40	55	91.23	133.02	9.96	11.71	2.17	2.83
120-days "	-----	30.56	7.39	-----	17.40	--	49	-----	121.29	----	13.15	----	2.47
150-days "	92.53	25.89	7.29	16.53	13.63	40	40	102.41	146.28	11.27	13.98	2.36	2.46
180-days "	-----	28.41	6.30	-----	15.83	--	30	------	147.04	-----	13.16	----	3.19
240-days "	90.80	25.68	5.60	16.44	13.60	40	23	97.76	147.68	11.77	11.46	1.90	2.18
Average during storage: 1/	91.46	29.25	6.96	16.55	15.93	48	73	89.54	127.87	10.59	12.70	2.14	2.62
Percentage loss during harvest: 2/	-315.80	-116.94	----	14.53	6.59	57.32	22.18	4.94	4.91	18.36	9.58	12.37	9.54
Percentage loss during storage: 3/	-19.81	26.56	----	6.23	17.42	52.94	60.75	-10.94	-58.39	3.40	-12.09	13.71	-2.34

1/, 2/, and 3/. See footnotes under Table XII.

TABLE IX. NUTRIENT COMPOSITION OF ALFALFA-CORN SILAGE

Second Cutting - 1943-44

Period of Storage	Dry Matter		pH	Crude Protein		Carotene		Ash		Calcium		Phosphorus	
	Hay	Silage	Silage	Hay	Silage	Hay	Silage	Hay	Silage	Hay	Silage	Hay	Silage
	Per Cent			D.M. Basis Per Cent		Per Gram of Dry Matter Gamma		Milligrams		Milligrams		Milligrams	
When cut	18.39	18.39	----	18.33	18.33	355	355	85.40	85.40	11.49	11.49	2.40	2.40
When stacked or put in silo	68.85	37.71	----	15.22	17.31	57	255	81.15	88.99	9.32	10.98	2.19	2.44
30-days storage	89.81	32.37	5.77	14.71	18.50	57	177	81.76	126.06	8.39	13.92	2.26	2.36
90-days "	-----	38.69	6.61	-----	16.20	--	140	-----	85.88	----	7.45	----	2.65
120-days "	89.22	25.37	7.19	14.48	15.97	56	110	98.08	110.12	11.06	12.31	2.10	2.66
135-days "	-----	28.78	5.83	-----	15.17	--	31	-----	127.54	-----	10.27	----	2.40
150-days "	-----	25.48	5.99	-----	15.40	--	29	-----	119.94	-----	13.57	----	2.27
160-days "	-----	33.51	6.20	-----	17.26	--	30	-----	112.92	-----	12.73	----	----
190-days "	-----	37.11	6.20	-----	18.23	--	29	-----	101.27	-----	11.44	----	2.23
210-days "	89.31	33.68	6.20	14.36	16.71	56	29	100.37	97.76	10.22	10.60	2.10	2.50
Average during storage: 1/	89.45	31.87	6.25	14.52	16.68	57	72	93.40	110.19	9.89	11.54	2.15	2.44
Percentage loss during harvest: 2/	-274.39	-105.06	----	16.97	5.56	83.94	28.17	4.98	-4.20	18.89	4.44	8.75	-1.67
Percentage loss during storage: 3/	-29.92	15.49	----	4.60	3.64	0.00	71.76	-15.10	-23.82	-6.12	-5.10	1.83	0.00

1/, 2/, and 3/. See footnotes under Table XII.

