T H E S I S

A STUDY OF METHODS OF FEEDING AND THE FEEDING VALUE OF SUGAR BEET TOPS FOR FATTENING LAMBS IN COLORADO

Submitted by

Fred H. Leinbach

for the Degree of Master of Science

Colorado Agricultural College

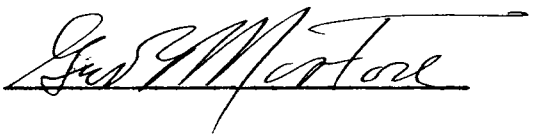
Fort Collins, Colorado

July 18, 1927

THIS THESIS HAS BEEN READ

APPROVED AND RECOMMENDED

FOR CREDIT



Head of the Department of Animal Husbandry

Colorado Agricultural College

Fort Collins, Colorado

THIS THESIS HAS BEEN APPROVED AND RECOMMENDED FOR

THE DEGREE OF MASTER OF SCIENCE

Chairman and Professor of Zoology

Professor of Horticulture

Professor of Veterinary Pathology

Committee on Advanced Degrees
Colorado Agricultural College
Fort Collins, Colorado

TABLE OF CONTENTS

A STUDY OF METHODS OF FEEDING AND THE FEEDING VALUE OF SUGAR BEET TOPS FOR FATTENING LAMBS IN COLORADO

INTRODUCTION

Importance of Sugar Beet Industry in Colorado

Colorado ranks first among the states in sugar beet production. One hundred thirty-one thousand acres raised in 1925 constituted 19.64 percent of the total acreage in the United States and produced 1,449,000 tons of sugar beets, 20.9 percent of the total production of the United States. (1)

The beet producing area in Colorado comprises only certain irrigated sections, namely: The Arkansas Valley, Northern Colorado, and the Western Slope, or approximately 26 percent of the total area of the state. Beet production in these three areas fits in well with their general agriculture and furnishes their principal cash crop.

By-Products of Sugar Beet Industry

There are several by-products from sugar beet production and the manufacture of beet sugar. These are: Beet tops, wet beet pulp, dried beet pulp, and beet molasses. While all of these feeds are important in livestock feeding, only beet tops will be dealt with here.

Investigation shows that generally the weight of these green tops is equal to about three-fourths of the tonnage of beets produced.

A farm rule, commonly used, has been that an acre of beet tops is equal in feeding value to a ton of alfalfa hay.(2)

On this basis, Colorado would have produced in 1925, 1,086,750 tons of green tops equivalent to 131,000 tons of alfalfa hay. With alfalfa hay at $10 per ton, the value of these tops, on this basis, would have been $1,310,000.

Because of the physical nature of beet tops and the rather primitive methods used in handling and feeding them, it seems evident that their actual feeding value expressed by these general rules has been underestimated. Proper handling of the tops themselves, and results secured from feeding them in a balanced ration in commercial feeding operations and in feeding experiments indicate a higher value than is secured when no precautions are taken.

Definition of Beet Tops

Beet tops consist of the crowns and leaves of the beet plant. In the crown of the beet certain salts, that have a detrimental effect in sugar production, accumulate. These are: Salt petre, a series of sulphates, potassium phosphate, magnesium phosphate, calcium phosphate, potassium chloride, sodium chloride, ammonium hydro-chloride, and lime oxalate.(3) These salts interfere with the recovery of sugar from the beet juices. For this reason the part of the beet to which the leaves are attached, commonly called the crown, is discarded along with the leaves. In the combination present the salts are cathartic and tend to cause scouring or looseness of the bowels in the animals to which they are fed, unless the quantity of beet tops consumed is restricted. (2)

Beet tops vary greatly in their chemical composition. Table 1 gives the analyses of beet tops from available sources.

Table No. 1--Composition of Beet Tops
(Dry Matter Basis)

Source	Protein	Ash	Fat	Carbohydrates: Crude Fibre	Carbohydrates: Nitrogen Free Extract
Average of 7 analyses on Colo. beet tops by: U. S. D. A. (4)	15.15	27.83	.95	12.17	43.90
Henry & Morrison (5)	22.81	17.54	2.64	10.53	46.49
Malpeaux (6)	9.78	35.16	1.10	10.00	43.96
Colo. Agricultural Exp. Station (7)	15.43	18.41	.85	25.96	47.87
Spread between maximum and minimum	12.03	17.62	1.78	15.96	3.97

The variations in this table are apparently due not only to natural differences of plant growth but may be influenced by the presence of more or less dirt. The presence of more dirt on one sample would cause an increase in the ash content and a corresponding decrease in the percentage of the other constituents. The ash content of clean beet tops varies from 12 to 15 percent. (4)

A change in the ratio of leaves to crown through differences in topping might also cause a variation in the percentages of the constituents of beet tops. An increased

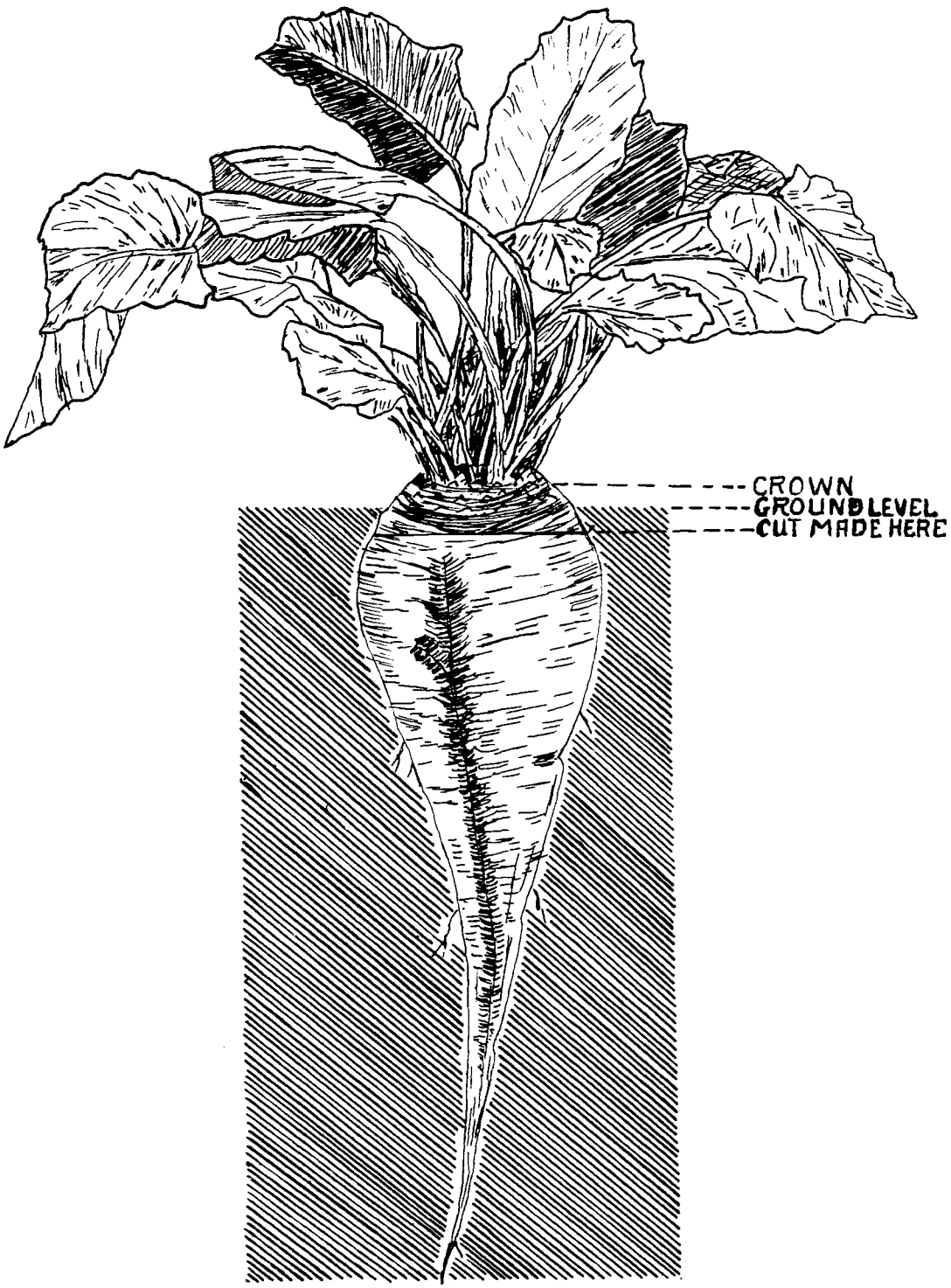


DIAGRAM OF SUGAR BEET INDICATING WHERE LEAVES AND CROWN ARE CUT FROM BEET AFTER PULLING IN THE FIELD

ratio of crown to leaves would result in a higher protein, ash and crude fibre content. (5)

On a digestible nutrient basis, Henry and Morrison (5) show that beet tops have a nutritive ratio of 1 : 3.3 indicating that they are a protein or growth producing feed quite comparable to wheat bran (nutritive ratio 1 : 3.9) or alfalfa (nutritive ratio 1 : 3.9). They can therefore be expected to show their maximum feeding value only when properly balanced by the presence of one or more carbohydrate supplements in the ration. Fed alone or with alfalfa, growth and not finish can normally be expected.

