THESIS

A COMPARISON OF VARIOUS METHODS OF STORING BEET TOPS IN RELATION TO THEIR VALUE FOR FATTENING STEERS

Submitted by

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INTRODUCTION

Background of Problem:

Colorado stockmen fatten and market annually between 75,000 and 150,000 cattle, with approximately 75 percent of them fed on sugar beet by-product rations, according to United States Department of Agriculture statistics (2). Beet tops, consisting of the leaves and the upper portion of the sugar beet crown (plate I), are recognized as one of the major beet by-products for fattening cattle. The limited amount of experimental work conducted to date gives indication of their exceptional value for this purpose (1).

The potential importance of beet tops for cattle fattening rations becomes even more impressive when one realizes that approximately 750,000 acres of sugar beets are grown in the United States annually (3). Colorado leads as a sugar beet state with an average of 190,000 acres grown each year (3). A study conducted by the Colorado Experiment Station (4) (5) reveals that the yield of green tops per acre will equal approximately 66 percent of the net weight of the beets produced. On the basis of an average yield for Colorado of 12.5 tons of sugar beets per acre (3) from the annual acreage devoted to the crop, the yield of green tops in the state each year will amount to 1,567,500 tons. When one also considers the average annual acreage of sugar beets grown in

Plate I. Beet Tops

the entire United States, the tonnage of available feed from beet tops becomes even more enormous.

There is a lack of definite information as to the most satisfactory method of handling or storing beet tops in order to obtain their maximum value for fattening cattle. This is true not only in Colorado, but also in eight other important sugar beet producing states according to information received from the respective experiment stations.

Pasturing beet tops in the field is still a common practice, but farmers are now gradually turning to other methods of handling them because of the high percentage of tops wasted and trampling of the field during rainy seasons. Common methods of storage include: (A) piling the tops in small piles about the size of an inverted wash tub, either in the field or in a vacant lot adjacent to the feed yards; (B) ensiling; and (C) stacking with varying proportions of straw or other dry roughage. Up to the present time lack of sufficient experimental data makes it impossible to say which method of storage gives the greatest returns per acre when used in steer fattening rations.

The Problem:

The problem deals with a study of the comparison of various methods of storing beet tops in relation to their value for fattening steers.

Minor Objectives:

1. To show the change in feed nutrients during storage when beet tops are stored as dried tops, silage, or stacked tops.

2. To show the factors which determine the cost of feed provided by beet tops under different methods of storage.

3. To determine the feeding value of dried beet tops, beet-top silage, and stacked tops in a standard beet by-product ration.

4. To determine the value of dried tops as a substitute and a partial substitute for alfalfa in a standard beet by-product ration.

5. To compare the relative value of whole beet tops versus ground beet tops.

6. To find the value of beet-top silage when replacing wet pulp in a standard beet by-product ration.

Basis of Study:

The study, which gives a comparison of various methods of storing beet tops in relation to their value for fattening steers, will be based on the Colorado Experiment Station 1935-36 and 1936-37 projects. The 1935-36 experiment was conducted for a period of 160 days, dating from November 26, 1935 to May 4, 1936. The second trial included a period of 175 days, from November 10, 1936, to May 4, 1937.

REVIEW OF LITERATURE

Skuderna and Sheets (6) point out that in the crown of the sugar beet certain salts accumulate that tend to interfere with the recovery of sugar; therefore the grower is required to remove that portion of the beet to

which the leaves are attached. The discarded portion, known as beet tops, consists of about one-third crown and two-thirds leaves by weight.

The green weight of tops usually equals from one-half to two-thirds of the weight of the beets produced (15). Recent investigations at the Colorado Station (4) (5) show an average yield of tops equal to 66 percent of the beets produced from the six fields included in the study. The dry matter in tops is in turn equal to approximately 10 to 15 percent of the net weight of the beets (15). Because of the possibility of wide variation in moisture content (1), beet tops are usually considered on the basis of "tops per ton of beets produced." For example, the tops from a 12 ton per acre yield of beets would be worth $6.00 per acre on the basis of 50 cents per ton of beets.

Beet tops vary a great deal in their chemical composition. This variation may be due to several factors. For example, an increased ratio of crown to leaves will result in a higher protein, ash, and crude fiber content (10). The percentage of soil adhering to the tops, along with blight and freezing, are other factors to be considered. The type of soil on which the beets are grown may also influence the composition of the tops. Headden (7) found that sugar beet tops grown on alkaline soils showed an increase in the percentage of ash and crude protein, and a decrease in the percentage of nitrogen-free extract. Bindschadler (8) found that heavy applications of treble

superphosphate increased the phosphorous content of the leaves and crown.

Table I gives the analyses of beet tops from various sources.

Table I. Composition of Beet Tops (dry matter basis).

Source of data	Crude protein	Ash	Crude fat	Crude fiber	N-free extract	No. samp.
	%	%	%	%	%	
Henry & Morrison (10)	22.81	17.54	2.63	10.53	46.49	4
Kellner (11)	13.94	29.09	2.42	9.70	44.25	?
Colo. Exp. Sta. (17)	13.10	19.58	2.24	12.95	52.14	10
Great Western Sugar Company (19)	11.90	19.50	1.30	9.60	57.70	?

On the basis of digestible nutrients, the Colorado Station (17) shows that beet tops have a nutritive ratio of 1:5.5, indicating that they are a growth producing feed quite comparable to red clover which has a nutritive ratio of 1:5.6 (10). They can therefore be expected to show their maximum feeding value only when balanced with one or more carbohydrate feeds in the ration. For example, in two experiments at the Colorado Station (15) the gains of lambs were increased 59 percent by adding corn to a basal ration of dried beet tops and alfalfa.

Mineral salts present in beet tops, according to Ware (12), include salt petre, a series of sulphates, potassium phosphate, magnesium phosphate, calcium phos-

phate, potassium chloride, sodium chloride, ammonium hydro-chloride, and lime oxalate. Tobiska (22) found the presence of carbon dioxide (qualitative), sulphites, phosphorus pentoxide, ferric oxide, aluminum oxide, calcium oxide, and magnesium oxide from the ash analysis of a sample of beet tops used in the 1936-37 experiment.

The salts present in beet tops are cathartic and tend to cause scours or looseness of the bowels in the animal to which they are fed, unless the quantity of tops consumed is restricted (13), or lime ($CaCO_3$) is fed to counteract the salts (6). Skuderna and Sheets (6) emphasize the fact that since beet tops are quite palatable when handled properly, and contain cathartic salts, they should be fed with care and supplementary feed counteracting the laxative effect should be used whenever practicable.

Henry and Morrison (10) point out the fact that sugar beet leaves contain considerable oxalic acid which is poisonous if the animals receive too large amounts, especially in the case of non-ruminants. Tops may be fed in larger amounts to ruminants because some of the oxalic acid is destroyed during fermentation in the paunch. They state further that in case it is desired to feed the maximum amount of tops, it is well to add 1 ounce of finely ground limestone or chalk to each 50 pounds of tops, because the calcium changes the oxalic acid to insoluble calcium oxalate. This will help to prevent scours

or digestive disorders.

Neidig (14) and Osland (1) stress the importance of storing beet tops as free from adhering soil as possible. They especially emphasize great care in case of silage, since it is difficult for the animals to sort out the soil from the moist feed. The silage is quite palatable; consequently they will eat it readily and consume most of the incorporated soil. Digestive trouble may result because of this condition. Difficulty with soil adhering to the tops may be especially troublesome during periods of rainy weather at harvest time.

Neidig (14) made a study of various samples of beet-top silage collected from different areas in Idaho. He found a range in soil content from 2.32 percent to as high as 18.39 percent. In moisture-free silage samples the soil content ranged from 9.65 percent to 53.44 percent. Some of the feeders from whom the samples were secured had experienced difficulty in feeding the silage to their livestock because of digestive trouble, and even death in some cases.

A study of three trials (1918-19, 1919-20, 1920-21) conducted by the Colorado Station (15) with steers on a basal ration of alfalfa hay showed that with good weather conditions most economical gains were secured when beet tops were pastured. However, one season of bad weather in three lowered the gains and increased the feed cost enough to make it less profitable than where the tops

were piled in the field and hauled to the feedlot (Plate II). During the season of bad weather many of the tops being pastured in the field were lost because of decay or trampling in the mud. Leaching most likely also caused considerable loss in feed nutrients of the tops that were utilized. The cattle, furthermore, puddled the soil badly through trampling.

In connection with the 1919-20, and 1920-21 trials at the Colorado Station (15), beet-top silage proved to be less efficient than dried tops piled in the field and hauled to the feedlot. The silage gave fairly good results for the short preliminary feed, but proved to be impractical for the entire feeding period. When exposed to the air the silage spoiled quickly and consequently caused digestive trouble, especially during mild weather. Slow feeding was largely responsible for this condition.

A trial (1921-22) was conducted by the Colorado Station (16) to compare pastured and ensiled tops as a preliminary fattening feed for yearling steers. The cattle received in addition a basal roughage of either alfalfa or wheat straw. Emphasis was directed toward a study of the latent effects of the four different combinations for feeding tops on the subsequent gains made by the steers when they were later put on a finishing ration which included grain. Results showed that wheat straw could be satisfactorily substituted for alfalfa hay when fed with pastured tops, but was not suitable when fed

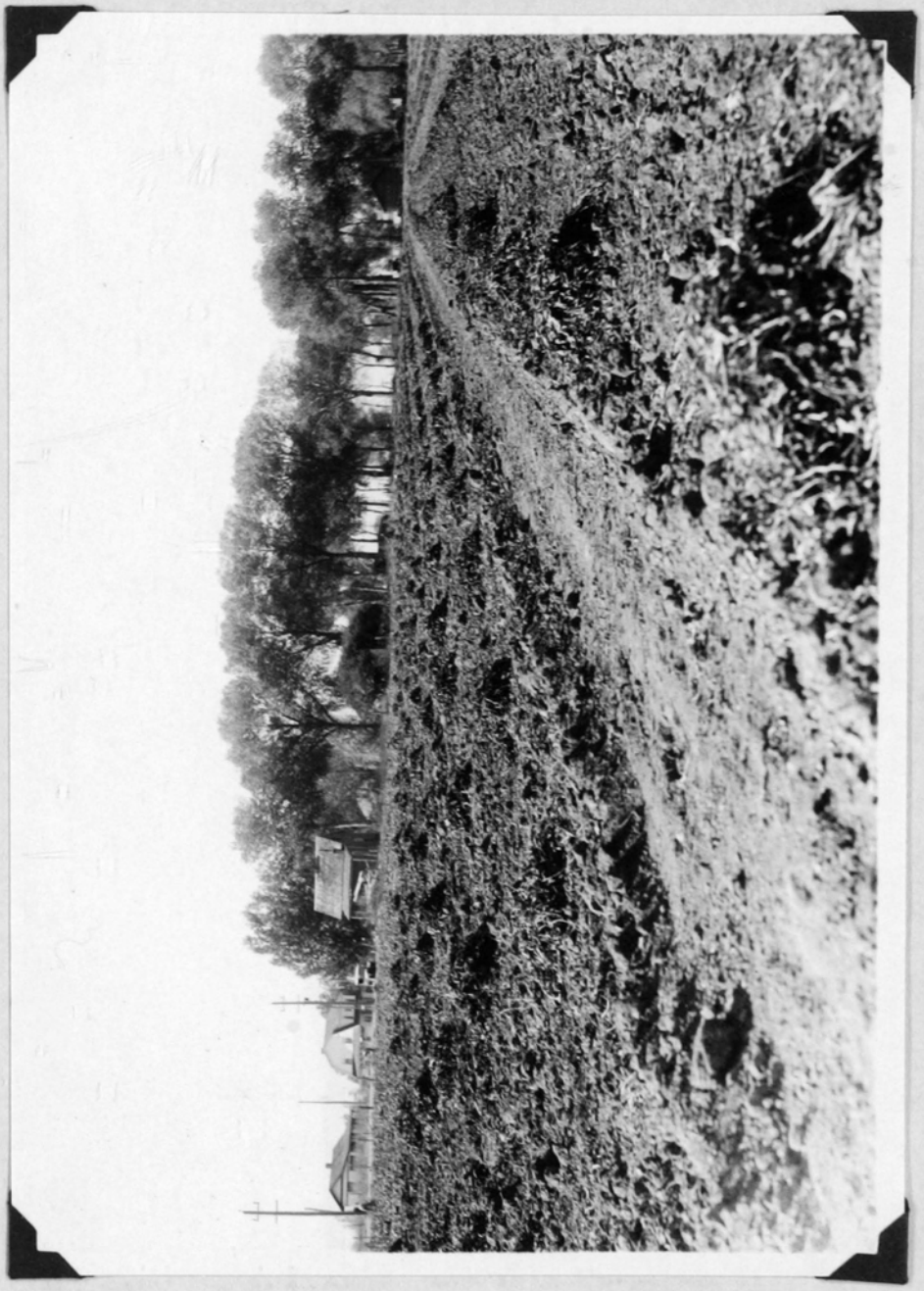

Plate II. Dried Beet Tops Piled in the Field

with beet-top silage. It was necessary to limit the amount of silage fed to prevent scouring; consequently the limited straw consumed was unable to compete with alfalfa in supplying the necessary nutrients. There was no appreciable difference in the latent effects of the methods of feeding beet tops on the gains of the steers after they were changed to a finishing ration.