TABLE X. NUTRIENT COMPOSITION OF STACKED BEET TOP SILAGE AND DRIED BEET TOPS

1943-44

Period of Storage	Dry Matter		pH	Crude Protein		Carotene		Ash		Calcium		Phosphorus	
	Dried Tops	Silage	Silage	Dried Tops	Silage	Dried Tops	Silage	Dried Tops	Silage	Dried Tops	Silage	Dried Tops	Silage
				D.M. Basis		Per Gram of Dry Matter							
	Per Cent			Per Cent		Gamma		Milligrams		Milligrams		Milligrams	
When topped	21.18	21.18	---	8.98	8.98	349	349	169.14	169.14	9.18	9.18	1.92	1.92
When stacked	-----	28.73	---	----	8.56	---	217	------	174.12	----	7.29	----	1.71
30-days storage	52.02	23.86	4.60	7.97	8.11	50	118	249.19	177.12	8.00	6.27	1.77	1.84
60-days "	70.03	17.91	3.95	7.40	8.30	29	103	167.54	222.85	9.23	8.65	1.52	1.74
75-days "	76.92	22.72	4.08	11.38	7.94	--	102	265.93	179.51	7.05	7.00	1.60	1.72
90-days "	71.58	19.93	4.20	9.36	7.95	35	121	179.07	207.46	7.00	7.95	1.07	1.89
120-days "	68.63	23.09	4.10	12.04	7.65	25	94	230.59	193.31	4.59	6.77	2.08	1.62
Average during storage: 1/	67.84	21.50	4.19	9.63	7.99	35	108	218.46	196.05	7.17	7.33	1.61	1.76
Percentage loss during harvest: 2/	-----	-35.65	----	----	4.68	--	37.82	------	-2.94	----	20.59	----	10.94
Percentage loss during storage: 3/	-----	25.17	----	----	6.66	--	50.23	------	-12.59	----	-0.55	----	-2.92

1/. Average during storage is the average value of all analyses during storage excluding that value when stacked.
2/. Value when topped minus value when stacked divided by value when topped multiplied by 100.
3/. Value when stacked minus average value during storage divided by value when stacked multiplied by 100.

TABLE XI. NUTRIENT COMPOSITION OF CORN SILAGE
1943-44

Period of Storage	Dry Matter	pH	Crude Protein	Carotene	Ash	Calcium	Phosphorus
			D.M.Basis	Per Gram of Dry Matter			
	%		%	Gamma	Mgms.	Mgms.	Mgms.
When cut	23.46	----	8.05	97	48.17	2.23	2.30
When put in silo	25.37	5.22	7.89	84	50.10	1.94	2.29
60-days storage	23.34	4.20	8.23	85	52.18	2.46	1.78
75-days "	24.50	3.65	7.61	79	40.90	1.77	1.97
90-days "	25.73	3.79	7.16	78	44.61	1.78	2.00
120-days "	25.14	3.80	7.71	75	53.05	2.42	2.65
150-days "	23.53	3.80	7.68	44	57.52	2.42	2.54
180-days "	26.16	3.80	8.01	49	55.46	2.40	2.40
Average during storage: 1/	24.73	3.84	7.73	68	50.62	2.21	2.22
Percentage loss during harvest: 2/	-7.53	----	2.35	13.40	-4.01	13.00	0.43
Percentage loss during storage: 3/	2.52	----	2.03	19.05	-1.04	-13.92	3.06

1/. Average during storage is the average value of all analyses during storage excluding that value when put in silo.
2/. Value when cut minus value when put in silo divided by value when cut multiplied by 100.
3/. Value when put in silo minus average value during storage divided by value when put in silo multiplied by 100.

TABLE XII. NUTRIENT COMPOSITION OF UNPRESERVED ALFALFA SILAGE AND HAY

First Cutting - 1944-45

Period of Storage	Dry Matter		pH	Crude Protein		Carotene		Ash		Calcium		Phosphorus	
	Hay	Silage	Silage	Hay	Silage	Hay	Silage	Hay	Silage	Hay	Silage	Hay	Silage
	Per Cent			D.M. Basis Per Cent		Per Gram of Dry Matter Gamma		Milligrams		Milligrams		Milligrams	
When cut	19.39	19.39	---	17.91	17.91	335	335	89.31	89.31	12.20	12.20	2.77	2.77
When stacked or put in silo	78.21	25.53	---	17.94	16.20	178	259	88.13	87.76	11.46	12.11	1.74	2.38
90-days storage	88.62	14.26	6.50	16.83	14.64	124	218	87.28	98.65	11.19	12.02	1.70	2.42
150-days "	----	12.84	5.50	----	13.97	---	175	----	105.09	----	11.90	----	2.06
210-days "	88.79	14.03	5.56	16.58	16.02	80	130	86.01	99.80	11.19	12.14	2.21	2.27
300-days "	86.30	12.65	8.10	16.71	12.71	76	76	81.49	104.27	12.66	12.13	1.73	2.61
Average during storage: 1/	87.90	13.45*	6.42	16.71	14.34	93	150	84.93	101.95	11.68	12.05	1.88	2.34
Percentage loss during harvest: 2/	-303.35	-31.67	----	-0.17	9.55	46.87	22.69	1.32	1.74	6.07	0.74	37.18	14.08
Percentage loss during storage: 3/	-12.39	47.32	----	6.86	11.48	47.75	42.08	3.63	-16.17	-1.92	0.50	-8.05	1.68