Factors Influencing the Feeding Value of Beet Tops in Lamb Feeding Rations

There are certain factors which have tended to indicate a low feeding value for beet tops.

1. Because of existing economic conditions beet tops have been fed largely in high protein and unbalanced rations. The lambs used in earlier feeding operations in Colorado were small, ranging from 42 to 53 pounds as against 60 to 70 pounds today. (8) They were the younger lambs and cut-backs from grower's flocks as the greater percentage of lambs has been sent to market direct from the range, grass fat. These little lambs could be grown out to advantage before fattening them. Beet tops and alfalfa hay were both abundant and cheap feeds and were largely used for this purpose during the early part of the feeding period. This

appeared to be an economic practice for many years but conditions have changed and feeding in this way now seems to produce a low feeding value for beet tops. Today a well-balanced ration is indicated for the present type of large, growthy lambs.

2. Field feeding or pasturing has been generally practiced and has resulted in much waste of feed nutrients, both in actual loss of plant food through leaching and because of losses incurred through trampling and wasting of the beet tops during inclement weather.

Unit of Measurement and Dry Matter Content of Beet Tops

The unit of measurement for most feeds is based on weight. Fresh beet tops contain as high as 86.77 percent moisture (4). Exposed to direct sunlight, the moisture content rapidly decreases; to rain or snow, the moisture content increases. Because of the wide variations in the moisture content of beet tops under different conditions, any system of measurement based on weights, alone, proves unsatisfactory.

A system of measurement which has been attempted is based on dry matter in tops per ton of beets produced. Holden (9) uses a factor of 250 pounds while Maxon (10) has found that with a yield of 12 tons of beets per acre, the dry matter content of the tops per ton of beets produced is only 180 pounds. Because of the variation in dry matter content of beet tops from different sources, this system of

measurement also seems to be unsatisfactory.

Feeders and growers of beets in beet producing territories, searching for some way in which to satisfactorily buy and sell tops, have generally adopted a unit of measurement based on the tonnage of beets produced. An arbitrary figure of 50 cents has generally been accepted as the value of tops per ton of beets produced. On this basis the beet tops from an 8 ton yield of beets would be valued at $4.00 per acre, while tops from a 16 ton yield of beets would have twice that value per acre. In many instances, however, much lower prices have been paid for beet tops.

The method of handling tops and weather conditions are factors in determining the amount actually available for feeding. However, some factor must be used which will most closely approximate the feed available and "tops per ton of beets produced" has seemed best adapted to all conditions.

THE BEET TOP FEEDING EXPERIMENT

Object of the Investigation

The object of this work was:

To determine the effect of different methods of feeding and of different feeds on the feeding value of beet tops. This seemed to involve the following comparisons:

1. Pasturing the tops in the field with alfalfa hay fed in dry lot as compared with hauling and feeding tops in

dry lot with alfalfa hay.

2. Pasturing the tops in the field with shelled corn and alfalfa hay fed in dry lot as compared with hauling and feeding tops in dry lot with corn and alfalfa hay.

3. The feeding of tops in the above manner with the addition of a supplementary grain feed to balance the ration.

4. The use of beet tops hauled and fed in dry lot and alfalfa, with and without wet beet pulp.

The comparisons of beet tops pastured and beet tops hauled and fed in dry lot with alfalfa, and with shelled corn and alfalfa, were made to determine what differences in the value of tops might be attributed to losses occurring to tops in the field through weathering, trampling, etc. These are common methods of feeding practiced in Colorado.

The addition of a supplementary grain feed was made, with the knowledge that feed costs would be increased by so doing, to see what effect the balancing of the ration would have on comparative gains and feed utilization.

The addition of pulp was made with the same purpose in mind.

Plan of the Experiment

The experiment was carried on near Delta on the Western Slope of Colorado. Here the winter climate is, as a rule, extremely mild and dry, any kind of a storm being exceptional. With such weather conditions, better results in lamb feeding were to be expected than would be obtained

where weather conditions were less favorable.

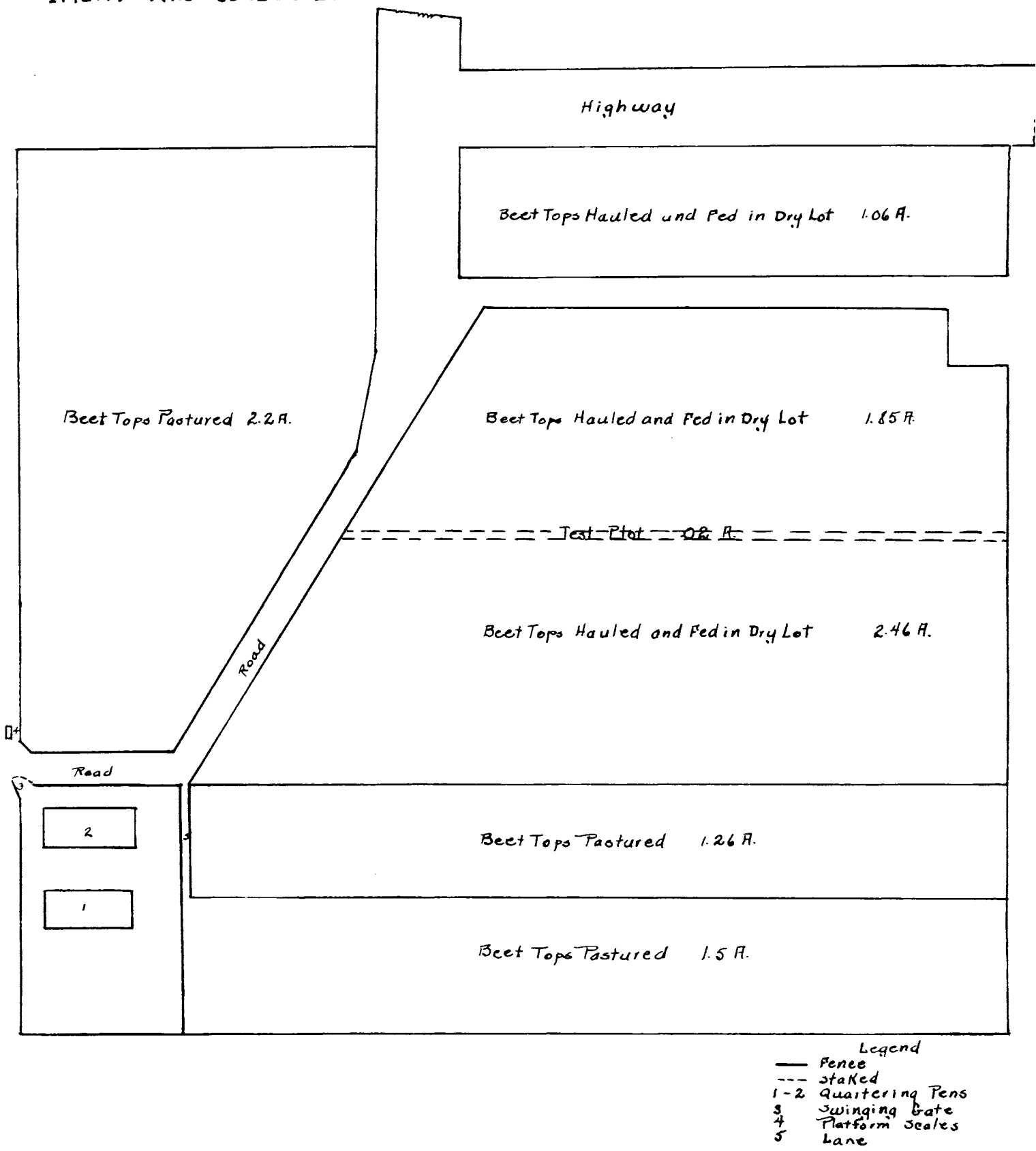
Beets raised on the ranch of L. W. Sweitzer, two miles southeast of Delta, were secured for this work. The total area of 10.36 acres was divided into three fields, separated only by narrow roads. One field contained 7.1 acres, another 2.2 acres, and the third 1.06 acres. The total tonnage of beets produced was 214.8 tons, an average production of 20.73 tons per acre.