A 2-year comparison (1927-28, 1928-29) was reported by the Colorado Station (1) where an average of 8.5 pounds of dried tops per head daily was fed as a succulent roughage in a basal ration including 6.6 pounds of ground barley, 1.0 pound of cottonseed cake, and 8.5 pounds of alfalfa per head for fattening steers. This experiment indicated that the ration was too narrow for optimum gains, even though it did lower the cost per unit gain. The selling price, dressing percentage, and carcass grade were lowered for the steers getting the beet tops. However, the beet tops showed a high replacement value, with each ton fed replacing 364.08 pounds of ground barley, 302.99 pounds of alfalfa, but requiring 24.68 pounds more of cottonseed cake.

Replacing wet pulp with dried tops in a basal ration of barley, cottonseed cake, and alfalfa for fattening cattle, reduced gains, increased feed cost per 100 pounds of gain, and lowered selling price, dressing percentage, and carcass grade respectively in a series of trials (1927-28, 1928-29) at the Colorado Station (1). Each ton

of beet tops replaced 7232.95 pounds of wet pulp, but required 212.90 pounds more barley, 33.94 pounds more cottonseed cake, and 748.53 pounds more alfalfa.

A 3-year comparison (1928-29, 1929-30, 1930-31) at the Colorado Station (1) showed that stacked tops not only produced lower but also more costly gains than corn silage when added to a wintering ration composed of ground barley, wet beet pulp, cottonseed cake, and alfalfa. The beet tops used were stacked in alternate layers of 6 inches of green tops and 2 inches of straw. Each ton of stacked tops replaced only 1504.16 pounds of corn silage, and required 44.42 pounds more ground barley, 12.16 pounds more cottonseed cake, 292.10 pounds more wet beet pulp, and 253.88 pounds more alfalfa hay.

MATERIALS AND METHODS

Equipment:

The experimental pens of the Colorado Experiment Station are located on the College Farm. They are 114 by 24 feet in size, the long dimension running north and south. Sheds 14 by 24 feet in size are located at the north end of each lot to provide shelter for the cattle. Automatic watering troughs are provided for all pens. Feed bunks for grain and roughage other than hay are located in the middle of the lots. Hay is stored in covered bunks at the south end of the pens. Feeding space is provided along the west and north sides of each hay bunk

respectively. The portions of the pens around the hay bunks and grain troughs are cemented and the rest of the yards graveled to eliminate mud and mire during rainy seasons.

Chutes and scales have been constructed so that the cattle can be weighed with very little disturbance. The scales are tested for accuracy annually.

Steers Used:

Eighty good-to-choice quality grade Hereford yearling steers were used in the 1935-36 experiment. They were purchased as calves in North Park in the fall of 1934 for use in a wintering experiment at the college during the winter of 1934-35. In the spring of 1935 they were taken to the foothill range and used in a range management experiment until October, when they were brought back to the college. They averaged 692.77 pounds in weight at the start of the test.

Seventy good-to-choice quality grade Hereford yearling steers were likewise used for the 1936-37 trial. They were purchased as calves in the Livermore area, northern Larimer County, in the fall of 1935. After being used for the 1935-36 calf wintering experiment, they were taken to the foothills and put on a range management test. When brought back to the college experimental pens on October 22, they were lacking somewhat in flesh compared to the cattle used the previous year. They averaged 641.55 pounds in weight at the start of the

experiment.

Prior to the start of both trials the steers were put on a preliminary ration of alfalfa hay in order to get them adjusted to feedlot conditions. This period consisted of 36 days for the 1935-36 experiment and 18 days for the 1936-37 trial.

Steer Weights:

The average of three consecutive weights taken at the beginning and end of the experimental periods respectively was used as the initial and final weight of each steer. The steers were allowed only the morning grain feed and the usual access to water prior to weighing.

Individual weights were also taken every 30 days and group weights every 10 days to permit a comparative check-up on the steers from the standpoint of gains produced by each lot and within the lots during the experimental periods. The steers were allowed their regular early morning feed of grain and wet beet pulp in addition to access to water prior to weighing.

All weights were taken at uniform hours, starting promptly at 8:00 A. M. on each weigh-day.

Allotment Factors:

The factors of weight, type, condition, origin, and color were used in dividing the steers into groups of 10 head per lot. The allotment was made with great care in order to reduce to a minimum the experimental error due to individuality.

Weight - The cattle were allotted so that each lot weighed as nearly the same as possible. An effort was also made to group the steers so that each lot received the same number of large, medium, and small individuals.

Type - Before being allotted, the steers were graded choice, choice minus, good plus, good, good minus, and medium. The individuals as graded were then distributed proportionally among the respective lots.

Condition - The steers were graded choice, choice minus, good plus, good, good minus, or medium, and distributed as uniformly as possible.

Origin - Origin was considered in order to reduce to a minimum any possible variation from this source, and to have the lots nearly identical as to breeding.

Color - The steers were graded dark, medium, and light, according to haircoat, and divided evenly among the respective lots.

Beet Tops Used:

Beet tops from three different sources were purchased each year for the feeding trials with the idea of securing a representative lot of tops, and also to study the ratio of tops to tonnage of beets produced. The results obtained are summarized in Table II.

Table II. Ratio of Tops to Tonnage of Beets Produced

Trial	Yield of Beets per acre	Tonnage of tops with different percent moisture					
		Green		Wilted		Dry	
		80%	70%	60%	50%	40%	30%
1936-37	9.5	7.73	5.15	3.87	3.09	2.58	2.21
1935-36	10.0	5.91	3.94	2.95	2.36	1.97	1.69
1936-37	13.0	9.78	6.51	4.89	3.91	3.26	2.79
1935-36	13.6	9.32	6.21	4.66	3.73	3.11	2.64
1936-37	14.5	7.90	5.26	3.95	3.16	2.63	2.25
1935-36	15.6	9.88	6.59	4.94	3.95	3.29	2.82
Ratio	1:	.66	.44	.33	.27	.22	.19

Summary of the data in Table II shows the yield of green tops equal to 66 percent of the tonnage of beets produced. The tops used in the 1935-36 experiment were not of average quality due to adverse weather conditions at harvest time. Moisture of 1.28 inches (20) during harvest, with continued partly cloudy and cloudy days resulted in slow-curing and dirty tops. On the other hand, the tops used in the 1936-37 experiment were of average quality and stored in cleaner condition with the aid of favorable weather, expecially during the early period of storage. However, one field showed a heavy leaf spot infestation, which resulted in a lower ratio of tops to tonnage of beets produced. This is shown in Table II by the corresponding low tonnage of tops in the field yielding 14.5 tons of beets per acre.

Storage of Beet Tops:

Beet-top silage was made by storing green tops in an upright concrete silo and allowing them to ferment. It was necessary to pitch them into the silo, since an attempt to run them through a silage cutter was not successful. The green tops, plus adhering soil, matted together and clogged the blower pipe.

The Colorado Station has secured good results by ensiling beet tops in a trench silo (Plate III). This method may prove especially practical because of the greater ease of handling the tops (18).

The dried tops used in the experiment were allowed to remain in the field at least 10 days after topping. Then they were hauled to a vacant lot adjacent to the feed yards and stacked in piles about the size of an inverted wash tub for proper drying.

Ground tops were prepared by running dried tops through an ensilage cutter. Only enough was ground to last a week at a time in order to eliminate spoilage, especially during the early part of the experiment when the tops contained a relatively high percentage of moisture.

Beet-top stacks rested on a 6-inch layer of straw serving as a foundation to prevent unnecessary spoilage of stack bottoms.

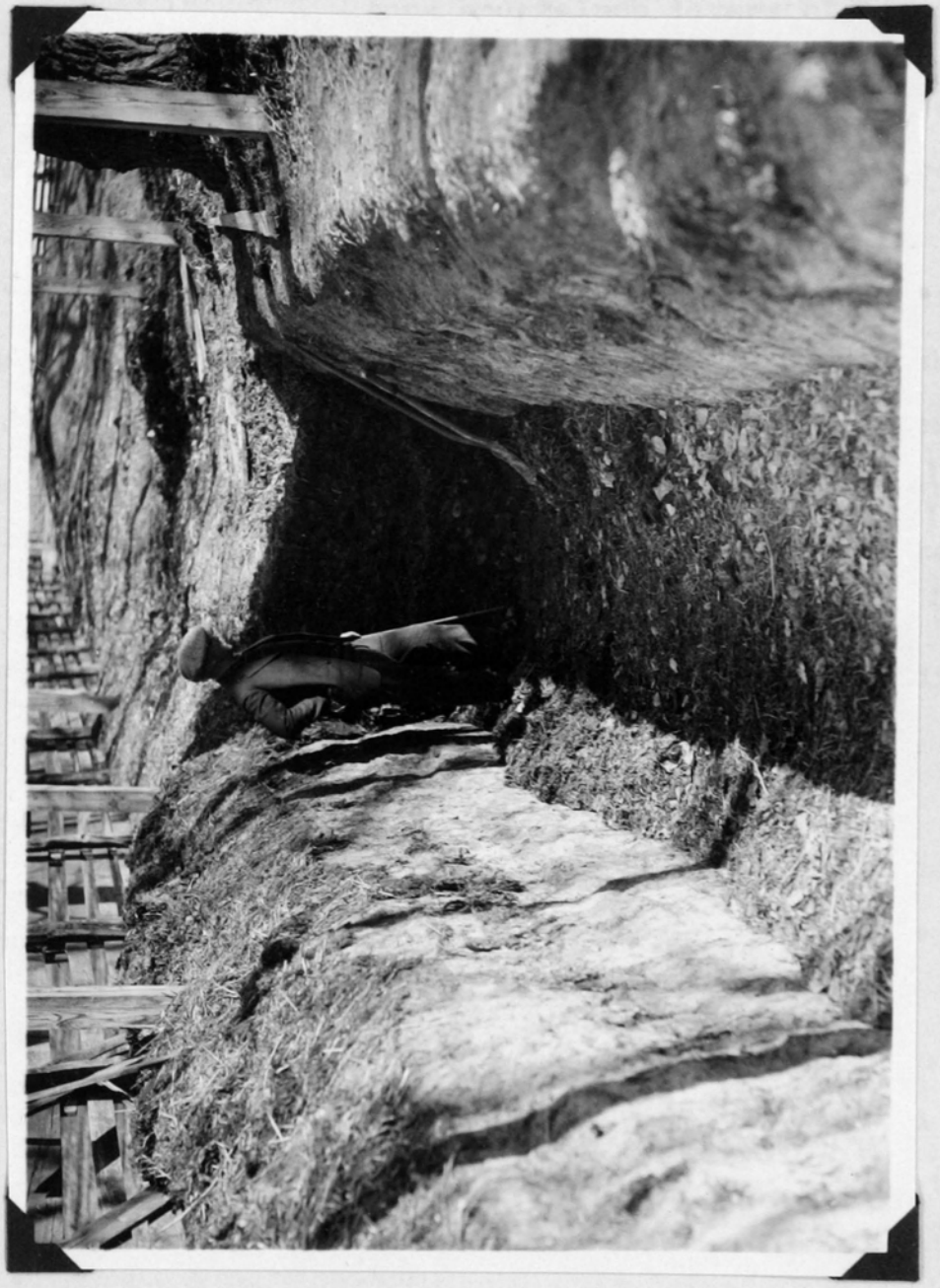

Plate III. Beet-Top Silage in a Trench Silo

The stacks were built as follows:

Stack No. 1 - alternate 6-inch layers of green tops and 2-inch layers of straw.

Stack No. 2 - alternate 2-inch layers of green tops and 2-inch layers of straw.

Stack No. 3 - alternate 6-inch layers of wilted tops and 2-inch layers of straw.

Plate IV shows the manner in which the stacks were constructed.

There are two especially important points to observe in stacking beet tops. First, the base of the stack should be made wide enough for solid support. This is particularly important since the tops will settle a great deal and slip very easily during the initial process of fermentation. Second, adhering soil and lumps of dirt should be separated from the tops as much as possible when building the stacks.

Other Feeds Used:

Corn used in the 1935-36 experiment was U. S. Grade No. 2 shipped in Nebraska grain. It weighed 54 pounds per bushel and averaged 15.51 percent moisture.

The corn used in the 1936-37 experiment was also graded No. 2 according to U. S. Standards, but weighed 55.5 pounds per bushel and averaged 13.65 percent moisture throughout the feeding period.

The corn used in both trials was ground medium fine.

Cottonseed cake had a guaranteed analysis of 43 percent protein. The average moisture content was 7.63 and

Plate IV. View of Beet-Top Stack Showing Alternate Layers of Beet Tops and Straw

8.10 percent respectively for the two trials.

Wet beet pulp was hauled directly from the local sugar factory as needed. The cost of the pulp was $1.10 per ton at the factory for the 1935-36 trial. To this was added a 45 cents per ton hauling charge and also a 14.90 percent shrinkage worth 27 cents per ton, making a total net cost of $1.82 per ton of wet pulp fed to the steers.