1/. Average during storage is the average value of all analyses during storage excluding that value when put in silo.
2/. Value when cut minus value when put in silo divided by value when cut multiplied by 100.
3/. Value when put in silo minus average value during storage divided by value when put in silo multiplied by 100.
* This silage decreased in dry matter which resulted from absorption of water accumulated in the bottom of silo caused by a high water table.

TABLE XIII. NUTRIENT COMPOSITION OF ALFALFA-CORN SILAGE

Second Cutting - 1944-45

Period of Storage	Dry Matter		pH	Crude Protein		Carotene		Ash		Calcium		Phosphorus	
	Hay	Silage	Silage	Hay	Silage	Hay	Silage	Hay	Silage	Hay	Silage	Hay	Silage
				D.M. Basis		Per Gram of Dry Matter							
	Per Cent			Per Cent		Gamma		Milligrams		Milligrams		Milligrams	
When cut	19.12	19.12	7.50	19.87	19.87	362	362	86.27	86.27	12.28	12.28	2.46	2.46
When stacked or put in silo	71.62	24.27	6.50	19.78	19.81	226	261	83.73	84.79	10.67	11.86	2.40	2.14
120-days storage	-----	17.19	4.40	-----	19.85	---	224	-----	86.46	-----	11.03	----	2.29
180-days "	89.58	14.91	4.71	18.62	19.38	182	173	81.63	104.91	9.40	13.45	2.50	3.35
270-days "	88.57	9.20	6.20	17.18	13.84	152	95	78.40	83.30	10.63	12.28	1.67	1.62
Average during storage: 1/	89.08	13.77*	5.10	17.90	17.69	167	164	80.02	91.56	10.02	12.25	2.09	2.42
Percentage loss during harvest: 2/	-274.58	-26.94	----	0.45	0.30	37.57	27.90	2.94	1.72	13.11	3.42	2.44	13.01
Percentage loss during storage: 3/	- 24.38	43.26	----	9.50	10.70	26.11	37.16	4.43	-7.98	6.09	-3.29	12.92	-13.08

1/. Average during storage is the average value of all analyses during storage excluding that value when stacked or put in silo.

2/. Value when cut minus value when stacked or put in silo divided by value when cut multiplied by 100.

3/. Value when stacked or put in silo minus average value during storage divided by value when stacked or put in silo multiplied by 100.

* This silage decreased in dry matter content which resulted from absorption of water accumulated in the bottom of silo caused by a high water table.

TABLE XIV. NUTRIENT COMPOSITION OF ALFALFA-ACID SILAGE AND HAY

Third Cutting - 1944-45

Period of Storage	Dry Matter		pH	Crude Protein		Carotene		Ash		Calcium		Phosphorus	
	Hay	Silage	Silage	Hay	Silage	Hay	Silage	Hay	Silage	Hay	Silage	Hay	Silage
				D.M. Basis		Per Gram of Dry Matter							
	Per Cent			Per Cent		Gamma		Milligrams		Milligrams		Milligrams	
When cut	15.68	15.68	7.50	18.87	18.87	416	416	97.68	97.68	12.68	12.68	2.62	2.62
When stacked or put in silo	76.98	25.42	5.90	18.21	18.59	313	376	84.37	98.24	10.46	12.93	1.72	3.98
120-days storage	90.13	15.05	5.57	15.56	15.03	309	368	81.85	107.09	10.30	17.05	1.69	4.58
210-days storage	87.76	15.35	5.25	14.90	18.44	244	336	71.13	130.37	10.29	18.67	1.74	5.23
Average during storage: 1/	88.95	15.20*	5.41	15.23	16.74	277	352	76.49	119.08	10.30	17.86	1.72	4.91
Percentage loss during harvest: 2/	-390.94	-62.12	----	3.50	1.48	24.76	9.62	13.63	- 0.57	17.51	-1.97	34.35	-51.91
Percentage loss during storage: 3/	-15.55	40.20	----	16.36	9.95	11.50	6.38	9.34	-21.21	1.53	-38.13	0.00	-23.37