A test plot of 1/50 of an acre, which was representative of the beets grown in all three fields, was set aside in the 7.1 acre field. This was used in determining the dry matter content of the beet tops used and all samples for moisture and chemical analyses were taken from this plot.

The 7.1 acre field was divided into four parts besides the test plot. Two of these were fenced and used for pasturing; the other two were staked off and the beet tops produced thereon fed in dry lot. The tops produced on the 1.06 acre field were hauled and fed in dry lot, while the 2.2 acre field was fenced and used for pasturing.

The tops in all fields were put in piles the size of a half bushel basket a few days after harvesting of the beets.

DIAGRAM SHOWING LOCATION OF, AND DIVISIONS MADE IN BEET FIELDS. ON FARM OF L.W. SWEITZER AT DELTA, COLORADO WHERE FEEDING EXPERIMENT WAS CONDUCTED.



Type of Lambs Used

Methods Used

Lambs used. The lambs used came from the Vernal section of Utah. They were good type feeding lambs showing a predominance of Rambouillet breeding. All were wethers, vigorous, thrifty, in good feeder condition, and fairly uniform in weight, both extremes in weight having been eliminated.

The lambs were received October 28th, and held till November 23rd, when the experiment began, the beet tops not being available sooner. Ordinarily the beets are harvested and the beet tops available by November 1st. The average weight of the lambs on October 28th was 58.7 pounds; on November 23rd, it was 61.1. The time between the arrival

of the lambs until they were put on test was ample for them to recover from any setback due to being shipped in, and from sore mouths due to lip and mouth ulceration from which they were suffering immediately following their arrival. This period also allowed them time to get accustomed to their new surroundings.

The allotting of the lambs into uniform groups for the test, consisted of sorting them into three groups based on weight and giving to each lot the same number of each of the three. It was possible to make a fair allotment of the lambs in this manner since they were uniform in other respects.

Rations fed. The lambs were then started on the experiment and fed the following rations:

Lot 1 Shelled corn and alfalfa hay (check ration)

Lot 2 Beet tops hauled and fed in dry lot and alfalfa hay

Lot 3 Beet tops pastured in field and alfalfa hay

Lot 4 Beet tops pastured in field and alfalfa hay 50 days; corn and alfalfa to finish

Lot 5 Shelled corn, beet tops hauled and fed in dry lot, and alfalfa hay

Lot 6 Shelled corn, beet tops pastured, and alfalfa hay

Lot 7 Wet beet pulp, beet tops hauled and fed in dry lot, and alfalfa hay

Feeds used. All three cuttings of alfalfa were used. Second cutting alfalfa was fed at the beginning of the experiment, followed by the feeding of first cutting,

and then finishing on third. This practice resulted in the most palatable hay being fed last when the appetites of the lambs might be somewhat lessened. The hay was grown near Delta and was of first quality, being pea green in color, fine stemmed, leafy, and having been put in the stack without becoming dampened. An analysis was made on each cutting of alfalfa to determine, if possible, the differences in the content of plant food contained. The cost of alfalfa was $6.00 per ton.

The corn was also raised in the immediate vicinity. It was mixed in color, often chaffy, and had a large percentage of moldy, spoiled kernels. Very few of the sacks of corn, which were fed, would have graded higher than No. 5. A moisture analysis was made on this corn every ten days, and a complete analysis made on a composite sample taken throughout the test. The cost of shelled corn was $1.75 per 100 pounds.

Wet beet pulp came from the Holly Sugar Factory at Delta. Fresh pulp was used during the first part of the test, but as soon as the siloed pulp was available it was fed. Moisture analyses were made on this pulp every ten days and a complete analysis at the end of the test. The cost of wet beet pulp including transportation to the feed yards was $1.90 per 100 pounds.

The cost of beet tops was 50 cents per ton of beets produced.

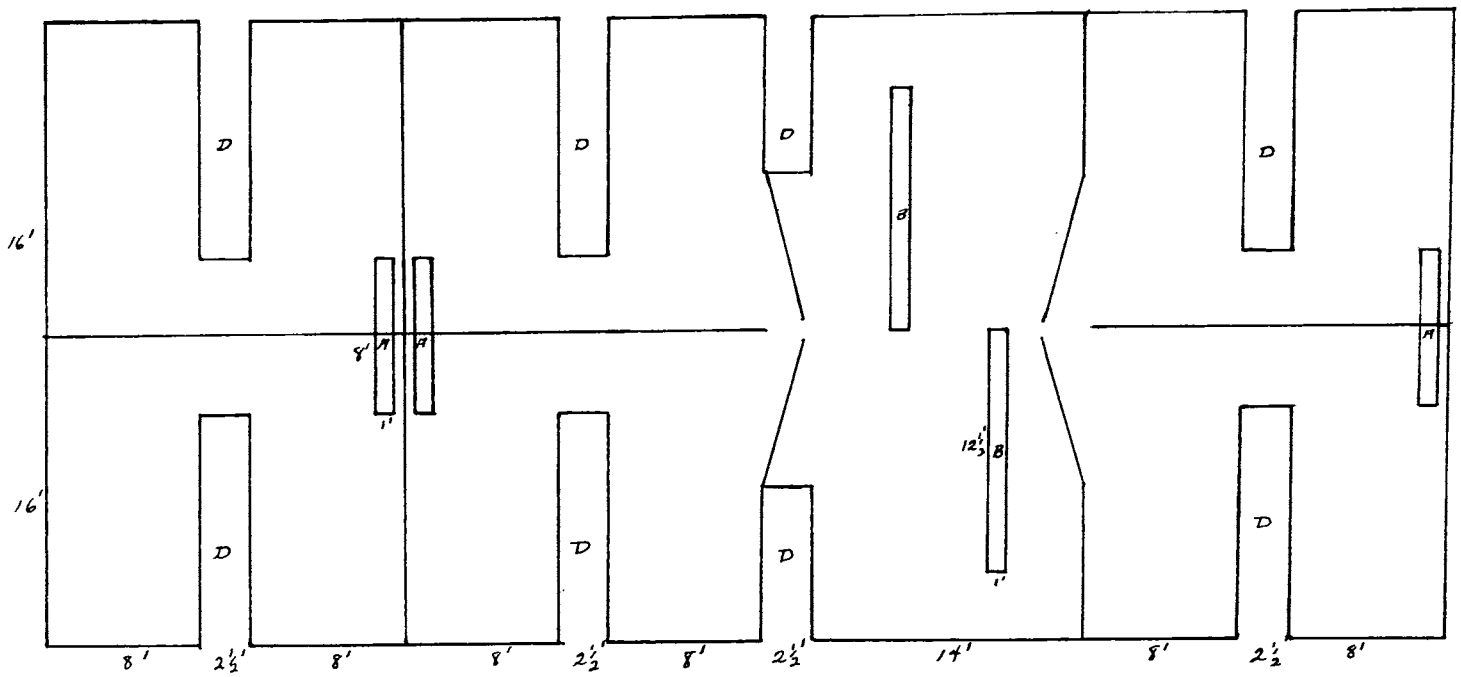
Feeding Equipment

Feeding equipment. Neither shelter or windbreak protection was given to any of the lots of lambs. The feeding pens were constructed of panels, and were built in two units. The space allowed per lamb was 5.5 square feet. Each pen was provided with hay panels arranged in the customary manner used in panel feeding of alfalfa.

Each unit of pens was provided with a common feed pen which contained two reversible grain troughs, each 12½ feet long. All lots receiving grain were located so that they could be turned directly from their pen into this central pen for grain feeding. This is the customary method used in commercial feed lots.