The net cost of the wet pulp used in the 1936-37 experiment was $1.95 per ton, which included an initial cost of $1.16 at the factory, a 45 cents per ton hauling charge, and a 34 cents per ton charge for 21.02 percent shrink.

The average moisture content of the pulp was 88.45 and 87.54 percent for the 1935-36 and 1936-37 trials respectively.

Alfalfa grown on the College Farm was fed the first 60 days of the 1935-36 experiment. It graded No. 3 according to U. S. Standards. During the last 100 days of the test, alfalfa grown in the Fort Collins area was used. This hay graded No. 2 according to U. S. Standards.

Alfalfa grown on the College Farm was used for the entire 175-day period of the 1936-37 experiment. It graded No. 2 according to U. S. Standards.

Only first cutting alfalfa was used in connection with the 1935-36 and 1936-37 experiments.

Chemical Analyses:

Fodder analyses were made on beet tops sampled in the various fields at topping time, 10 days, and 30 days after topping respectively. Composite samples were analyzed to show the condition of the tops at the time of storage. In addition, fodder analyses were also run every 30 days on the various methods of storing tops, dating from time of storage on through the experimental period. Moisture analyses were taken on every method of storage at 10-day intervals during the trials. This series of chemical analyses of beet tops was planned in order to gain a maximum amount of information as to the comparative changes in composition of beet tops under various methods of storage.

During each experiment two fodder analyses were made of composite samples of corn and wet pulp, but only one was run on composite samples of cottonseed cake and alfalfa. Moisture tests were also made on these feeds at 10 day intervals during the experiment.

All chemical analyses were made by the Chemistry Section of the Experiment Station.

Methods of Feeding:

The grain and cake was fed twice daily, promptly at 6:00 A. M. and 12:45 P. M. The wet pulp was hauled into the pens shortly after the morning grain feed. Beet tops were fed in the afternoon following the grain ration. All the alfalfa hay the steers cared to consume in addi-

tion to their grain, cottonseed cake, wet pulp, and beet tops, was fed in the late afternoon, with the exception of lots 3 and 4 in the 1935-36 experiment. These steers received no hay during the first 134 days of the period. Check lot 6 in both trials also received alfalfa hay during mid-morning.

The steers were put on full feed as quickly as possible after the start of the tests. In the 1935-36 experiment they were started on 1 pound of grain per head daily and gradually increased to 11 pounds per head by the one-hundredth day of the period. During the 1936-37 trial they were started on 2 pounds of grain per head daily and carefully increased to a maximum of 10 pounds within seventy-eight days. In both cases cottonseed cake was started at the rate of .5 of a pound per head daily. It was increased to 1 pound per head daily by the twelfth day of the 1935-36 experiment and to the same amount by the fifth day in the 1936-37 test. Wet beet pulp was fed as heavily as the steers would consume it. The maximum feed in both trials was 35 pounds per head daily. When a full feed of grain and roughages was reached, the pulp allowance was cut down to 25 pounds per head in both experiments.

The daily ration of beet tops varied with the type of tops being fed. The maximum daily feed of dried tops when used as a partial substitute for alfalfa was 15 pounds per head in the 1935-36 experiment and 10 pounds per head

during the 1936-37 trial. The maximum daily feed of beet-top silage per steer was 20 pounds during the 1935-36 experiment and 15 pounds for the 1936-37 period. However, lot 2 in the latter trial, which received no pulp, did secure a maximum of 30 pounds of beet-top silage daily for a short time. In both trials a maximum of 15 pounds per head daily of the stacked tops was fed. Where whole and ground tops were fed as the only roughage in the 1935-36 experiment a maximum of 20 pounds per head was fed daily.

Rations Fed:

1935-36

Lot 1. Corn, cottonseed cake, wet pulp, beet-top stack No. 1, alfalfa, and salt.

Lot 2. Corn, cottonseed cake, wet pulp, beet-top silage, alfalfa, and salt.

Lot 3. Corn, cottonseed cake, wet pulp, ground (dried) beet tops, and salt.

Lot 4. Corn, cottonseed cake, wet pulp, whole (dried) beet tops, and salt.

Lot 5. Corn, cottonseed cake, wet pulp, whole (dried) beet tops, alfalfa, and salt.

Lot 6. Corn, cottonseed cake, wet pulp, alfalfa, and salt.

Lot 7. Corn, cottonseed cake, wet pulp, beet-top stack No. 2, alfalfa, and salt.

Lot 8. Corn, cottonseed cake, wet pulp, beet-top stack No. 3, alfalfa, and salt.

1936-37

Lot 1. Corn, cottonseed cake, wet pulp, beet-top silage, alfalfa, and salt.

Lot 2. Corn, cottonseed cake, beet-top silage, alfalfa, and salt.

Lot 3. Corn, cottonseed cake, wet pulp, dried beet tops, alfalfa, and salt.

Lot 4. Corn, cottonseed cake, wet pulp, beet-top stack No. 1, alfalfa, and salt.

Lot 5. Corn, cottonseed cake, wet pulp, beet-top stack No. 2, alfalfa, and salt.

Lot 6. Corn, cottonseed cake, wet pulp, alfalfa, and salt.

Lot 7. Corn, cottonseed cake, wet pulp, beet-top stack No. 3, alfalfa, and salt.

Death or Removals:

When it was necessary to remove a steer from the experiment because of severe sickness or other uncontrollable factors, both the weight of the steer and the average total feed it had consumed were deducted from the records and the results based on the remaining number of steers in the lot.

EXPERIMENTAL RESULTS

Beet Top Storage Studies

Chemical Analyses of Beet Tops Stored:

Table III shows a comparison of the beet tops used for the two experiments. These fodder analyses were taken at topping time for each year respectively.

Table III. Comparison of the Beet Tops Used in the 1935-36 and 1936-37 Trials.

Trial	Moisture	Protein	Fiber	N.F.E.	Fat	Ash
Green basis:	%	%	%	%	%	%
1935-36	85.60	2.64	2.00	6.34	.22	3.20
1936-37	79.08	2.58	2.68	10.98	.71	3.98
Average	82.34	2.61	2.34	8.66	.47	3.59
Dry Basis:						
1935-36	-----	18.33	13.89	44.03	1.53	22.22
1936-37	-----	12.07	12.75	52.60	3.29	19.29
Average	-----	15.20	13.32	48.32	2.41	20.76

The beet tops used in the 1935-36 experiment showed a higher moisture content with a corresponding higher percent of protein and less nitrogen-free extract than the tops used in the second trial. They also showed a lower percent of fat. On a dry matter basis they contained 2.93 percent more ash.

The amount of soil adhering to the tops at the time of storage had a direct effect on the ash content of the feed. Table IV shows a comparison of the percentage of ash on a dry matter basis for the tops used in the two trials under the five methods of storage included in this study.

Table IV. Ash Content of Beet Tops.

Trial	Stack No.1 %	Stack No.2 %	Stack No.3 %	Silage %	Dried %
1935-36	48.64	36.26	35.14	30.60	18.26
1936-37	33.41	30.27	34.00	28.63	16.89

The beet tops under the different methods of storage in the 1936-37 experiment were consistantly lower in ash content than those used the previous year. This was due not only to the actual lower ash content of the tops as shown in Table III, but also to the presence of less adhering soil. The tops for the 1935-36 experiment were harvested under adverse conditions. Excessive rain during harvest time with cloudy days produced dirty and slow-curing tops.

In analyzing the results of the trials the difference in quality of the tops should be kept in mind.

Chemical Changes During Storage:

A study of the trend of moisture analyses of the beet tops under the different methods of storage will not only serve to compare the dry matter in the various kinds of tops, but it will also partially aid in explaining the comparative shrinkage in weight for the tops during the experimental period. Table V gives the average moisture content of the five kinds of stored beet tops studied in the two years' work.

Table V. Average Percentage Moisture of Beet Tops Under Different Methods of Storage.

Period	Stack 1 6" green tops 2" straw	Stack 2 2" green tops 2" straw	Stack 3 6" wilted tops 2" straw	Beet-top silage	Dried tops
	%	%	%	%	%
Storage	79.82	77.10	65.01	80.04	50.86
30-day	74.01	64.79	61.94	72.87	43.40
60-day	67.14	65.72	63.92	73.92	33.02
90-day	63.59	61.21	62.77	75.97	31.01
120-day	67.08	63.95	63.90	76.53	22.68
150-day	65.58	62.56	59.33	71.97	22.87
168-day	70.11	62.92	59.89	74.10	25.79
Average	67.92	63.53	61.96	74.23	29.80
Loss:	-11.90	-13.57	- 3.05	- 5.81	-21.06

Dried tops naturally showed the greatest loss of moisture because they were stored under conditions which allowed them to dry out to a great extent.

Of the stacked tops, No. 3 showed the least loss of moisture primarily because the tops were stored during the wilted stage when they contained 13.45 percent less moisture than the green tops. Stack No. 2 showed the greatest moisture loss of the different methods of storage. In comparison with the tops in stack No. 1, those in stack No. 2 showed a decided loss in moisture during the first 30 days due to the bulkier and looser stack.

Stack No. 3 and beet-top silage showed the least

variation in percentage of moisture thoughout the period. Silage ranked next to stack No. 3 from the standpoint of low moisture loss. This was to be expected, considering the conditions under which it was stored.

The data compiled in Table VI shows the actual loss in feed nutrients for the beet tops under various methods of storage. This table compares the fodder analyses at the time of storage with the average of the fodder analyses of the stored tops taken at 30-day intervals during both experimental periods. The analyses are computed on a dry matter basis.

Table VI. Change in Feed Nutrients of Beet Tops Under Different Methods of Storage.

	Crude protein	Crude fiber	N-free extract	Crude fat	Ash
	%	%	%	%	%
Beet-top stack No.1					
Storage	14.70	13.19	48.31	2.26	21.56
Average	10.54	15.82	30.72	1.21	41.62
Change	-4.16	+ 2.63	-17.59	-1.05	+20.06
Beet-top stack No.2					
Storage	14.99	13.27	48.25	2.36	21.15
Average	11.87	18.53	35.01	1.33	33.27
Change	-3.12	+ 5.26	-13.24	-1.03	+12.12
Beet-top stack No.3					
Storage	14.98	13.22	51.75	1.66	18.41
Average	12.00	17.22	35.03	1.18	34.57
Change	-2.98	+ 4.00	-16.72	- .48	+16.16
Beet-top Silage					
Storage	15.21	13.33	48.29	2.42	20.77
Average	13.58	16.01	39.48	1.32	29.62
Change	-1.63	+ 2.68	- 8.81	-1.10	+ 8.85
Dried Beet tops					
Storage	14.94	14.22	52.05	1.24	17.58
Average	14.06	14.31	50.88	.94	19.82
Change	- .88	+ .09	- 1.17	- .30	+ 2.24

Dried tops showed the least loss of feed nutrients when compared to the other types of stored beet tops. This was due to the fact that drying prevented fermentation and spoilage. The ash content showed only a minimum increase because repeated handling tended to separate the soil from the tops.

The silage showed less loss of nutrients than either of the three methods of stacking tops because the decrease in feed nutrients was mainly due to fermentation with only a small amount of spoilage. The high increase in ash content, compared to the dried tops, was due to incorporated soil.

All three stack methods of storing tops showed a consistant loss in crude protein, an increase in crude fiber, a loss in both nitrogen-free extract and fat, and a comparatively great increase in ash content. Stack No. 1, built with green tops and a limited amount of straw, showed the greatest loss of nutrients, evidently due to favorable conditions for a maximum amount of fermentation. Excessive fermentation and a higher moisture content during the feeding period in stack No. 1 was responsible for a lower increase in fiber than either stack No. 2 or No. 3. Stack No. 2 showed .14 percent greater loss of protein and .55 percent higher fat loss than stack No. 3, but lost 3.48 percent less nitrogen-free extract. The high increase in percentage of ash shown by the stacks was mainly due to soil adhering to the tops at the time of storage,

and also to greater nutrient loss from fermentation.

The decidedly greater loss of nutrients shown by the stacked tops compared to beet-top silage was due primarily to the greater degree of fermentation and spoilage. The only advantage of the stacked tops over silage from the standpoint of conserving feed nutrients was a somewhat smaller loss of crude fat. This was especially true in case of stack No. 3.

Comparative Feed Cost of Beet Tops:

Initial cost, hauling charge, and a charge for shrink and waste were included in computing the net cost of the tops provided under the different methods of storage. The cost of straw was also included for the stacked tops, and a grinding charge for ground tops.

Table VII shows the results of both trials relative to the shrink and waste loss from the different methods of storage. Shrink relates to the loss due to fermentation and decrease in moisture content. Waste included spoilage, refused feed and dirt, and a small amount of broken stems and shattered leaves in case of dried tops.

Table VII. Percentage Shrink and Waste of Beet Tops Under Various Methods of Storage.