1/. Average during storage is the average value of all analyses during storage excluding that value when stacked or put in silo.

2/. Value when cut minus value when stacked or put in silo divided by value when cut multiplied by 100.

3/. Value when stacked or put in silo minus average value during storage divided by value when stacked or put in silo multiplied by 100.

* This silage decreased in dry matter content which resulted from absorption of water accumulated in the bottom of silo caused by a high water table.

TABLE XV. NUTRIENT COMPOSITION OF CORN SILAGE
1944-45

Period of Storage	Dry Matter	pH	Crude Protein	Carotene	Ash	Calcium	Phosphorus
			D.M.Basis	Per Gram of Dry Matter			
	%		%	Gamma	Mgms.	Mgms.	Mgms.
When cut	23.49	---	8.19	161	56.90	2.22	2.03
60-days storage	19.63	3.50	8.27	125	56.92	2.13	2.03
210-days "	19.44	3.50	7.98	112	63.84	2.25	1.87
Average during storage: 1/	19.54	3.50	8.13	119	60.38	2.19	1.95

TABLE XVI. NUTRIENT COMPOSITION OF POTATO-CORN FODDER SILAGE.
1944-45

Period of Storage	Dry Matter	pH	Crude Protein	Carotene	Ash	Calcium	Phosphorus
			D.M.Basis	Per Gram of Dry Matter			
	%		%	Gamma	Mgms.	Mgms.	Mgms.
When put in silo	32.68	5.80	7.96	----	50.62	1.43	1.59
30-days storage	32.72	4.30	7.77	----	49.87	1.36	1.51
60-days "	32.09	4.20	7.55	----	57.19	1.10	1.48
210-days "	37.81	4.20	7.86	----	48.18	1.02	1.52
330-days "	40.26	4.20	7.57	----	51.66	1.31	1.48
Average during storage: 1/	35.72	4.23	7.69	----	51.73	1.20	1.50
Percentage Loss during storage: 2/	-9.30	----	3.39	----	-2.19	16.08	5.66

1/. Average during storage is the average value of all analyses during storage excluding that value when put in silo.
2/. Value when put in silo minus average value during storage divided by value when put in silo multiplied by 100.

TABLE XVII. NUTRIENT COMPOSITION OF POTATO-ALFALFA HAY SILAGE. 1944-45

Period of Storage	Dry Matter	pH	Crude Protein	Carotene	Ash	Calcium	Phos-phorus
			D.M.Basis	Per Gram of Dry Matter			
	%		%	Gamma	Mgms.	Mgms.	Mgms.
When put in silo	30.78	5.90	13.16	----	57.18	4.40	1.83
30-days storage	30.41	4.80	13.06	----	57.21	4.36	1.79
60-days "	29.99	4.80	13.03	----	62.27	2.62	1.34
210-days "	36.19	4.80	11.27	----	63.08	4.33	1.79
330-days "	34.02	4.70	10.78	----	57.69	4.17	1.71
Average during storage: 1/	32.65	4.78	12.04	----	60.06	3.87	1.66
Percentage loss during storage: 2/	-6.08	----	8.51	----	-5.04	12.05	9.29

1/. Average during storage is the average value of all analyses during storage excluding that value when put in silo.

2/. Value when put in silo minus average value during storage divided by value when put in silo multiplied by 100.