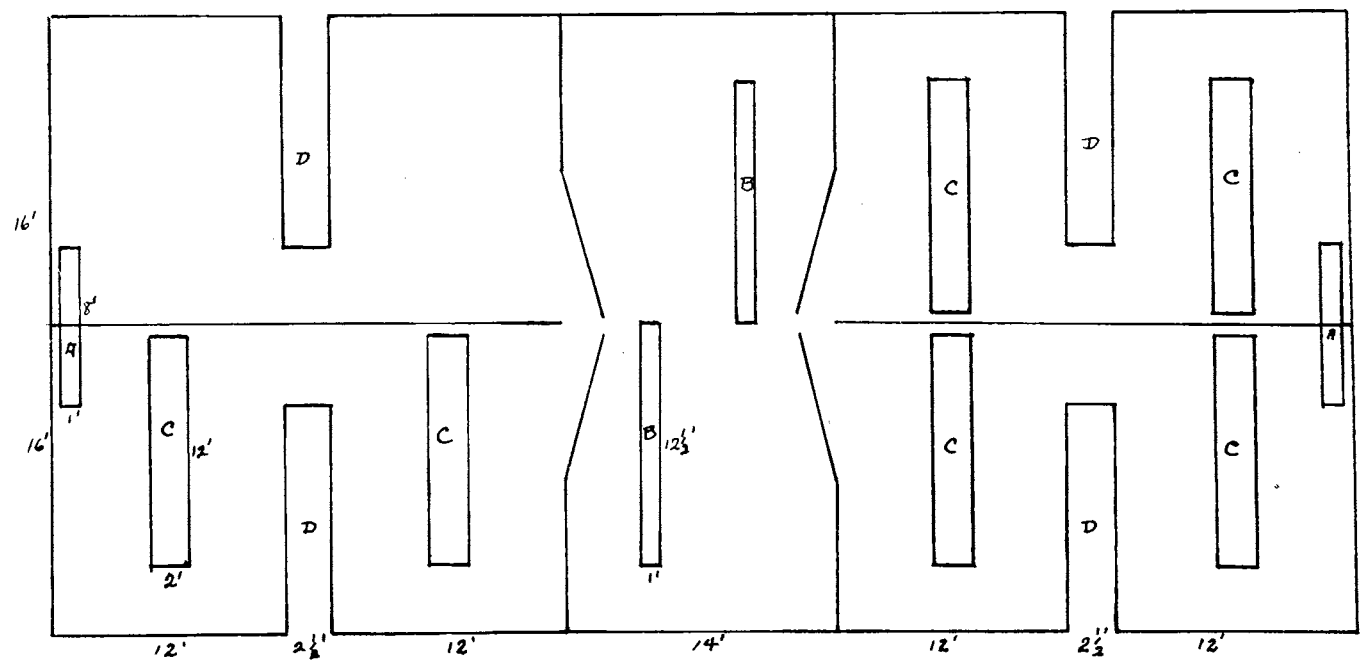
Wet beet pulp was fed in two troughs located in the

Plan of Experimental Feed Yards Indicating Type of Feeding Equipment Used



LEGEND

A Watering Trough
B Grain Trough
C Pulp Trough
D Hay Chute



pen, one on each side of the hay chute.

One 8 foot watering trough provided drinking space for lambs in two lots. A salt box was located in a corner of each pen.

Weights of animals in experiment. Group weighings on each lot were made on three consecutive days at the beginning and at the end of the experiment. The average was taken as the initial and final weights, respectively. Ten day group weighings were made throughout the test.

Death loss. The experiment being concerned with feed comparisons only, there was no death loss problem involved. In the event of a death loss in any lot, both the weight of the dead lamb and the feed it had consumed was deducted and the results based on 49 rather than 50 head of lambs.

General management. Grain was fed beginning at 7 a. m. followed by the feeding of wet beet pulp, alfalfa hay, and hauled beet tops in the order named. Following this, about 9:30, the lots receiving pastured beet tops were turned into their respective fields. These were brought in at noon and allowed to remain in for an hour before turning back. At 4 p. m. the pastured lots were brought in and beginning at 4:30 grain was fed, followed by the feeding of the other feeds in the order of the morning. Beet tops hauled and fed in dry lot were fed through the hay panels, spread out on the alfalfa. All feeds were fed

in quantities that the lambs would readily consume.

Access to crushed rock salt was allowed at all times, and care was taken to always have clean, fresh water in the troughs.

The pens were kept well bedded with barley straw and as they became filled with manure the panels were raised.

RESULTS OF THE EXPERIMENT

Weather Conditions During the Experiment

Weather conditions were exceptionally mild throughout the experiment except for a few days. The coldest days were December 24th, 25th, and 28th, when the temperature dropped to 5 degrees below zero.

During November there was no precipitation, and only four stormy days during December; light rains on the 6th and 12th and a light snow fall on both the 19th and 22nd.

There were three stormy days during January. It rained on the 11th and there was a light snow fall on the 22nd and 27th.

There was more precipitation during February. The first snow, on the 7th, was light but was followed by another snow storm which lasted from the 13th to the 17th. However, this snow was light, melting almost as quickly as it fell and it was gone the day after the storm. On the 18th, there was snow and rain and again during the night of the 27th, and the morning of the 28th.

There were only two rainy days during March, the

9th and 10th.

The inclement weather had but little effect on the lambs. Following the heavy snow storm in February, it was necessary to reduce the grain ration fed for two days. The consumption of pastured beet tops was noticeably less during the storms. Bad weather favored pen feeding rather than field feeding; more tops were consumed and less wasted in the pens during the storms.

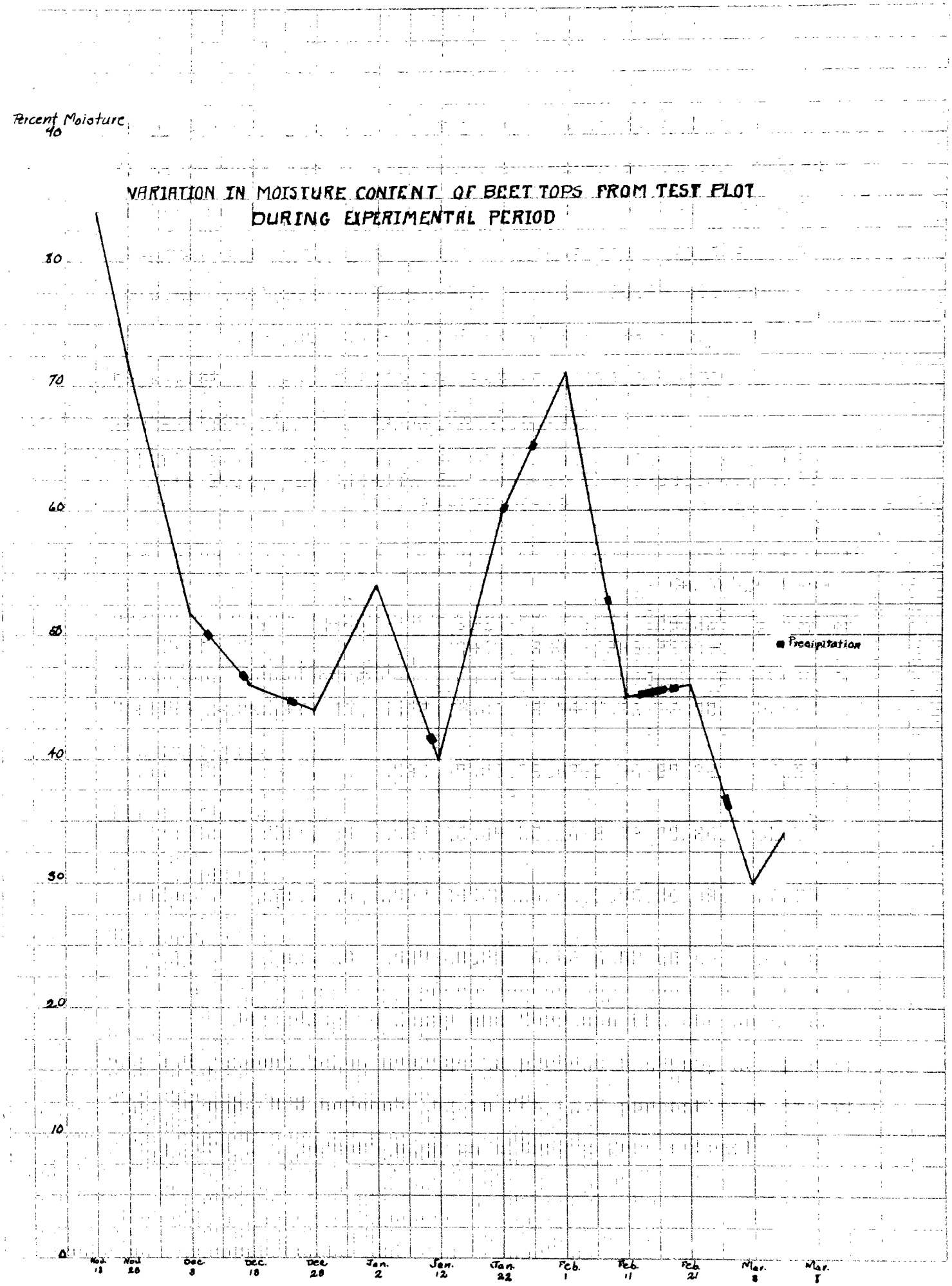
Composition of Beet Tops Used in the Feeding Test

Table No. 2--The Chemical Composition of Beet Tops (11)
(Dry Matter Basis)

Time of analysis	Protein	Ash	Fat	Carbohydrates: Crude Fibre	Carbohydrates: Nitrogen Free Extract
Dec. 7, 1926	12.43	18.29	.63	7.55	61.10
Mar. 19, 1927	7.78	20.59	.75	10.82	60.05

From December 7th to March 19th, the beet tops from the test plot lost 37.41 percent of the protein they contained at the earlier date. A comparison of the figures in table 2 indicates the loss of protein is greater than any other ingredient. These figures indicate the added value available through early utilization of the tops.