Trial	Stack 1	Stack 2	Stack 3	Silage	Dried
Shrink:					
1935-36	37.99	42.61	36.47	25.82	39.44
1936-37	37.80	37.98	31.86	23.18	44.69
Waste:					
1935-36	13.42	12.01	7.51	0.38	5.16
1936-37	7.88	10.50	12.82	0.55	1.39

Summary of the data in Table VII shows the percentage of shrink and waste for the silage checked closely for the two trials. Dried tops showed a greater shrink during the second trial because of greater moisture loss. The smaller amount of waste for the 1936-37 dried tops compared to the previous year was due to a better quality of tops with less adhering soil. Percent shrinkage of the stacks checked fairly close for the two periods, with stack No. 2 showing the greatest shrinkage and stack No. 3 the least in both studies. Stacks No. 1 and No. 2 showed less waste during the 1936-37 experiment because the tops were stored in better condition. The excess waste for stack No. 3 for this period was due to an abnormal amount of spoilage on the outer portion of the stack.

Table VIII gives a comparison of the factors which determine the net cost per ton of dried and ground beet tops.

Table VIII. Net Cost of Dried and Ground Beet Tops.

Beet tops	Initial cost	Hauling	Grinding	Waste	Grinding waste	Storage shrink	Shrink & waste	Net cost
				%	%	%		
Dried	$1.58	$2.00	-----	5.16	----	39.44	$2.88	$6.46
Ground	$1.58	$2.00	$2.00	2.49	7.43	39.43	$3.88	$9.46

The 5.16 percent waste shown by the dried tops and the 2.49 percent waste for the ground tops was due to soil shaken from the tops during handling. Grinding separated

much dirt from the tops as shown by the 7.43 percent waste during this operation.

The nearly identical storage shrink for the ground and whole tops was mainly due to moisture loss plus possibly a small amount of fermentation.

The higher cost of $3.00 per ton for the ground tops was due to a $2.00 per ton grinding charge in addition to a charge to cover the greater amount of waste.

A summary of computing cost per ton of beet tops based on the average of the 2-year comparison is presented in Table IX.

Table IX. Factors Determining the Net Cost Per Ton of Feed Produced by Five Different Methods of Storage.

Beet tops	Initial cost	Hauling	Straw	Waste %	Shrink %	Shrink & Waste	Net cost
Stack 1	$0.74	$1.75	$0.08	10.65	37.54	$2.39	$4.96
Stack 2	0.86	1.75	0.14	11.26	40.30	2.96	5.71
Stack 3	1.04	1.75	0.10	10.17	34.17	2.29	5.18
Silage	0.87	1.75	----	0.47	24.50	0.88	3.50
Dried	1.68	1.75	----	3.28	42.07	2.81	6.24

The amount of dry matter or feed nutrients is the same or about the same in green, wilted, or dried tops, but the tonnage per acre varies in direct proportion with the moisture content. Since tops are bought per ton of beets produced, the lighter tonnage of wilted and dried

tops makes them more costly.

Beet-top silage showed by far the least percentage waste, or spoiled and unedible tops. This .47 percent waste consisted mostly of spoilage on top of the silo. Dried tops ranked next to silage with only 3.28 percent waste, consisting of shattered leaves in addition to separated dirt in the feed bunk. The stacked tops showed a uniformly high percentage of waste compared to silage and dried tops. The high loss consisted largely of spoilage about the outer portions of the stacks.

The relative percent of shrinkage under the different methods of storage, which included moisture and fermentation loss but not waste, can be explained to a great degree by reference to Tables V and VI. These tables show moisture and nutrient losses respectively. Table V shows a moisture loss for the different kinds of tops in the following order: dried tops, 21.06 percent; stack No. 2, 13.57; stack No. 1, 11.90 percent; silage, 5.81 percent; and stack No. 3, 3.05 percent. Table VI shows the greatest loss in nutrients for the beet top stacks. Silage shows approximately 50 percent less loss of nutrients on the average than the stacked tops. Dried tops showed the smallest loss of nutrients.

Feedlot Studies

Average and Maximum Daily Feed Consumption:

A statement of both average and maximum daily feed

consumption per steer in the respective lots may be especially important relative to explaining dietary problems. Table X shows the average and maximum daily feed for the steers included in the 2-year experiment. In addition the feed consumption is presented for the lots given whole and ground beet tops as their only roughage in the 1935-36 trial, and also for the steers getting beet-top silage as their only succulent feed in the 1936-37 experiment.

Table X. Average and Maximum Daily Feed Consumption in Pounds.

Lot	Corn		C.S.C.		Wet Pulp		Beet Tops		Alfalfa
	Max.	Av.	Max.	Av.	Max.	Av.	Max.	Av.	Av.
Stack 1	10.5	8.49	1.00	0.98	30.00	27.41	15.0	12.34	6.58
Stack 2	10.5	8.49	1.00	0.98	30.00	27.43	15.0	12.30	5.66
Stack 3	10.5	8.49	1.00	0.98	30.00	27.41	15.0	12.39	4.67
Silage	10.5	8.49	1.00	0.98	30.00	27.35	17.5	13.79	4.97
Dried	10.5	8.49	1.00	0.98	30.00	27.41	8.5	7.99	5.01
Check	10.5	8.49	1.00	0.98	30.00	27.41	----	-----	9.61
Whole	11.0	7.71	1.00	0.96	25.00	28.22	14.0	15.42	----
Ground	11.0	7.84	1.00	0.97	25.00	28.46	14.0	16.37	----
Silage no pulp	10.0	8.80	1.00	0.99	-----	-----	30.0	20.05	7.34

Dietary Factors:

Beet-top silage proved to be the most palatable form of tops when it was free from excessive soil. Dried tops were palatable, except when excessively dry and brittle. Stacked tops even when slightly molded were quite palatable until warm weather caused quick spoilage of the top and straw combinations.

Trouble was experienced with beet-top silage in regard to its laxative effect on the cattle. The addition of .1 pound of lime ($CaCO_3$) per head daily spread over the silage controlled this condition effectively. However, it was found that despite the addition of lime, it was impossible to feed the beet-top silage in quantities similar to corn silage, due to its laxative properties.

The beet-top silage fed during the 1935-36 experiment caused a great deal of digestive disturbance because of the presence of much soil which had been incorporated with the silage at storage time. The feed was quite moist and it was impossible for the steers to separate out the soil as they did with the stacked and especially the dried tops. This condition resulted in difficulties, especially during the latter part of the feeding period, such as frequent scouring and slow appetites.

Feeding beet tops in place of all of the alfalfa hay in the fattening ration was apparently quite satisfactory until the 130-day period was reached. Then steer No. 72 in lot 4 getting dried tops came down with urinary calculi.

Four days later steer No. 32 in lot 3 on ground tops also developed calculi.

Urinary calculi are due to the formation of mineral particles in the urinary tract which may result in partial or complete obstruction to the passage of urine. In case of complete obstruction, the bladder or some other portion of the urinary tract ruptures and death of the animal occurs about 24 hours later. This may be prevented in most cases, however, by timely operation before any portion of the urinary tract has ruptured (21). In cattle the trouble is wholly confined to the male animals (9).

Symptoms of urinary calculi shown by the two steers in the 1935-36 experiment were first indicated by loss of appetite followed by frequent straining and continual restlessness. Their heads were carried unusually low and their backs arched. An operation on the steers made it necessary to remove them from the test. Other steers in lots 3 and 4 began to show slight symptoms of urinary calculi. Because of this affliction the two lots were taken out of the experiment at the end of 134 days and put on a standard beet by-product ration including alfalfa. No further trouble occured.

The lots fed limited amounts of beet tops in various forms showed no trouble during the experiment, which lasted 160 days.

The first symptoms of urinary calculi in the 1936-37 experiment were noticed April 2, 142 days after the

beginning of the period. A steer in lot 3, getting dried tops as a partial substitute for alfalfa hay in a standard beet by-product ration, developed loss of appetite accompanied with unusual stiffness, especially in the hind legs. His condition gradually became more serious, with almost complete loss of appetite, loss in weight, extreme stiffness, and abnormal urination. The veterinarians pronounced it urinary calculi. Treating him twice daily for a period of three consecutive days with 1 pound of baking soda dissolved in water seemed to help his condition, but he never entirely recovered. It was necessary to remove him from the experiment because of loss in weight.

Other partial cases of urinary calculi in the 1936-37 experiment included abnormal urination by two steers in lot 4, getting stack No. 1 tops. However, nothing serious developed. A steer in lot 7, getting stack No. 3 tops, showed definite symptoms of urinary calculi May 1, only 3 days before the end of the trial. He went off feed, became extremely stiff, and stood humped up a great deal of the time. He finally came back on feed after being treated with baking soda, but never entirely recovered from the lameness. Another steer, from lot 1, getting beet-top silage with wet beet pulp, also developed lameness at the end of the feeding period, but never went off feed to any extent.

A check-up was made of the steers at the close of the

1936-37 feeding period in regard to indications of urinary calculi disturbances. An examination for mineral deposits on the sheath of each individual steer showed 28 having excessive formation of crystals, 22 with only slight deposits, and 16 with normal sheaths (17). Samples of urine from steers in each lot, analyzed by the Chemistry Section of the Experiment Station, showed a variation of specific gravity for the different samples ranging from 1.048 to 1.378, with an average of 1.256. The specific gravity of normal ox urine varies from 1.030 to 1.045. Analyses of the solids found in the individual urine samples showed the presence of carbon dioxide (qualitative), sulphites, phosphorus pentoxide, ferric oxide, aluminium oxide, calcium oxide, and magnesium oxide. (22)

Table XI shows the percentage of ash in the average daily rations given to the various lots of steers during the 1936-37 experiment.

Table XI. Ash Content of Average Daily Rations, 1936-37.

	Lots identified by beet tops fed						
Ash	Stack No. 1	Stack No. 2	Stack No. 3	Silage pulp	Silage	Dried	Check
Pounds	1.97	1.92	2.17	1.56	1.79	2.23	.90
Percent	3.53	3.45	4.05	2.91	3.61	5.98	1.96

The analyses of the urine samples indicated that the high percentage of ash in the rations was responsible for

an abnormally high elimination of minerals by the animal's body. These mineral salts probably presented favorable conditions for the development of urinary calculi.

Summarizing the dietary difficulties of the two experiments, it is apparent that the quality of the tops and the length of the feeding period had a direct bearing on the trouble involved. Silage made with poor quality, dirty tops, resulted in digestive trouble among the silage-fed steers in the first trial. This trouble was not experienced with better quality silage in the second experiment. The effect of feeding large quantities of tops over too long a period is indicated by the lots getting ground and whole tops as their only roughage. These cattle developed cases of urinary calculi after 130 days in the 1935-36 trial. Lots getting various forms of beet tops in limited quantities showed no trouble during the 160-day period in the same experiment. Likewise, the steers in the 1936-37 trial showed no urinary calculi disturbances until after 160 days, with the exception of one individual in the dried top-fed lot that developed a definite case of calculi after 142 days. In addition to urinary calculi disturbances after the 160-day period in the 1936-37 experiment, the steers getting limited quantities of beet tops developed cases of bloating more or less in all lots. This was not true of the two lots that did not get beet tops, including the check lot and one other pen of steers separate from the beet top experiment that received "C" molasses in

place of cottonseed cake in a standard beet by-product ration. In view of these facts it seems safe to conclude that in order to avoid possible dietary trouble, beet tops in any form should not be fed in large quantities to fattening cattle for longer than 120 days, and not over 150 days in limited amounts.

Cattle Gains:

The cattle gains for the various lots in the respective experiments are shown graphically on the basis of total gain per average steer. In addition, subsequent tables are presented to show the average daily steer gains in each lot. These data are presented not only for the experimental periods as a whole, but also for periods within the experiments.

It should be kept in mind that the steers did not have access to wet pulp during the initial and final weights for the trials. However, on weigh-days within the experimental periods they did have their regular morning feed of wet pulp. Due to this fact, the lots getting wet beet pulp show a relative increase in the rate of gain for the first 30 days of each experiment presented in Tables XII and XIII. These lots likewise show a corresponding decrease in the rate of gain for the last 10 days in the 1935-36 experiment and the final 25 days in the 1936-37 period.