TABLE XVIII. NUTRIENT COMPOSITION OF THIRD CUTTING ALFALFA HAY. 1943-44

Period of Storage	Dry Matter	Crude Protein	Carotene	Ash	Calcium	Phos-phorus
		D.M.Basis	Per Gram of Dry Matter			
	%	%	Gamma	Mgms.	Mgms.	Mgms.
When cut	18.98	19.18	314	103.97	11.95	2.07
When stacked	80.35	15.84	109	93.05	10.38	1.90
90-days storage	86.29	15.61	94	90.62	10.22	1.84
180-days "	88.92	15.15	70	81.09	10.16	1.79
Average during storage: 1/	87.61	15.38	82	85.86	10.19	1.82
Percentage loss during harvest: 2/	-323.34	17.41	65.29	10.50	13.14	8.21
Percentage loss during storage: 3/	-9,04	2.90	24.77	7.73	1.83	4.21

1/. Average during storage is the average value of all analyses during storage excluding that value when stacked.

2/. Value when cut minus value when stacked divided by value when cut multiplied by 100.

3/. Value when stacked minus average value during storage divided by value when stacked multiplied by 100.

TABLE XIX. FEED REPLACEMENT VALUES. *

Feeding Trial	Feed Comparisons			Monetary Feed Replacement Values	Replacement Value of Its Cost
	Feeds Compared		Standard	%	%
1943-44 Feeding Trial:					
1	Alfalfa-corn silage	vs.	Corn silage	69.07	49.33
1	Beet top silage	vs.	Corn silage	111.47	209.00
1	Dried beet tops	vs.	Corn silage	227.73	213.50
1944-45 Feeding Trial:					
2	Unpreserved alfalfa silage	vs.	Corn silage	37.07	37.07
2	Alfalfa-corn silage	vs.	Corn silage	65.73	50.31
2	Alfalfa-acid silage	vs.	Corn silage	67.60	57.61
2	Potato-corn fodder silage	vs.	Corn silage	242.00	181.50
2	Potato-alfalfa hay silage	vs.	Corn silage	336.13	252.10
2	Alfalfa-corn silage	vs.	Alfalfa silage	128.67	98.47
2	Alfalfa-acid silage	vs.	Alfalfa silage	130.27	111.02

* No record is available as to authorship of this method for computing feed replacement values. Colorado A. & M. College has used the method for many years in evaluating monetary feed values.

Method of computing feed replacement values as given in Table XIX.

Example: Beet top silage vs. corn silage.

1. Compute the feed required for each feed (grain, silage, hay, mineral, and salt) to produce one hundred pounds gain. (See Table XXI for feed required in Lots 1 and 2).
2. Calculate the amount of each feed replaced by the silage to be compared:

   2000 lbs. divided by weight of silage to be compared (2000 ÷ 1584.68 = 1.2621) which gives the correction factor (C. F.) on ton basis.

Beet top silage		Corn silage	Grain mix	Alfalfa hay	Salt	Mineral
			378.16	387.65	1.35	3.10
1584.68	=	1484.72	377.04	271.15	0.76	2.07
			-1.12	116.50	0.59	-1.03

One ton of beet top silage is equal to:

1873.87 lbs. corn silage	(1484.72 x C. F.)	@	$ 7.50	per ton =	$ 7.03
-1.41 lbs. grain mix	(-1.12 x C. F.)	@	48.00	" =	-0.03
147.03 lbs. alfalfa hay	(116.50 x C. F.)	@	19.00	"	1.40
0.74 lbs. salt	(0.59 x C. F.)	@	15.00	"	0.01
-1.30 lbs. mineral	(-1.30 x C. F.)	@	75.00	"	-0.05
					$ 8.36

Therefore, one ton of beet top silage replaced 1873.87 lbs. corn silage, 147.03 lbs. alfalfa hay, 0.74 lbs. salt, but required 1.41 lbs. more grain and 130 lbs. more mineral. Hence, using the current feed prices, the beet top silage showed a value of $8.36.

3. Divide the total cost (8.36) by the price per ton of standard corn silage ($7.50) to obtain monetary feed replacement value (111.47 %).
4. Divide the total cost ($8.36) by the price per ton of silage to be compared (beet top silage, $4.00) to get the replacement value of its cost.

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