An analysis made on the tops November 18th, (12) showed 84.06 percent moisture. Five days later the moisture content was 72.23 percent, and 30 days after that it had


Percent Moisture
VARIATION IN MOISTURE CONTENT OF BEET TOPS FROM TEST PLOT
DURING EXPERIMENTAL PERIOD
80
70
60
50
40
30
20
10
0
Precipitation
Nov. 13
Nov. 28
Dec. 8
Dec. 18
Dec. 28
Jan. 2
Jan. 12
Jan. 22
Feb. 1
Feb. 11
Feb. 21
Mar. 3
Mar. 7

dropped to 44 percent. Forty days later it had risen to 71.22 percent due to the rains and snows which had fallen in the meantime. From this time on the moisture content fluctuated according to weather conditions with the last moisture analysis on March 8th, showing 34.78 percent.

The dry matter content of the beet tops fed in this test was 220 pounds per ton of beets produced.

Composition of Other Feeds Used in Test

Table 3--The Chemical Composition of Shelled Corn, Wet Beet Pulp, and Alfalfa Hay Used in the Experiment (11) (Dry Matter Basis)

Feed	Time of Analyses	Protein	Ash	Fat	Carbohydrates: Crude Fibre	Carbohydrates: Nitrogen Free Extract
Shelled corn	Mar. 19, 1927	9.51	2.94	3.01	3.92	80.62
2nd cutting alfalfa	Dec. 2, 1926	17.55	10.47	1.94	37.74	32.27
1st cutting alfalfa	Mar. 19, 1927	15.49	15.14	2.39	33.84	33.13
3rd cutting alfalfa	Mar. 19, 1927	14.02	15.81	1.92	34.89	33.35
Wet beet pulp	Mar. 19, 1927	12.32	6.48	4.82	43.44	32.94

According to Henry and Morrison (5) the corn used was 1.8 percent below average in protein content, 1.2 percent high in ash, 2.5 percent low in fat, 1.7 percent high in crude fibre, and 1.4 percent high in nitrogen free extract.

The average of the alfalfa used in the experiment shows the same percentage of protein as Henry and Morrison's average but 3.9 percent more ash, .2 percent more fat, 2.4 percent more crude fibre, and 6.5 percent less nitrogen free extract.

The wet beet pulp was 2.7 percent low in protein, 3.5 percent high in ash, .8 percent high in fat, 12.4 percent high in crude fibre but 14.1 percent low in nitrogen free extract, according to the same authorities.

DISCUSSION OF RESULTS

Beet Tops Pastured in the Field vs. Beet Tops Fed in Dry Lot

Table 4--Pastured vs. "Hauled" Beet Tops with Alfalfa Hay Only (Based on Market Weight of Lambs)

Ration Fed	Shelled corn : Alfalfa (check ration)	Beet tops pastured: Alfalfa	Beet tops hauled & fed in dry lots: Alfalfa
Av. gain per lamb(110 days)	26.7 lbs.	19.5 lbs.	15.7 lbs.
Feed required per 100# gain			
Shelled corn	370.0 lbs.		
Beet tops from:		beets: 5.41 tons of	beets 5.1 tons of
Alfalfa	879.3 lbs.	750.9 lbs.	992.5 lbs.
Feed cost per 100 lbs. gain	$9.11	$4.96	$5.53
Total cost of lamb at market	$11.35	$9.93	$9.76
Total return per lamb	$12.26	$11.37	$10.78
Profit per lamb	$0.91	$1.44	$1.02
Percentage of fat lambs produced	41	34	10

Pasturing the tops in the field with alfalfa hay fed in dry lot as compared with hauling and feeding tops in dry lot with alfalfa hay. When the tops were pastured instead of hauled and fed in dry lot, the average gain per lamb was 3.8 pounds greater. This method also proved much more efficient in producing finish, there being 24 percent more

fat lambs produced. Field feeding of beet tops has generally proved more efficient than dry lot feeding of beet tops when good weather conditions have prevailed. Weather conditions were very favorable during this test. Further tests conducted during inclement weather may give contrary results.

In feeding beet tops through panels it was found that the lambs would consume only a certain amount before starting to pull the tops through the panels, trampling them under foot and wasting them. Many feeders have found that feeding beet tops through panels in dry lot was unsatisfactory, but in the majority of these instances, it was due to the lambs being fed a greater quantity of beet tops than they could readily consume. It is an economical practice to regulate the amount of beet tops fed to just what the lambs will consume.

In feed required per 100 pounds gain, tops from 5.41 tons of beets when pastured replaced 370 pounds of corn and 128.4 pounds of alfalfa in the check ration of shelled corn and alfalfa. Tops from one ton of beets pastured replaced 68.4 pounds of corn and 23.7 pounds of alfalfa and had a replacement value of $1.27.

In feed required per 100 pounds gain, tops from 5.1 tons of beets hauled and fed in dry lot replaced 370 pounds of corn less 113.2 pounds of alfalfa in the check ration of shelled corn and alfalfa. Tops from one ton of beets hauled and fed in dry lot replaced 72.5 pounds of corn

less 22.2 pounds of alfalfa and had a replacement value of $1.13.

On a ration of beet tops and alfalfa an acre of beet tops, when pastured, was worth $26.29 and only $23.39 when hauled and fed in dry lot.

The lambs consumed more of the crown when the beet tops were pastured than when they were hauled and fed in dry lot, which apparently accounts for the increased value of beet tops when fed in this manner.

Tables 5 and 6 give the replacement values of beet tops pastured and beet tops hauled and fed in dry lot in the ration of beet tops and alfalfa with corn and alfalfa at various prices.

Table 5--The Replacement Value of Tops from One Ton of Beets, When Pastured, in the Ration of Beet Tops and Alfalfa

Corn at	$1.25 cwt.	$1.50 cwt.	$1.75 cwt.	$2.00 cwt.	$2.25 cwt.
Alfalfa at:					
$4 ton	.91	1.08	1.25	1.42	1.59
$6 ton	.93	1.10	1.27	1.44	1.61
$8 ton	.95	1.12	1.29	1.46	1.63
$10 ton	.98	1.15	1.32	1.49	1.66
$12 ton	1.00	1.17	1.34	1.51	1.68
$14 ton	1.03	1.20	1.37	1.54	1.71

Table 6--The Replacement Value of Tops from One Ton of Beets, When Hauled and Fed in Dry Lot, in the Ration of Beet Tops and Alfalfa

Corn at	$1.25 cwt.	$1.50 cwt.	$1.75 cwt.	$2.00 cwt.	$2.25 cwt.
Alfalfa at:					
$4 ton	.87	1.05	1.23	1.41	1.59
$6 ton	.84	1.02	1.20	1.38	1.56
$8 ton	.82	1.00	1.18	1.36	1.54
$10 ton	.80	.98	1.16	1.34	1.52
$12 ton	.78	.96	1.14	1.32	1.50
$14 ton	.75	.93	1.11	1.29	1.47

With the price of corn a constant factor the replacement value of beet tops when pastured increases as the price of alfalfa is advanced; while the replacement value of beet tops when hauled and fed in dry lot decreases as the price of alfalfa is advanced. This is due to the fact that the replacement value of tops pastured was 68.4 pounds of corn plus 23.7 pounds of alfalfa; while the replacement value of tops hauled and fed in dry lot was 72.5 pounds of corn less 22.2 pounds of alfalfa.