Figure I. Average Steer Gains Per Lot
1935-36

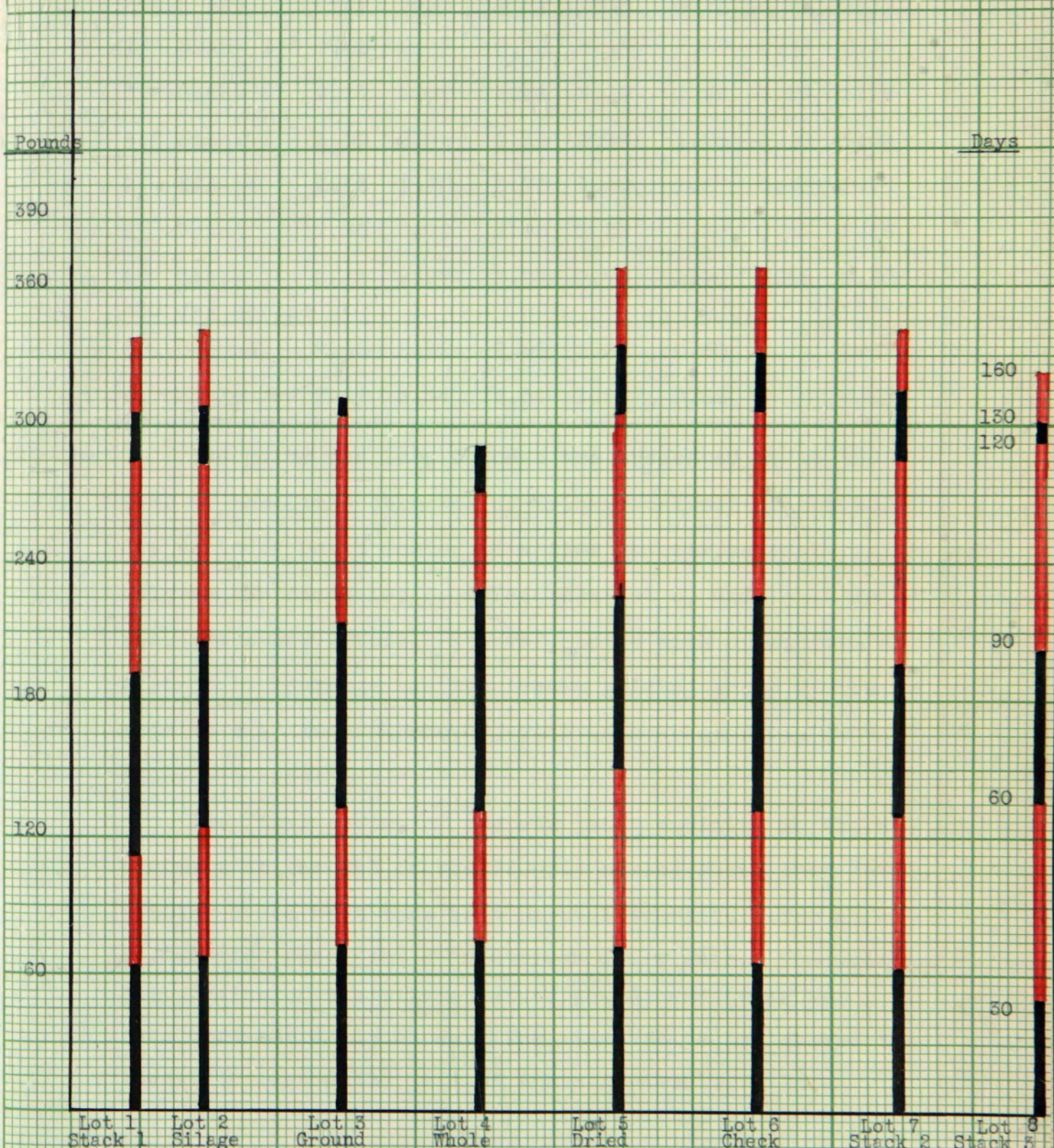

Table XII. Average Daily Gains - 1935-36.

Lot No.	Beet tops fed	First 30 days	Second 30 days	Third 30 days	Fourth 30 days	Fifth 30 days	Last 10 days	Average 160 days
1	Stack 1	2.08	2.13	2.13	3.17	1.85	-0.31	2.11
7	Stack 2	2.17	2.32	2.31	3.17	1.56	-0.59	2.12
8	Stack 3	1.59	2.95	2.13	3.12	1.25	-1.00	2.01
2	Silage	2.23	1.90	2.73	2.60	1.67	0.92	2.14
5	Dried	2.30	2.78	2.48	2.65	1.88	0.55	2.30
6	Check	2.13	2.27	3.07	2.73	1.90	0.55	2.30
130 day period						(10 days)		Average 130 days
3	Ground	2.40	2.12	2.62	3.07	0.50		2.39
4	Whole	2.47	2.54	2.54	1.50	0.82		2.25

The gains for lots 3 and 4 are presented up to the time of the first outbreak of urinary calculi at the 130-day period. Lot 3 during this time was surpassed in gain only by the check lot 6, dried tops lot 5, and lot 7 getting stack No. 2 tops. However, lot 4 with dried tops as their only roughage was the lowest gaining group of the test at the time of removal, with an average daily gain of 2.25 pounds.

The final status of the six lots remaining in the experiment at the end of the 160-day period shows that lot 5, getting dried beet tops as a partial substitute for alfalfa, equaled check lot 6 in average daily gain. The average daily gains of the silage, stack No. 2, and stack No. 1 lots were extremely close. The stack No. 3 lot showed the lowest average daily gain of the experiment.

Figure II. Average Steer Gains per Lot
1936-37

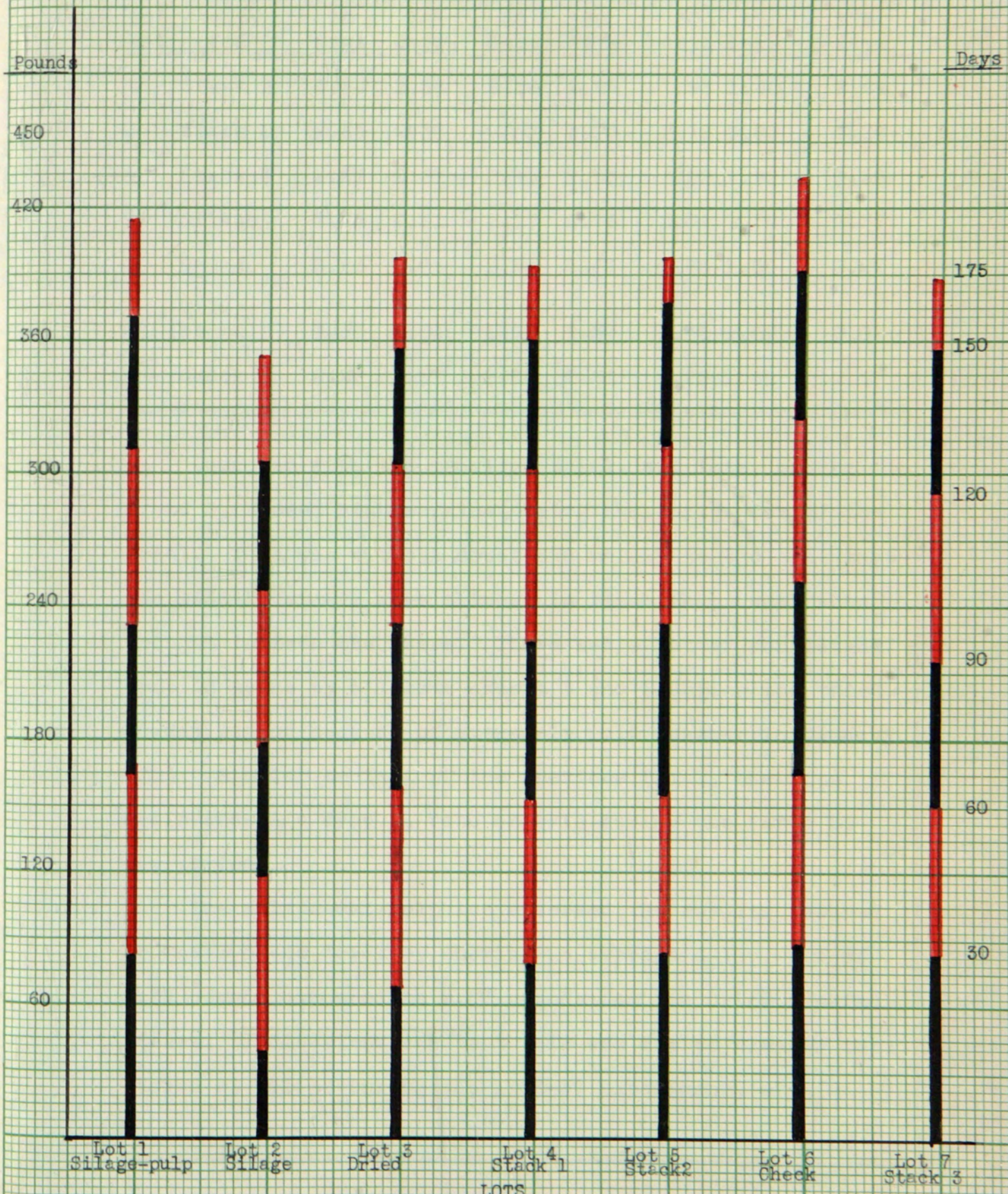

Table XIII. Average Daily Gains - 1936-37

Lot No.	Beet tops fed	First 30 days	Second 30 days	Third 30 days	Fourth 30 days	Fifth 30 days	Last 25 days	Average 175 days
4	Stack 1	2.64	2.33	2.33	2.67	1.93	1.40	2.24
5	Stack 2	2.85	2.35	2.55	2.70	2.12	0.82	2.27
7	Stack 3	2.67	2.37	2.15	2.53	2.20	1.22	2.22
1	Silage	2.77	2.81	2.17	2.76	2.04	1.54	2.37
3	Dried	2.26	2.96	2.54	2.42	1.73	1.59	2.27
2	Silage (no pulp)	1.38	2.61	1.93	2.37	1.85	1.89	2.01
6	Check	2.92	2.67	2.78	2.50	2.22	1.62	2.47

Compared with the previous trial, all lots, except 2 and 3, showed higher gains during the early part of the trial. This was without doubt due mainly to the fact that the 1936-37 steers were thinner in flesh than usual when brought in from the range. There was a rather consistant drop in gains by all lots except 5 and 6 during the third 30-day period because of extremely cold weather in January (20). Similar to that of the previous trial, the lots again showed a drop in rate of gain during the fifth 30-day period.

The silage-wet-pulp lot reversed the results secured in the 1935-36 trial by showing an average daily gain of 2.37 pounds compared to 2.27 pounds for the dried top-fed steers. Indications are that this was due to cleaner tops stored as silage during the 1936-37 experiment, with

consequently less digestive trouble than was experienced during the first trial. This is evidently a very important factor in beet-top silage, since it is more difficult for the steers to separate out the excess soil than in case of the dried tops.

The steer gains resulting from feeding stacked tops checked very closely with the results in the first experiment. None of the stack top-fed lots made as high gains as those fed silage or dried tops.

Results secured from lot 2, fed beet-top silage without wet beet pulp, show conclusively that beet-top silage is not equal to wet pulp as a succulent feed in a corn, cottonseed cake, and alfalfa ration. The steers made consistantly inferior gains throughout the trial, except during the second 30-day period. The exceptionally low gains during the first 30-day period compared to the other lots was caused partially by scouring and digestive trouble during the first two weeks, and also by lack of fill at weighing time. Lot No. 2 was fed silage after weighing, whereas the other lots had access to wet pulp before the weights were taken.

Figure III. Average Steer Gains Per Lot
1935-36 and 1936-37

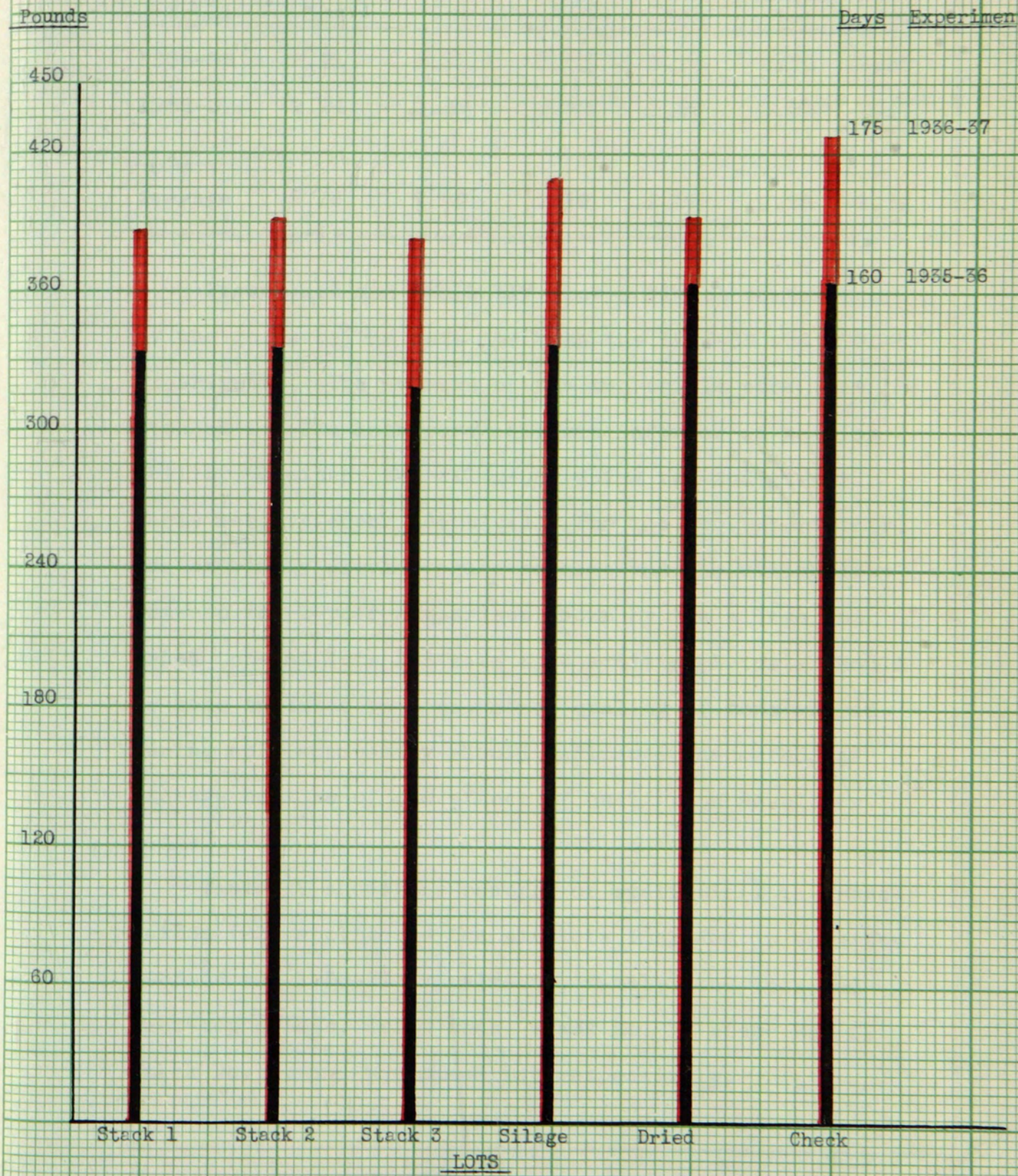

Table XIV. Average Daily Gains - 1935-36 Compared to 1936-37 Trial.