Pasturing the tops in the field with shelled corn and alfalfa hay fed in dry lot as compared with hauling and feeding tops in dry lot with shelled corn and alfalfa hay.

Table 7-- Pastured vs. "Hauled" Beet Tops with Shelled Corn and Alfalfa Hay
(Based on Market Weight of Lambs)

Ration Fed	Shelled corn : Alfalfa hay (check lot)	Shelled corn : Beet tops pastured : Alfalfa hay	Shelled corn : Beet tops hauled & fed in dry lots : Alfalfa hay
Av. gain per lamb(110 days)	26.7 lbs	29.6 lbs.	27.4 lbs.
Feed required per 100# gain			
Corn	370.0 lbs	298.5 lbs.	315.4 lbs.
Beet tops from		2.78 tons of beets	2.34 tons of beets
Alfalfa	879.3 lbs	410.4 lbs.	526.2 lbs.
Feed cost per 100 lbs. gain	$9.11	$7.84	$8.27
Total cost of lamb	$11.35	$11.33	$11.30
Total return per lamb	$12.26	$12.71	$12.43
Profit per lamb	$0.91	$1.38	$1.13
Percentage of fat lambs produced	41	86	64

Pasturing tops also proved more efficient than hauling and feeding in dry lot when corn was fed. The average gain per lamb was 2.2 pounds greater, and there were 22 percent more fat lambs in the pastured lot.

In feed required per 100 pounds gain, tops from 2.78 tons of beets, when pastured, replaced 71.5 pounds of corn and 468.9 pounds of alfalfa in the check ration. Tops from one ton of beets, pastured, replaced 25.7 pounds of corn and 168.7 pounds of alfalfa and had a replacement value of $.96.

Tops from 2.34 tons of beets, when hauled and fed in dry lot, replaced 54.6 pounds of corn and 353.1 pounds of alfalfa in the check ration, in feed per 100 pounds gain. Tops from one ton of beets, hauled and fed in dry lot, replaced 23.3 pounds of corn and 150.9 pounds of alfalfa and had a replacement value of $.86.

On a ration of shelled corn, beet tops and alfalfa, an acre of beet tops, when pastured, was worth $19.87 as compared to $17.80 when hauled and fed in dry lot.

Tables 8 and 9 show the replacement value of beet tops when pastured and when hauled and fed in dry lot in a ration of shelled corn, beet tops and alfalfa.

Table 8--The Replacement Value of Tops from One Ton of Beets, When Pastured, in the Ration of Shelled Corn, Beet Tops and Alfalfa Hay

Corn at	$1.25 cwt.	$1.50 cwt.	$1.75 cwt.	$2.00 cwt.	$2.25 cwt.
Alfalfa at:					
$ 4 ton	.66	.73	.79	.85	.92
$ 6 ton	.83	.90	.96	1.02	1.09
$ 8 ton	.99	1.06	1.12	1.18	1.25
$10 ton	1.16	1.23	1.29	1.35	1.42
$12 ton	1.33	1.40	1.46	1.52	1.59
$14 ton	1.50	1.57	1.63	1.69	1.76

Table 9--The Replacement Value of Tops from One Ton of Beets When Hauled and Fed in Dry Lot, in the Ration of Shelled Corn, Beet Tops, and Alfalfa Hay

Corn at	$1.25 cwt.	$1.50 cwt.	$1.75 cwt.	$2.00 cwt.	$2.25 cwt.
Alfalfa at:					
$ 4 ton	.59	.65	.71	.77	.82
$ 6 ton	.74	.80	.86	.92	.97
$ 8 ton	.89	.95	1.01	1.07	1.12
$10 ton	1.04	1.10	1.16	1.22	1.27
$12 ton	1.20	1.26	1.32	1.38	1.43
$14 ton	1.35	1.41	1.47	1.53	1.58

The Addition of a Carbohydrate Concentrate

The feeding of beet tops pastured and alfalfa hay with the addition of a supplementary grain feed to balance the ration.

Table 10--The Value of Adding Shelled Corn to a Ration of Beet Tops Pastured and Alfalfa Hay (Based on Market Weight of Lambs)

Ration Fed	Shelled corn : Alfalfa hay (check lot)	Beet tops pastured : Alfalfa hay	Shelled corn Beet tops pastured : Alfalfa hay
Av. gain per lamb(110 days)	26.7 lbs	19.5 lbs.	29.6 lbs.
Feed required per 100# gain			
Shelled corn	370.0 lbs		298.5 lbs. (beets
Beet tops from		5.41 tons of beets	2.78 tons of
Alfalfa hay	879.3lbs	750.9 lbs.	410.4 lbs.
Feed cost of 100# gain	$9.11	$4.96	$7.84
Total cost per Lamb	$11.35	$9.93	$11.33
Total return per lamb	$12.26	$11.37	$12.71
Profit per lamb	$0.91	$1.44	$1.38
Percentage of fat lambs produced	41	34	86

An additional gain of 10.1 pounds per lamb was obtained when corn was added to the ration of beet tops pastured and alfalfa hay, and there was an increase of 52 percent in the number of fat lambs produced.

Lambs on Ration of Shelled Corn, Beet Tops, and Alfalfa--Eating Hay in Dry Lot

The Same Lambs Out on Beet Top Pasture

Tops from 2.63 tons of beets in the ration of beet tops pastured and alfalfa hay replaced 298.5 pounds of shelled corn less 340.5 pounds of alfalfa hay in the ration of shelled corn, beet tops pastured and alfalfa hay, in feed required per 100 pounds gain. Tops from one ton of beets replaced 113.5 pounds of corn less 129.5 pounds of alfalfa and had a replacement value of $1.60.

While the addition of shelled corn did not prove economical in this comparison, it would be economical with certain other feed prices. Table 11 shows at what prices of the other feeds, shelled corn can be profitably added to the ration of beet tops pastured and alfalfa hay.

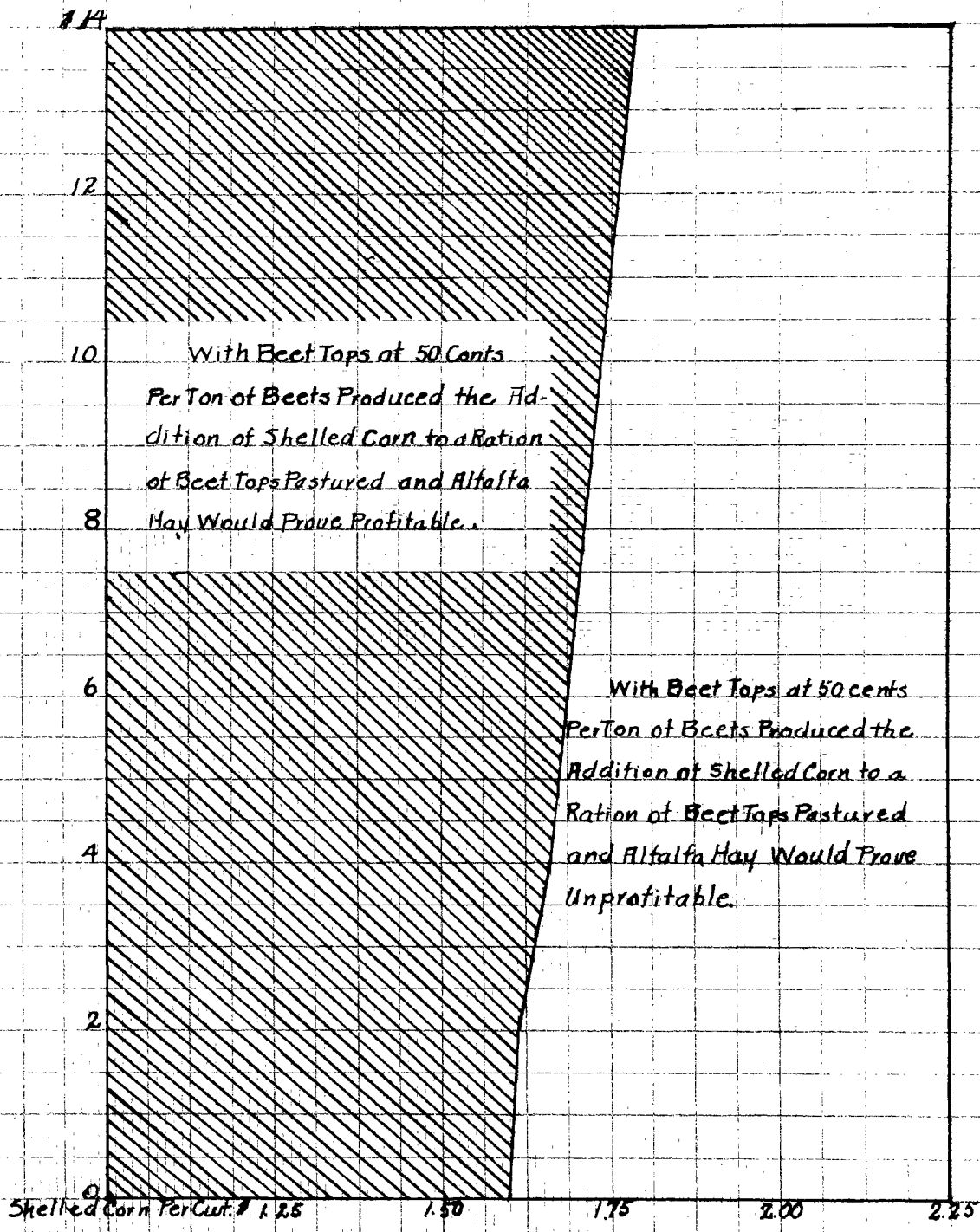
With shelled corn as high as $1.60 per cwt., and alfalfa as low as $2.00 per ton, it would have been an economical practice to have added shelled corn to the ration of beet tops pastured and alfalfa hay. This is because of the following reasons:

First: While the addition of shelled corn to a ration of beet tops pastured and alfalfa did raise the feed cost of 100 pounds gain, it resulted in the average gain per lamb being increased 51.8 percent. The profit per pound of gain is less when shelled corn is added, but because of the greater gains made the profit per lamb is greater at the above feed prices.

Second: The cost of alfalfa per 100 pounds gain is small.

Table No.11

The Value of Adding Shelled Corn to a Ration of Beet Tops Pastured and Alfalfa Hay (Based on Market Weight of Lambs)



The additional 340.5 pounds of alfalfa required by the lambs on the ration of pastured beet tops and alfalfa, compared to the feed requirement per 100 pounds gain of the lambs on the ration of shelled corn, pastured beet tops and alfalfa hay, represents a value of $2.40, with alfalfa at $14.00 per ton or a feed cost per lamb of only 47 cents.

As the price of alfalfa advances, with the prices of beet tops and shelled corn constant, the greater the relative cost per 100 pounds gain in the ration of beet tops pastured and alfalfa due to the greater requirement of alfalfa hay, and the higher the price of shelled corn may be in the ration of shelled corn, beet tops pastured and alfalfa.

The value of substituting corn for pastured beet tops in a ration of pastured beet tops and alfalfa hay after 50 days on feed.

Table 12--Substituting Corn for Pastured Tops in a Ration of Beet Tops Pastured and Alfalfa Hay After 50 Days on Feed

(Based on Market Weight of Lambs)

Ration Fed	Shelled corn : Alfalfa hay (check lot)	Beet tops pastured : Alfalfa hay	Shelled corn : Beet tops pastured Alfalfa hay
Av. gain per lamb(110 days)	26.7 lbs.	19.5 lbs.	21.5 lbs.
Feed required per 100# gain			
Shelled corn	370.0 lbs.		223.1 lbs.
Beet tops from:		beets 5.41 tons of	(beets 2.49 tons of
Alfalfa hay	879.3 lbs.	750.9 lbs.	874.5 lbs.
Feed cost of 100 lbs. gain	$9.11	$4.96	$7.77
Total cost per lamb	$11.35	$9.93	$10.59
Total return per lamb	$12.26	$11.37	$11.57
Profit per lamb	.91	$1.44	$0.98
Percentage of fat lambs produced	41	34	45

Substituting corn for pastured tops after 50 days on feed increased the gain per lamb over the whole period 2 pounds only, but increased the number of fat lambs produced, 11 percent.

There was not enough difference in gains produced to justify this change in the ration, the profit per lamb being 46 cents more on the straight ration of pastured tops and alfalfa.

In feed required per 100 pounds of gain, tops from 5.41 tons of beets in the ration of tops pastured and alfalfa hay, replaced 370 pounds of corn and 128.4 pounds of alfalfa in the check ration of corn and alfalfa hay. Tops from one ton of beets replaced 68.4 pounds of corn and 23.7 pounds of alfalfa and had a replacement value of $1.27.

When corn was substituted for pastured beet tops after 50 days, in the ration of beet tops pastured and alfalfa hay, tops from 2.49 tons of beets replaced 146.9 pounds of corn and only 3.8 pounds of alfalfa in the check ration of corn and alfalfa hay in the feed required per 100 pounds gain. Tops from one ton of beets replaced 59 pounds of corn and 1.5 pounds of alfalfa and had a replacement value of $1.03.

Tops from a ton of beets replaced 9.4 pounds less corn and 22.2 pounds less alfalfa when shelled corn was substituted for pastured tops after 50 days on feed, than when corn was omitted from the ration.

The feeding of tops hauled and fed in dry lot and alfalfa hay with the addition of a supplementary grain feed to balance the ration.

Table 13--The Value of Adding Shelled Corn to a Ration of Beet Tops Hauled and Fed in Dry Lot and Alfalfa Hay

(Based on Market Weight of Lambs)

RATION FED	Shelled corn : Alfalfa hay (check lot)	Beet tops hauled & fed in dry lot : Alfalfa hay	Shelled corn : Beet tops hauled & fed in dry lot : Alfalfa hay
Av. gain per lamb(110 days)	26.7 lbs.	15.7 lbs.	27.4 lbs.
Feed required per 100# gain			
Shelled corn	370.0 lbs.		315.4
Beet tops from		5.1 tons of	(beets 2.34 tons of
Alfalfa hay	879.3 lbs.	992.5 lbs.	526.2 lbs.
Feed cost of 100 lbs. gain	$9.11	$5.53	$8.27
Total cost per lamb	$11.35	$9.76	$11.30
Total return per lamb	$12.26	$10.78	$12.43
Profit per lamb	$0.91	$1.02	$1.13
Percentage of fat lambs produced	41	10	64

The addition of corn to a ration of beet tops hauled and fed in dry lot and alfalfa hay increased the gain per lamb for the period 11.7 pounds or 74.5 percent. It changed the ration to a fattening rather than a growing one. While the

cost of gains were increased 66.9 percent when corn was added to the ration, the actual profit per lamb was 11 cents greater due to the increased amount of gain produced. This margin of profit would still have been larger had finished lambs sold at a higher price than feeder lambs at the time of marketing.

In feed required per 100 pounds gain, tops from one ton of beets, in the ration of beet tops hauled and fed in dry lot and alfalfa hay, replaced 112.6 pounds of corn less 166.5 pounds of alfalfa in the ration of shelled corn, beet tops hauled and fed in dry lot and alfalfa hay and had a replacement value of $1.47.

Holden (13) found that the addition of corn to a ration of beet tops hauled and fed in dry lot and alfalfa hay, increased the average gain per lamb 13.6 pounds or 58.3 percent and that tops from one ton of beets replaced 81.6 pounds of corn, less 150.6 pounds of alfalfa hay and had a replacement value of $.98.