Trial	Stack 1 lot	Stack 2 lot	Stack 3 lot	Silage lot	Dried lot	Check lot
1935-36	2.11	2.12	2.01	2.14	2.30	2.30
1936-37	2.24	2.27	2.22	2.37	2.27	2.47
Average	2.18	2.20	2.12	2.26	2.28	2.39

Figure III and Table XIV show a direct comparison of the gains by the lots for both the 1935-36 and 1936-37 experiments. The average of the two trials show that the stacked top-fed lots were somewhat inferior in gaining ability to either the silage or dried top-fed steers. These results check identically for the two experiments. The extremely close average results and the variability between the 2-year comparison shown by the silage and dried top-fed lots indicate that additional tests should be made on these rations, since quality of tops and adhering soil apparently should influence the method of storage because of the effect of quality on resulting gains.

Table XV shows the results of statistical interpretation (23) applied to the six lots included in both the 1935-36 and 1936-37 experiments, namely, the lots fed beet-top silage, dried tops, stack No. 1, stack No. 2, stack No. 3, and the check lot respectively.

Table XV. Statistical Analysis of the Steer Gains.

Variance	D. F.	Sum Squares	Mean Square	S. E.	F.
Years	1	.5487	.54870		5.54[x]
Between lots	5	.3531	.07062		1.40
Lots X years	5	.7934	.15868		1.60
Within lots	102	10.0999	.09902	.3415	
Total	113	11.7951			

[x] 5 percent point

The F value (24) of 5.54 shows a significant difference between the two years' mean daily gain. That is, the chances of the variance within the lots being as great as the variance between years, or greater, are less than 1 to 20.

The F value indicates that the variance between lots and lots X years can be attributed to sampling error.

Replacement Value of Beet Tops:

The replacement value of a feed is not only reflected in the gains put on by the cattle, but also by the amount of feed required to put on a unit amount of gain. This factor is based on the feed requirement per 100 pounds of market gain, which includes the total gain for the experimental period minus a 3 percent shrink.

The replacement values for beet tops stored under the different conditions and fed in specific combinations are presented on the ton basis in order to permit ease of

comparison. The feed requirements per 100 pounds of market gain for each lot are also given with the replacement value.

Average feed prices for the two trials are used, including: corn, $34.70 per ton; cottonseed cake, $39.25 per ton; wet beet pulp, $1.89 per ton; alfalfa, $9.00 per ton; and salt, $13.00 per ton.

Table XVI shows the value of ground beet tops compared to whole beet tops fed as the only roughage to fattening steers for 130 days in the 1935-36 experiment.

Table XVI. Ground Beet Tops versus Whole Beet Tops.

Lot No.	B.Tops fed	Corn	C.S.C.	Pulp	Beet tops	Alfalfa	Salt	
	(a) Pounds of Feed Required Per 100 Pounds Market Gain:							
3	Ground	327.8	40.4	1189.7	684.4	-------	.5	
4	Whole	343.5	42.6	1257.2	686.8	-------	.3	
6	Check	307.5	37.9	1116.1	-----	416.4	.9	
	(b) Replacement Value:							Value
3	Ground	- 59.3	- 7.3	-215.1	-----	+1216.8	+1.2	+$4.10
4	Whole	-104.8	-13.7	-410.9	-----	+1212.6	+1.8	+$2.97

The $1.13 higher replacement value in favor of the ground tops over the whole tops was not enough to cover the $3.00 higher net cost per ton of feed produced. In other words grinding was not economical.

Table XVII shows the value of beet-top silage with wet pulp compared to beet-top silage without wet pulp

in a steer fattening ration of corn, cottonseed cake, and alfalfa.

Table XVII. Beet Top Silage versus Beet Top Silage Supplemented With Wet Pulp, As a Succulent Feed.

Lot	B.Tops fed	Corn	C.S.C.	Pulp	Beet tops	Alfalfa	Salt	
(a) Pounds of Feed Required Per 100 Pounds of Gain:								
1	Silage pulp	402.1	45.3	1236.0	496.0	266.8	.3	
2	Silage	479.0	54.0	------	1091.3	399.5	.5	
6	Check	384.2	43.3	1180.1	-----	400.9	.7	
(b) Replacement Value:								Value
1	Silage pulp	- 72.18	- 8.06	- 255.40	----	+540.73	+1.61	+$0.80
2	Silage	-173.74	- 19.61	+2162.73	----	+ 2.57	+ .37	-$1.35

The low replacement value for lot 2 shows conclusively that beet-top silage is not sufficient as the only succulent feed in a ration of corn, cottonseed cake, and alfalfa. A combination of a limited amount of beet-top silage with wet pulp proved to be much more desirable.

Table XVIII shows the comparative value of dried tops, beet-top silage, stack No. 1, stack No. 2, and stack No. 3 in a standard beet by-product ration.

Table XVIII. Dried Tops, Beet-Top Silage, and Stacked Tops Compared in a Standard Beet By-Product Ration.

Lot	Corn	C.S.C.	Pulp	Beet tops	Alfalfa	Salt	
(a) Pounds of Feed Required Per 100 Pounds Market Gain:							
Stack 1	426.4	49.4	1380.0	617.8	333.8	.35	
Stack 2	422.3	49.0	1366.8	609.7	282.8	.35	
Stack 3	440.2	51.1	1426.2	642.2	245.1	.40	
Silage	410.3	47.6	1326.6	676.8	238.3	.35	
Dried	404.7	46.9	1307.2	381.3	238.7	.35	
Check	386.2	44.8	1250.4	-----	438.8	.90	
(b) Replacement Value:							Value
Stack 1	-126.66	-14.56	-409.47	-----	+ 334.35	+1.82	-$1.39
Stack 2	-118.88	-13.68	-384.51	-----	+ 513.13	+1.82	-$0.39
Stack 3	-168.17	-19.47	- 547.47	-----	+ 603.16	+1.56	-$1.12
Silage	- 69.64	- 8.03	-219.17	-----	+ 583.62	+1.60	+$1.04
Dried	- 59.44	- 9.90	- 274.56	-----	+1054.04	+2.98	+$3.24

Dried tops and beet-top silage were the only ones to show a plus value with the prices used. In no case did the beet tops show a replacement value equal to their cost.

Stack No. 1 showed the least replacement value in comparison to the other stacks because of the smaller amount of alfalfa replaced. However, the steers fed stack No. 1 were approximately equal to those fed stack No. 2 and superior to the stack No. 3 fed steers from the standpoint of gain. They also showed better finish than

either the stack No. 2 and No. 3 fed cattle. Reference to Table IX shows that the net cost per ton of feed was less for stack No. 1.

Stack No. 3 showed less replacement value than stack No. 2 because of the smaller amount of corn, cottonseed cake, and wet pulp replaced. The stack No. 3 fed steers made correspondingly less gain during the two trials.

Silage showed a higher replacement value than the stacks because of the greater amount of corn, cottonseed cake, and wet pulp replaced. Silage in comparison with the stacks also replaced more alfalfa, with the exception of stack No. 3. The silage-fed steers made .094 of a pound higher average daily gain for the combined experiments than the average of the stack lots.

Dried tops showed the highest replacement value of any of the tops, not only due to the greater amount of alfalfa and corn replaced, but also because, with the exception of beet-top silage, they showed a higher replacement of cottonseed cake and wet pulp. Reference to Table XIV shows that the dried top-fed steers made consistantly good gains. However, the silage-fed steers were nearly equal to the dried top-fed steers in average rate of gain for the two trials. This was due to a higher average daily gain made by the silage-fed steers during the second trial when they received silage of much better quality than that fed the previous year.

Table XIX shows the comparative replacement value of the various kinds of beet tops with alfalfa at different prices.

Table XIX. Price of Alfalfa As Affecting the Replacement Value of Various Kinds of Beet Tops.

Price of alfalfa	Stack 1	Stack 2	Stack 3	Silage	Dried
$5.00	-$2.05	-$1.42	-$2.32	-$0.13	+$1.14
$6.00	- 1.89	- 1.16	- 2.02	+ 0.16	+ 1.66
$7.00	- 1.72	- 0.90	- 1.72	+ 0.45	+ 2.19
$8.00	- 1.55	- 0.65	- 1.42	+ 0.74	+ 2.72
$9.00	- 1.39	- 0.39	- 1.12	+ 1.04	+ 3.24
$10.00	- 1.22	- 0.13	- 0.81	+ 1.33	+ 3.77
$11.00	- 1.05	+ 0.12	- 0.51	+ 1.62	+ 4.30
$12.00	- 0.88	+ 0.38	- 0.21	+ 1.91	+ 4.82
$13.00	- 0.72	+ 0.64	+ 0.09	+ 2.20	+ 5.35
$14.00	- 0.55	+ 0.89	+ 0.39	+ 2.50	+ 5.88
$15.00	- 0.38	+ 1.15	+ 0.69	+ 2.79	+ 6.41

This shows that even with alfalfa at $15.00 per ton the stacked tops did not approach a replacement value equal to their cost shown in Table IX. On the other hand, with alfalfa at $15.00 per ton, beet-top silage lacked but 71 cents of showing a replacement value equal to its cost. Dried tops, however, showed a replacement value of 17 cents more than the actual cost per ton of feed produced.

Appraisal Value of Steers:

The steers were appraised at the end of each trial by a representative from a Denver commission company. Table XX shows the results of the appraisal.

Table XX. Comparative Appraisal Value of the Steers - 1935-36 and 1936-37 Trials.

	Lots						
Trial	Stack No. 1	Stack No. 2	Stack No. 3	Dried tops	Silage pulp	Silage	Check
1935-36	$ 8.20	$ 8.10	$ 8.00	$ 8.35	$ 7.85	$-----	$ 8.35
1936-37	10.65	10.75	10.80	10.85	11.00	10.50	11.25
Average	9.43	9.43	9.40	9.60	9.43	-----	9.80

The appraisal for the two trials indicates little difference in the finish of the steers fed the stacked tops. However, there was definite trend towards better finish in the stack No. 1 fed steers followed in order by the stack No. 2 cattle, with the steers getting the stack No. 3 tops showing decidedly the least finish. Parties acquainted with the experiment felt that the 1936-37 appraisal for lot 7, getting stack No. 3 tops, was somewhat high.

The difference in appraisal for the silage-wet-pulp-fed steers for the two years gives a picture of the difference in condition produced by clean and dirty silage.

The appraisal indicates good finish on the dried top-fed steers, even though in 1936-37 they did not carry

quite as high condition as in 1935-36.

The steers fed beet-top silage with no wet pulp were decidedly inferior in condition and finish to the other 1936-37 lots.

SUMMARY

A series of two experiments conducted at the Colorado Station relative to various methods of storing beet tops in relation to their value for fattening steers offered an excellent opportunity to make a study of this problem.

The methods of storage included:

1. Dried tops stored in piles about the size of an inverted wash tub.
2. Ensiled beet tops.
3. Stacked tops, including:
   A. Stack No. 1 - alternate 6-inch layers of green tops and 2-inch layers of straw.
   B. Stack No. 2 - alternate 2-inch layers of green tops and 2-inch layers of straw.
   C. Stack No. 3 - alternate 6-inch layers of wilted tops and 2-inch layers of straw.

The objectives of the study were:

1. To show the changes in feed nutrients during storage when beet tops are stored as dried tops, silage, or stacked tops.
2. To show the factors which determine the cost of feed provided by beet tops under different methods of storage.
3. To determine the feeding value of dried tops, beet-top silage, and stacked tops in a standard beet by-product ration which is composed of corn, cottonseed cake, wet pulp, and alfalfa.
4. To determine the value of dried tops as a

substitute and a partial substitute for alfalfa hay in a standard beet by-product ration.

5. To compare the relative value of whole versus ground beet tops.

6. To find the value of beet-top silage when replacing wet beet pulp in a standard beet by-product ration.

The ash content of the beet tops used in both trials emphasized the importance of separating as much soil as possible from the tops at time of storage. The consistantly lower percentage of ash for the beet tops used in the 1936-37 experiment compared to those in 1935-36 showed the effects of favorable weather in storing beet tops relatively free from adhering soil.