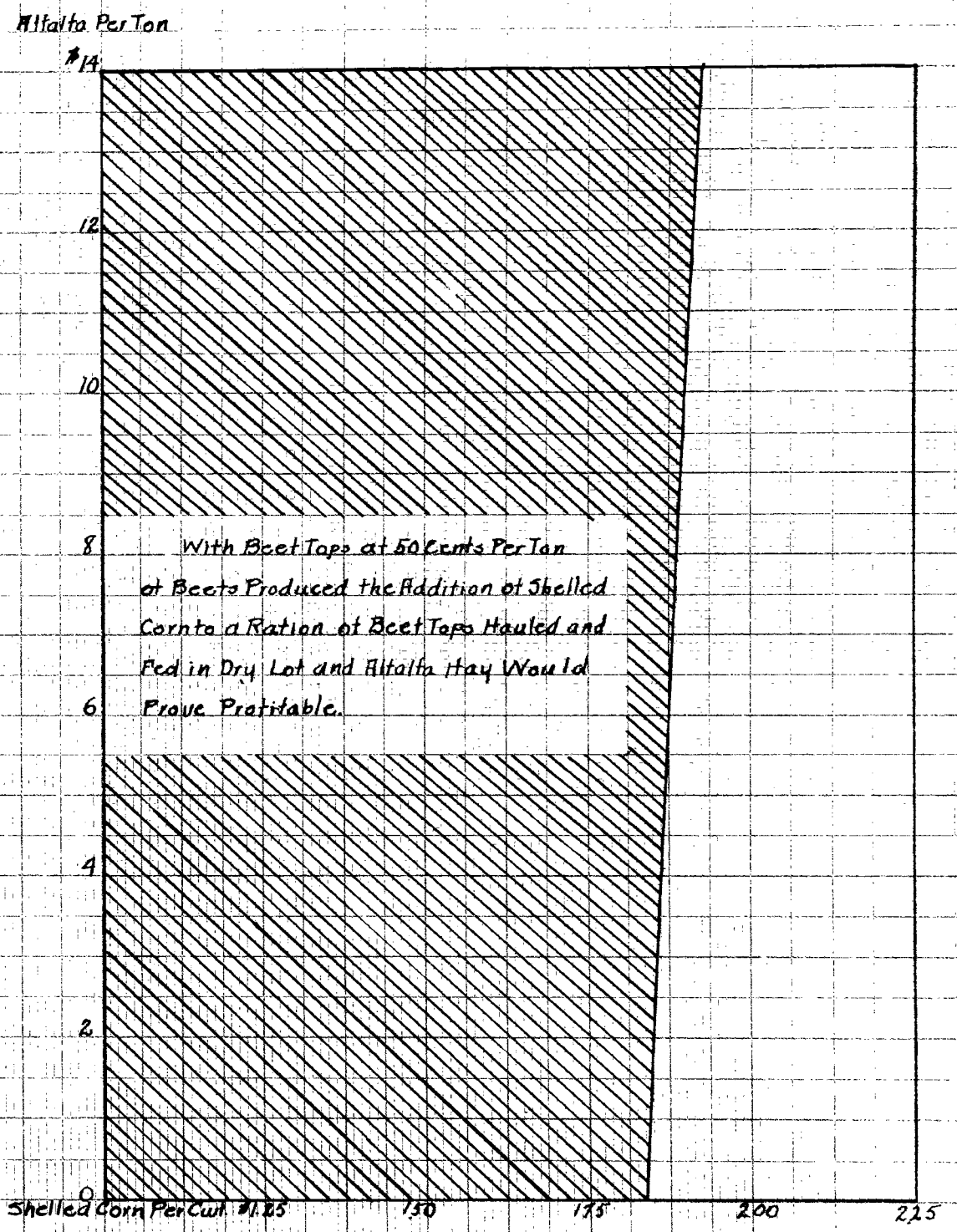
The higher replacement value of beet tops in the experiment probably was due to the manner in which they were fed. When beet tops were pulled through the panels into the pens the greater part was wasted, as the lambs refused to eat soiled feed. Holden's method of feeding beet tops was to throw them directly into the pen and not to feed them through panels, which practice would likely result in many being wasted.

Table 14 shows at what prices of shelled corn and alfalfa hay, it was profitable to add shelled corn to a ration of beet tops hauled and fed in dry lot and alfalfa hay.

Shelled corn at a price up to $1.82 per cwt. could have been profitably added to the ration of beet tops hauled and fed in dry lot and alfalfa hay. This is due to the increased gain per lamb it produced. Because of the greater requirement of alfalfa per 100 pounds of gain with the ration of beet tops hauled and fed in dry lot and alfalfa, compared to the ration of shelled corn, beet tops hauled and fed in dry lot and alfalfa, the feed cost of the first ration becomes relatively greater as the price of alfalfa increases. Shelled corn at a higher cost may be added when the price of alfalfa is increased.

Table No. 14

The Value of Adding Shelled Corn to a Ration of Beet Tops Hauled and Fed in Dry Lot and Alfalfa Hay. (Based on Market Weight of Lambs)



The Value of Adding Wet Beet Pulp

The use of beet tops hauled and fed in dry lot with and without wet beet pulp.

Table 15--The Value of Wet Beet Pulp in a Ration of Beet Tops Hauled and Fed in Dry Lot and Alfalfa

(Based on Market Weight of Lambs)

Ration Fed	Shelled corn : Alfalfa hay (check lot)	Beet tops hauled & fed in dry lot : Alfalfa hay	Wet beet pulp Beet tops hauled & fed in dry lot : Alfalfa hay
Av. gain per lamb(110 days)	26.7 lbs.	15.7 lbs.	19.4 lbs.
Feed required per 100# gain			
Shelled corn	370.0 lbs.		
Beet tops from		5.1 tons of beets	3.12 tons of beets
Wet beet pulp			2004.5 lbs.
Alfalfa hay	879.3 lbs.	992.5 lbs.	772.0 lbs.
Feed cost of 100 lbs. gain	$9.11	$5.53	$5.78
Total cost of lamb	$11.35	$9.76	$10.00
Total return per lamb	$12.26	$10.78	$11.24
Profit per lamb	$0.91	$1.02	$1.24
Percentage of fat lambs produced	41	10	20

The addition of wet beet pulp to a ration of beet tops hauled and fed in dry lot increased the average gain per lamb 3.7 pounds, doubled the number of fat lambs produced,

and increased the profit per lamb 22 cents. The maximum daily feed of wet beet pulp was 4.4 pounds per lamb. This amount of pulp contained but .46 pounds of dry matter. While wet beet pulp proved to be a good feed with beet tops and alfalfa, it proved to be too bulky to provide enough carbohydrates to properly balance the ration.

CONCLUSIONS

1. Beet tops when piled in the field lose protein rapidly. This causes the apparent increase in content of ash, fat, and crude fibre noted in chemical analyses reported on a dry matter basis.

2. The moisture content of beet tops is influenced considerably by weather conditions and a system of measurement for beet tops which is based on weight, alone, has proven unsatisfactory. The most satisfactory method available for measuring and selling tops seems to be "tops per ton of beets produced". Experimental evidence shows the weight of green tops to be practically 3/4 of the tonnage of beets produced.

3. Tops from the average ton of beets in this experiment contained 220 pounds of dry matter.

4. Pasturing proved to be a more economical method of feeding beet tops than hauling and feeding in dry lot under favorable weather conditions, both when the ration consisted of beet tops and alfalfa, alone, and when a carbohydrate concentrate was added.

5. The addition of shelled corn to a ration of beet tops pastured and alfalfa with shelled corn costing more than $1.69 per cwt., and with alfalfa at $6.00 per ton, did not prove to be an economical practice.

6. When beet tops were hauled and fed in dry lot, the addition of shelled corn, costing as high as $1.82 per cwt., with alfalfa at $6.00 per ton, proved to be an econom-

ical practice.

7. The addition of wet beet pulp at $1.90 per ton improved the ration of beet tops hauled and fed in dry lot, in the amount of gain produced, percentage of fat lambs produced, and in the profit per lamb. Wet beet pulp proved to be too bulky to provide enough carbohydrates to properly balance this ration and to secure the maximum gain on the lambs, however. Wet beet pulp was not fed to lambs pastured on tops.

8. Unless the amount of beet tops fed in dry lot through hay panels is regulated to what the lambs will readily consume, excessive wasting may occur.

9. A ration composed of beet tops and alfalfa, alone, proved to be a growth producing rather than a fattening ration. Without the use of a carbohydrate concentrate this ration cannot be successfully used to fatten lambs.

In some instances, however, when alfalfa hay and beet tops are abundant and cheap and when feeder lamb prices equal those paid for fat lambs, this ration may prove most economical.

BIBLIOGRAPHY

1. Colorado Year Book 1926, p. 55.

2. J. W. Jones, U. S. D. A. Bulletin 1095, 1919.

3. L. S. Ware, "The Sugar Beet", pp. 82-83.

4. S. F. Sherwood, U. S. D. A. Cir. 319, 1924, pp. 8, 7.

5. Henry & Morrison, "Feeds and Feeding", pp. 721-742

6. L. Malpeaux, La Vie Agricole 1916, p. 387, reported in U. S. D. A. Cir. 319.

7. V. L. Aikin, Traveling Chemist for Great Western Sugar Company, unpublished data 1919.

8. W. W. Cooke, Colorado Bulletin 32, 1895.

9. J. A. Holden, Supt. Scottsbluff, Neb. Exp. substation, information to author.

10. A. C. Maxon, Director Great Western Sugar Company Exp. Station, Longmont, Colorado, information to author.

11. W. C. Harvey, Dairy Commission Chemist, Colorado Agricultural College, unpublished data.

12. I. M. McDonald, Chief Chemist, Holly Sugar Company, Delta, Colorado, unpublished data.

13. J. A. Holden, Nebraska Bulletin 194, 1923.