The amount of fermentation and spoilage determined the loss of nutrients by the tops under the various methods of storage. Dried tops showed the least loss of nutrients because drying prevented fermentation and spoilage to a great extent. Beet-top silage showed approximately 50 percent less loss of nutrients than either of the three methods of stacking tops, due mainly to fermentation with only .47 percent spoilage. Stacked tops showed a comparatively greater loss in feed nutrients because of conditions favorable for more fermentation and spoilage. Stack No. 1 showed a slightly greater loss of nutrients than the other two stacks. Stack No. 2 showed .14 percent greater loss of protein and .55 percent higher fat loss than stack No. 3, but lost 3.48 percent less nitrogen-free extract.

Factors determining the net cost of feed provided by the various methods of storing beet tops included: initial cost of tops; hauling charge; shrink; waste; straw, in case of stacked tops; and grinding charge, in case of ground tops.

The initial cost of dried and wilted tops was higher because of less tonnage per acre, which varies in direct proportion with the moisture content of the tops. However, the amount of dry matter or feed nutrients is the same or about the same in green, wilted, or dried tops.

The percent of shrinkage for the different forms of beet tops was determined primarily by the degree of moisture and fermentation loss. Dried tops showed the greatest loss of moisture followed in order by stack No. 2, stack No. 1, silage, and stack No. 3. Fermentation loss was greatest in the stacked tops, with silage ranking next, and then dried tops.

The percent of waste by the various beet tops was determined by the amount of spoilage, refused feed and dirt, plus a small amount of broken stems and shattered leaves in case of dried tops. Beet-top silage showed by far the least percentage of waste, which consisted of a small amount of spoilage on top of the silo. Dried tops ranked next with only a minimum of waste consisting of shattered leaves in addition to separated soil in the feed bunk. The stacked tops showed a uniformly high per-

centage of waste compared to silage and dried tops. This high loss consisted largely of spoilage about the outer portion of the stacks.

Palatability has long been considered an important factor in feeds. Beet-top silage proved to be extremely palatable, when it was free from excessive soil. Dried tops proved to be very palatable, except when excessively dry and brittle. Stacked tops, even when slightly molded proved to be quite palatable until warm weather caused quick spoilage.

Beet-top silage caused some trouble because of its laxative effect on the cattle. The addition of .1 pound of lime ($CaCO_3$) per head daily spread over the silage controlled this condition effectively.

The quality of beet tops proved to be an important factor, especially in the case of silage. When made with poor quality, dirty tops, silage resulted in digestive trouble accompanied with decreased appetite among the steers in the 1935-36 experiment. This trouble was not experienced with better quality silage in the 1936-37 trial. No trouble was encountered with excess soil relative to the stacked and dried tops, since the steers were able to sort it out with much greater efficiency than in case of the more moist silage. This was especially true in case of the dried tops.

The length of the feeding period and the quantity of tops fed had a direct bearing on the dietary factors

involved in feeding beet tops. This was indicated by the development of cases of urinary calculi after 130 days in the 1935-36 experiment by the steers in the lots getting ground and whole beet tops as their only roughage. No further trouble occured in these lots after they were taken off of the test ration at the end of 134 days and put on a standard beet by-product ration including alfalfa. Lots getting the different forms of tops in limited quantities showed no trouble during the 160-day feeding period in the 1935-36 experiment. Likewise, the steers in the 1936-37 trial receiving only limited amounts of tops showed no urinary calculi disturbances until after 160 days, with the exception of one steer in the dried top-fed lot which developed a definite case of calculi at 142 days. In addition to urinary calculi disturbances after the 160-day period in the 1936-37 experiment, the steers in all lots getting beet tops in various forms developed cases of bloating and loss of appetite. This was not true of the steers that did not get beet tops in their ration. In view of these facts it seems safe to say that in order to avoid possible dietary trouble, beet tops in any form should not be fed in large quantities to fattening cattle for longer than 120 days, and not over 150 days if fed in limited amounts.

A check-up of the average daily rations fed to the steers in the 1936-37 experiment showed a variation in ash content from 2.91 to 4.05 percent for the lots re-

ceiving limited quantities of beet tops. The analyses of the urine samples from steers in each lot indicated that the high percentage of ash in the ration was responsible for an abnormally high elimination of mineral salts by the animal's body. These mineral salts probably presented favorable conditions for the development of urinary calculi.

Ground tops compared to whole tops as the only roughage in a basal ration of corn, cottonseed cake, and wet beet pulp, produced .14 of a pound higher average daily gain for a period of 130 days in the 1935-36 experiment. However, the $1.13 higher replacement value in favor of the ground tops was not enough to cover the $3.00 greater net cost per ton of feed produced. In other words grinding was not economical.

Beet-top silage in the 1936-37 experiment did not prove to be sufficient as the only succulent feed in a ration of corn, cottonseed cake, and alfalfa, compared to the same basal ration including a limited amount of silage supplemented with wet pulp. The steers made the lowest gains and showed the poorest finish compared to the other lots in the experiment.

The combined results of the two experiments showed dried tops and beet-top silage to be superior to stacked tops as a partial substitute for alfalfa in a standard beet by-product ration. They produced more gain, higher finish, and showed a greater replacement value in the ration. Dried tops showed an advantage over beet-top

silage in these respects for the 2-year comparison. This was due mainly to digestive trouble caused by dirty, poor quality silage fed in the 1935-36 experiment, which resulted in poor gains and steers with inferior finish. On the other hand, good quality silage in the 1936-37 experiment produced higher gains and superior finish compared to the dried top-fed steers. Stack No. 1 showed less replacement value than the other stacks, but produced more gain than stack No. 3 and developed better finished steers than those fed either stack No. 2 or No. 3. The net cost per ton of feed provided was also less for stack No. 1. Stack No. 3 was the least desirable because of the lower gains and inferior finish produced along with its low replacement value.

Statistical analysis was applied to the steer gains for the combined trials, including the check lot and the lots receiving either dried tops, beet-top silage, stack No. 1, stack No. 2, or stack No. 3 tops in limited quantities in a standard beet by-product ration. There was a significant difference in the mean daily gain between years, with an F value of 5.54 (5 percent point). The low F value of 1.40 for between lots and 1.60 for lots X years indicated that these variances could be attributed to sampling error.

CONCLUSIONS

1. Great care should be used in storing beet tops in order to eliminate as much adhering soil as possible.

2. Stacked beet tops will lose a greater proportion of feed nutrients during storage than either silage or dried tops.

3. Beet tops replacing all of the alfalfa in a standard beet by-product ration for yearling steers may cause severe dietary trouble after 120 days.

4. Grinding beet tops is expensive, and the feeding value is not enhanced enough to justify its cost.

5. Dried tops and beet-top silage are more desirable for yearling steers as a partial substitute for alfalfa in a standard beet by-product fattening ration than beet tops stacked with straw.

6. When beet tops are dirty, they give best results in a standard beet by-product ration when fed as dried tops, since the cattle are able to separate out a high percentage of the incorporated soil.

7. Clean beet tops will return the most in the form of beet-top silage, when fed in limited quantities in a standard beet by-product ration.

8. Beet-top silage will not fully replace wet beet pulp as a succulent feed in a standard beet by-product ration.

9. Feeding .1 of a pound of lime ($CaCO_3$) per head daily will control the laxative effect of beet-top silage.

10. Beet-top silage cannot be fed to fattening cattle in quantities similar to corn silage, because of its laxative properties.

11. In order to avoid possible dietary trouble, beet tops in any form should not be fed in large quantities to yearling steers for longer than 120 days, and not over 150 days if fed in limited amounts.

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APPENDIX

Table XXI. 1935-36 Steer Allotment

Factors	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6	Lot 7	Lot 8
Weight:	7070	7065	7075	7070	7065	7070	7070	7070
Type:								
Choice	9	9	9	9	9	9	9	9
Good	1	1		1			1	
Medium			1		1	1		1
Condition:								
Choice	4	3	4	3	3	4	4	4
Good	5	7	5	7	7	5	6	6
Medium	1		1			1		
Origin:								
North Park	9	9	9	9	9	9	9	9
Smith	1	1	1	1	1	1	1	1
Color:								
Dark	2	1	2	1	2	2	2	2
Medium	7	8	7	7	7	7	7	7
Light	1	1	1	2	1	1	1	1

Table XXII. 1936-37 Steer Allotment

Factors	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6	Lot 7
Weight:	6435	6435	6445	6450	6440	6435	6430
Type:							
Choice	6	5	6	6	5	6	6
Choice-	1	1			1	1	1
Good +	1	2	1	1	1		
Good	1	2	3	2	3	3	2
Good-	1			1			1
Condition:							
Choice	1	1	1	1			
Choice-							
Good +							1
Good	8	6	7	7	8	8	8
Good-		2	1	1	2	1	1
Medium	1	1	1	1		1	
Origin:							
Brackenbury	3	3	2	3	3	3	2
Swan	2	3	3	2	3	2	2
Dunlap	2	2	2	2	1	2	3
Williams	3	2	3	3	3	3	3
Color:							
Dark	1	3	1	2	2	3	1
Medium	9	5	9	7	7	6	8
Light		2		1	1	1	1

Table XXIII. Meteorological Data

Mean Maximum Temperature				Mean Minimum Temperature			
Month	1935-36	1936-37	Normal	Month	1935-36	1936-37	Normal
October	60.8	60.5	63.8	October	33.6	33.4	32.5
November	45.6	52.8	50.9	November	22.7	21.9	21.5
December	45.6	43.3	41.7	December	15.9	17.7	13.7
January	41.6	23.5	40.4	January	16.6	-2.1	12.0
February	34.0	41.8	41.9	February	5.4	15.8	14.0
March	52.0	46.3	49.7	March	23.9	23.3	22.1
April	62.1	59.2	59.8	April	33.5	31.2	31.8
May	73.0	70.6	67.8	May	45.3	43.2	40.6

Mean Temperature				Precipitation			
Month	1935-36	1936-37	Normal	Month	1935-36	1936-37	Normal
October	47.2	47.0	47.8	October	0.62	1.38	1.09
November	34.2	37.4	36.0	November	0.66	0.18	0.48
December	30.8	30.5	27.6	December	0.00	0.38	0.45
January	29.1	10.7	26.1	January	0.04	0.36	0.38
February	19.7	28.8	27.9	February	0.39	0.53	0.62
March	37.9	34.8	35.9	March	0.71	1.14	0.99
April	47.8	45.2	45.7	April	1.17	2.23	1.98
May	59.1	56.9	54.2	May	1.10	1.48	2.87

Table XXIV. Summary of Steer Gains - Stack No.1 Lot.

Trial	Date	Days	Average weight	Average gain	Average daily gain
1935-36:	November 26	----	695.63	-----	----
	December 26	30	758.13	62.50	2.08
	January 25	30	821.88	63.75	2.13
	February 24	30	885.63	63.75	2.13
	March 25	30	980.63	95.00	3.17
	April 24	30	1036.25	55.62	1.85
	May 4	10	1033.13	- 3.12	-0.31
	Entire period	160	-------	337.50	2.11
1936-37:	November 10	----	641.83	-----	----
	December 10	30	721.00	79.17	2.64
	January 9	30	791.00	70.00	2.33
	February 8	30	861.00	70.00	2.33
	March 10	30	941.00	80.00	2.67
	April 9	30	999.00	58.00	1.93
	May 4	25	1034.00	35.00	1.40
	Entire period	175	-------	392.17	2.24

Table XXV. Summary of Steer Gains - Stack No.2 Lot

Trial	Date	Days	Average weight	Average gain	Average daily gain
1935-36:	November 26	----	696.11	-----	----
	December 26	30	761.11	65.00	2.17
	January 25	30	830.56	69.45	2.32
	February 24	30	900.00	69.44	2.31
	March 25	30	995.00	95.00	3.17
	April 24	30	1041.67	46.67	1.56
	May 4	10	1035.74	- 5.93	-0.59
	Entire period	160		339.63	2.12
1936-37:	November 10	----	640.50	-----	----
	December 10	30	726.00	85.50	2.85
	January 9	30	796.50	70.50	2.35
	February 8	30	873.00	76.50	2.55
	March 10	30	954.00	81.00	2.70
	April 9	30	1017.50	63.50	2.12
	May 4	25	1038.00	20.50	0.82
	Entire period	175		397.50	2.27

Table XXVI. Summary of Steer Gains - Stack No.3 Lot.

Trial	Date	Days	Average weight	Average gain	Average daily gain
1935-36:	November 26	----	691.17	-----	----
	December 26	30	739.00	47.83	1.59
	January 25	30	827.50	88.50	2.95
	February 24	30	891.50	64.00	2.13
	March 25	30	985.00	93.50	3.12
	April 24	30	1022.50	37.50	1.25
	May 4	10	1012.50	-10.00	-1.00
	Entire period	160	-------	321.33	2.01
1936-37:	November 10	-----	642.50	-----	----
	December 10	30	722.50	80.00	2.67
	January 9	30	793.50	71.00	2.37
	February 8	30	858.00	64.50	2.15
	March 10	30	934.00	76.00	2.53
	April 9	30	1000.00	66.00	2.20
	May 4	25	1030.50	30.50	1.22
	Entire period	175	-------	338.00	2.22

Table XXVII. Summary of Steer Gains - Beet-top Silage Lot.

Trial	Date	Days	Average weight	Average gain	Average daily gain
1935-36:	November 26	----	688.50	-----	----
	December 26	30	755.50	67.00	2.23
	January 25	30	812.50	57.00	1.90
	February 24	30	894.50	82.00	2.73
	March 25	30	972.50	78.00	2.60
	April 24	30	1022.50	50.00	1.67
	May 4	10	1031.67	9.17	0.92
	Entire period	160		343.17	2.14
1936-37:	November 10	----	645.93	-----	----
	December 10	30	728.89	82.96	2.77
	January 9	30	813.33	84.44	2.81
	February 8	30	878.33	65.00	2.17
	March 10	30	961.11	82.78	2.76
	April 9	30	1022.22	61.11	2.04
	May 4	25	1060.74	38.52	1.54
	Entire period	175		414.81	2.37

Table XVIII. Summary of Steer Gains - Dried Top Lot.

Trial	Date	Days	Average weight	Average gain	Average daily gain
1935-36:	November 26	----	699.00	-----	----
	December 26	30	768.00	69.00	2.30
	January 25	30	851.50	83.50	2.78
	February 24	30	926.00	74.50	2.48
	March 25	30	1005.50	79.50	2.65
	April 24	30	1062.00	56.50	1.88
	May 4	10	1067.50	5.50	0.55
	Entire period	160	-------	368.50	2.30
1936-37:	November 10	----	640.42	-----	----
	December 10	30	708.13	67.71	2.26
	January 9	30	796.88	88.75	2.96
	February 8	30	873.13	76.25	2.54
	March 10	30	945.63	72.50	2.42
	April 9	30	997.50	51.87	1.73
	May 4	25	1037.29	39.79	1.59
	Entire period	175	-------	396.87	2.27

Table XXIX. Summary of Steer Gains - Check Lot.

Trial	Dates	Days	Average weight	Average gain	Average daily gain
1935-36:	November 26	----	695.50	-----	----
	December 26	30	759.50	64.00	2.13
	January 25	30	827.50	68.00	2.27
	February 24	30	919.50	92.00	3.07
	March 25	30	1001.50	82.00	2.73
	April 24	30	1058.50	57.00	1.90
	May 4	10	1064.00	5.50	0.55
	Entire period	160		368.50	2.30
1936-37:	November 10	----	640.00	-----	----
	December 10	30	727.50	87.50	2.92
	January 9	30	807.50	80.00	2.67
	February 8	30	891.00	83.50	2.78
	March 10	30	966.00	75.00	2.50
	April 9	30	1032.50	66.50	2.22
	May 4	25	1073.00	40.50	1.62
	Entire period	175		433.00	2.47

Table XXX. Summary of Steer Gains - Ground Beet Top Lot.

Trial	Date	Days	Average weight	Average gain	Average daily gain
1935-36:	November 26	----	690.50	-----	----
	December 26	30	762.50	72.00	2.40
	January 25	30	826.00	63.50	2.12
	February 24	30	904.50	78.50	2.62
	March 25	30	996.50	92.00	3.07
	April 4	10	1001.50	5.00	0.50
	Entire period	130	-------	311.00	2.39

Table XXXI. Summary of Steer Gains - Whole Beet Top Lot.

Trial	Date	Days	Average weight	Average gain	Average daily gain
1935-36:	November 26	----	688.15	-----	----
	December 26	30	762.22	74.07	2.47
	January 25	30	838.33	76.11	2.54
	February 24	30	914.44	76.11	2.54
	March 25	30	959.44	45.00	1.50
	April 4	10	980.00	20.56	0.82
	Entire period	130	------	291.85	2.25

Table XXXII. Summary of Steer Gains - Beet-Top Silage (without wet pulp) Lot.

Trial	Date	Days	Average weight	Average gain	Average daily gain
1936-37:	November 10	----	641.48	-----	----
	December 10	30	682.78	41.30	1.38
	January 9	30	761.11	78.33	2.61
	February 8	30	818.89	57.78	1.93
	March 10	30	890.00	71.11	2.37
	April 9	30	945.56	55.56	1.85
	May 4	25	992.78	47.22	1.89
	Entire period	175	------	351.30	2.01

Table XXXIII. Data Sheet - Ground Tops versus Whole Tops

STEER FEEDING EXPERIMENT
Colorado Experiment Station, Fort Collins, Colorado
10 steers per lot - fed 130 days - November 26, 1935 to April 4, 1936
(Table based on one average steer)

Lot number	3*	4*	6
Rations Fed Salt self-fed in all lots.	Ground Corn Cottonseed Cake Wet Pulp Ground Beet Tops	Ground Corn Cottonseed Cake Wet Pulp Whole Beet Tops	Ground Corn Cottonseed Cake Wet Pulp Alfalfa
Weight at Start	690.5	688.2	695.5
Weight at Finish	1001.5	980.0	1027.0
Total Gain	311.0	291.9	331.5
Daily Gain	2.39	2.25	2.55
Average Daily Ration -			
Ground Corn	7.84	7.71	7.84
Cottonseed Cake	.97	.96	.97
Wet Beet Pulp	28.46	28.22	28.46
Beet Tops	16.37	15.42	
Alfalfa			10.62
Maximum Daily Ration -			
Ground Corn	11.0	11.0	11.0
Cottonseed Cake	1.0	1.0	1.0
Wet Beet Pulp	25.0	25.0	25.0
Beet Tops	14.0	14.0	
Feed Required Per Cwt. Feedlot Gain -			
Ground Corn	327.8	343.5	307.5
Cottonseed Cake	40.4	42.6	37.9
Wet Beet Pulp	1189.7	1257.2	1116.1
Beet Tops	684.4	686.8	
Alfalfa			416.4
Salt	.5	.3	.9
Feed Cost Per Cwt. Feedlot Gain	$9.34	$8.61	$7.40

*One steer in each lot developed urinary calculi.

Feed Costs Used:

Ground Corn	$26.40 per Ton	Whole Dried Beet Tops	$6.46 per Ton
Cottonseed Cake	33.50 per Ton	Ground Dried Beet Tops	9.46 per Ton
Wet Beet Pulp	1.82 per Ton	No. 1 Stacked Beet Tops	5.47 per Ton
Alfalfa	8.00 per Ton	No. 2 Stacked Beet Tops	6.04 per Ton
Salt	13.00 per Ton	No. 3 Stacked Beet Tops	5.21 per Ton
		Beet Top Silage	$3.47 per Ton

Table XXXIV. Data Sheet

STEER FEEDING EXPERIMENT
Colorado Experiment Station, Fort Collins, Colorado
10 steers per lot - fed 160 days - November 26, 1935 to May 4, 1936
(Table based on one average steer)

Lot number	1	2	5	6	7	8
Rations Fed Salt self-fed in all lots.	Gr. Corn C.S.Cake Wet Pulp No.1 Stacked Tops Alfalfa	Gr. Corn C.S.Cake Wet Pulp Beet-Top Silage Alfalfa	Gr. Corn C.S.Cake Wet Pulp Whole Beet Tops Alfalfa	Gr. Corn C.S.Cake Wet Pulp Alfalfa	Gr. Corn C.S.Cake Wet Pulp No.2 Stacked Tops Alfalfa	Gr. Corn C.S.Cake Wet Pulp No.3 Stacked Tops Alfalfa
Weight at Start	695.6	688.5	699.0	695.5	696.1	691.2
Weight at Finish	1002.1	1000.7	1035.5	1032.1	1004.7	982.1
Total Gain	* 306.5	312.2	336.5	336.6	308.6	291.0
Daily Gain	1.92	1.95	2.10	2.10	1.93	1.82
Average Daily Ration -						
Ground Corn	8.17	8.17	8.17	8.17	8.18	8.17
Cottonseed Cake	.97	.97	.97	.97	.97	.97
Wet Beet Pulp	27.78	27.65	27.78	27.78	27.82	27.78
Beet Tops	10.78	16.73	7.33		11.02	11.68
Alfalfa	7.97	4.09	5.97	10.03	6.25	5.54
Maximum Daily Ration -						
Ground Corn	11.0	11.0	11.0	11.0	11.0	11.0
Cottonseed Cake	1.0	1.0	1.0	1.0	1.0	1.0
Wet Beet Pulp	25.0	25.0	25.0	25.0	25.0	25.0
Beet Tops	15.0	20.0	7.0		15.0	15.0
Feed Required Per Cwt. Market Gain -						
Ground Corn	426.3	418.4	388.3	388.1	424.1	449.0
Cottonseed Cake	50.8	49.9	46.3	46.3	50.5	53.5
Wet Beet Pulp	1450.2	1417.1	1321.1	1320.6	1442.4	1527.7
Beet Tops	562.5	857.6	348.4		571.2	642.4
Alfalfa	416.2	209.8	283.7	476.6	323.9	304.5
Salt	.5	.4	.4	1.1	.5	.6
Feed Cost Per Cwt. Market Gain	11.01	9.99	9.38	9.02	10.79	11.12
Valuation Placed on Steers	8.20	7.85	8.35	8.35	8.10	8.00

*Est. 3% Market Shrink.

Feed Costs Used:

Ground Corn	$26.40 per Ton	Beet-Top Silage	$3.47 per Ton
Cottonseed Cake	33.50 per Ton	Whole Dried Beet Tops	6.46 per Ton
Wet Pulp	1.82 per Ton	Ground Dried Beet Tops	9.46 per Ton
Alfalfa	8.00 per Ton	No. 1 Stacked Beet Tops	5.47 per Ton
Salt	13.00 per Ton	No. 2 Stacked Beet Tops	6.04 per Ton
		No. 3 Stacked Beet Tops	$5.21 per Ton

Table XXXV. Data Sheet

STEER FEEDING EXPERIMENT
Colorado Experiment Station, Fort Collins, Colorado
10 steers per lot - fed 175 days - November 10, 1936 to May 4, 1937
(Table based on one average steer)

Lot number	1	2	3	4	5	6	7	8
Rations Salt self-fed in all lots	Gr. Corn C.S.Cake Wet Pulp Beet-Top Silage Alfalfa	Gr. Corn C.S.Cake Beet-Top Silage Alfalfa	Gr. Corn C.S.Cake Wet Pulp Dried Beet Tops Alfalfa	Gr. Corn C.S.Cake Wet Pulp No.1 Stacked Tops Alfalfa	Gr. Corn C.S.Cake Wet Pulp No.2 Stacked Tops Alfalfa	Gr. Corn C.S.Cake Wet Pulp Alfalfa	Gr. Corn C.S.Cake Wet Pulp No.3 Stacked Tops Alfalfa	Gr. Corn "C" Molasses Wet Pulp Alfalfa
Weight at Start	645.9	641.5	640.4	641.8	640.5	640.0	642.5	645.0
Weight at Finish)*	1028.9	963.0	1006.2	1003.0	1006.9	1040.8	999.6	1024.2
Total Gain)*	383.0	321.5	365.8	361.2	366.4	400.8	357.1	379.2
Daily Gain)	2.19	1.84	2.09	2.06	2.09	2.29	2.04	2.17
Average Daily Ration								
Ground Corn	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.23
Cottonseed Cake	.99	.99	.99	.99	.99	.99	.99	
"C" Molasses								2.39
Wet Beet Pulp	27.05		27.03	27.03	27.03	27.03	27.03	27.03
Beet Tops	10.85	20.05	8.65	13.89	13.57		13.10	
Alfalfa	5.84	7.34	4.05	5.19	5.06	9.18	3.79	9.20
Maximum Daily Ration								
Ground Corn	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.0
Cottonseed Cake	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
"C" Molasses								2.5
Wet Beet Pulp	35.0		35.0	35.0	35.0	35.0	35.0	35.0
Beet Tops	15.0	30.0	10.0	15.0	15.0		15.0	
Feed Required Per Cwt. Market Gain								
Ground Corn	402.1	479.0	421.0	426.4	420.4	384.2	431.3	379.9
Cottonseed Cake	45.3	54.0	47.4	48.0	47.4	43.3	48.6	
"C" Molasses								110.4
Wet Beet Pulp	1236.0		1293.2	1309.7	1291.1	1180.1	1324.6	1247.5
Beet Tops	496.0	1091.3	414.1	673.0	648.1		642.0	
Alfalfa	266.8	399.5	193.7	251.4	241.6	400.9	185.6	424.8
Salt	.3	.5	.3	.2	.2	.7	.2	.4
Feed Cost Per Cwt. Market Gain	$13.08	15.40	13.58	14.31	14.32	12.39	14.24	12.02

*Est. 3% Market Shrink

Feed Costs Used:

Ground Corn	$43.00 per Ton	Salt	$13.00 per Ton
Cottonseed Cake	45.00 per Ton	Beet-Top Silage	3.45 per Ton
"C" Molasses	9.00 per Ton	Dried Beet Tops	5.90 per Ton
Wet Beet Pulp	1.95 per Ton	No. 1 Stacked Beet Tops	4.50 per Ton
Alfalfa	10.00 per Ton	No. 2 Stacked Beet Tops	5.35 per Ton
		No. 3 Stacked Beet Tops	$5.15 per Ton