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A Research Study of Lamb Feeding in Winter Dry Lots at Monroe, Utah, 1928-29

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A RESEARCH STUDY OF LAMB FEEDING IN WINTER DRY LOTS AT MONROE, UTAH, 1928-29

Thesis

By
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SUMMARY

It seems unjustifiable to draw conclusions from one year's work. However, a brief summary of what this experiment indicated follows:

1. Utah home-grown rations are well adapted to lamb feeding.

2. Third cutting alfalfa appeared to give better results than either first or second cutting alfalfa.

3. Results from this study indicated that first crop alfalfa ranked second to third crop and above second crop.

4. Brown cured alfalfa fed to Lot 6 apparently increased the profit per lamb 51 cents per head.

5. Corn seemed to make a better showing than barley when fed with first crop alfalfa, but when molasses was added barley seemed to excell.

6. Wheat although apparently producing slightly less gains than did barley seemed to produce a better finish. Wheat seems to be fully equal to barley as a feed, pound for pound, but the difference in yield per acre makes barley a more profitable feed to grow for lamb feeding.

7. It seems that molasses can be used in the lamb feeding ration to good advantage when combined with barley.

8. This study indicates that it did not pay to grind barley for lambs.

9. The feeding of kelp did not prove profitable.

10. No appreciable difference in the profit per lamb was noticed in changing from first to second crop alfalfa or the reverse.

SUMMARY OF SUPPLEMENTARY STUDIES

1. This study seemed to indicate that the mean and minimum atmospheric temperature had a direct bearing upon the rate of gains.

2. In this experiment there was a high negative correlation between the temperature and the amount(or cost) of feed eaten.

3. There appeared to be no correlation between amount(or cost) of feed and rate of gains.

4. Handling the lamb incident to weighing seemed to retard the rate of gains.

INTRODUCTION

By reason of the topography of the land, Utah is and probably will remain a livestock grazing state. As far as agriculture is concerned over 90 per cent of the area is suitable for grazing only. This grazing range is used by cattle and sheep.

An interesting phase of the livestock situation in America is the switch from cattle production to sheep production, particularly during the last decade, when cattlemen turned to sheep to quite an extent. Tables 1 and 2 show the change from cattle to sheep.

Table 1.- Showing the number of sheep and beef cattle in Utah, the Eleven Western states and United States, 1920-29 inclusive[1] (Thousands)

Year	Utah		Eleven Western States		U.S.A.	
	Sheep	Beef Cattle	Sheep	Beef Cattle	Sheep	Beef Cattle
1920	2345	484	22147	10504	39025	35,778
1921	2200	453	21300	10114	37452	34,775
1922	2250	450	20773	10340	36186	34,805
1923	2340	470	21018	9861	36212	32,291
1924	2475	456	21218	9527	36876	30,972
1925	2355	420	22123	8900	38112	29,415
1926	2472	394	22882	8266	39730	27,267
1927	2650	383	23558	7928	41881	25,167
1928	2730	368	25364	7542	44854	23,938
1929	2866	365	26722	7250	47171	23,833
AVR.	2458		22710		39720	

[1] Figures, Year Books of U.S.D.A. and 1930 census

While the number of sheep was increasing the number of cattle was decreasing. This condition has been fairly general throughout America, and particularly in the eleven western states which in 1928 had 56 per cent of the sheep of United States.

Table 1 shows that during the last ten years sheep in Utah have increased approximately 27 per cent, that in the last five years the numbers of sheep in the eleven western states have increased approximately 16 per cent,

and that the total number of sheep for the United States has increased about 20 per cent.

At the same time the best available figures indicate there has been a sharp decrease in the number of beef cattle. An analysis of figures of the U.S.D.A. yearbooks and the 1930 census shows that in 1930 there were in Utah 39 per cent more beef cattle than in 1929. The beef cattle of the United States as a whole during this same time decreased approximately 33 per cent in numbers, while in the eleven western states the number of beef cattle decreased approximately 31 per cent.

This increase in sheep is of vital significance to the lamb feeding industry of Utah, and in a measure perhaps explains the causes of the financial losses from feeding lambs during the past winter.

Table 2.- Showing trend in numbers of ewes and lambs Colorado, thirteen western states and United States[1] (Thousands)

	1925	1926	1927	1928	1929	1930
COLORADO						
Ewes January 1	878	920	969	1,002	1,046	1,050
Lambs docked	701	810	824	802	785	
E. lambs held	87	96	152	165	194	
THIRTEEN WESTERN						
Ewes January 1	18,199	18,660	19,451	20,574	22,048	22,750
Lambs docked	14,304	16,349	15,278	17,233	16,645	
E. lambs held	3,943	4,103	5,022	5,270	5,618	
UNITED STATES						
Ewe January 1	25,983	26,570	27,748	29,414	31,343	31,690
Lambs docked	21,958	23,878	24,153	26,825	25,976	
E. lambs held	5,537	5,645	6,691	7,143	7,445	

[1] Figure by F.W. Beier Jr. Livestock Statistician, Bureau of Agricultural Economics, Denver, Colorado.

Table 2 bears out Table 1 in indicating the tendency to increase in sheep numbers during the last decade.

Approximately two-thirds of the income from sheep is derived from the lamb crop[1], which is marketed either as stockers, feeders, or fat lambs, which sell for considerably more per hundred weight than do wethers or other sheep. As a rule when the sheep leave the high mountain ranges for the winter the majority of the lambs are not ready for the block, therefore it is advisable to place them on feed for a time, to improve the quality of the lean meat as well as to increase the weight so as to bring a larger price.

Inasmuch as there is an abundance of comparitively cheap and at the same time highly nutritious feeds admirably suited to lamb feeding many farmers have found it profitable to feed western lambs which because of their health and freedom from parasites are highly prized, and meet a strong demand from feeders generally, especially feeders of the corn belt section.

Table 3 shows that there has been a substantial and general increase in numbers of lambs fed during the last eight years.

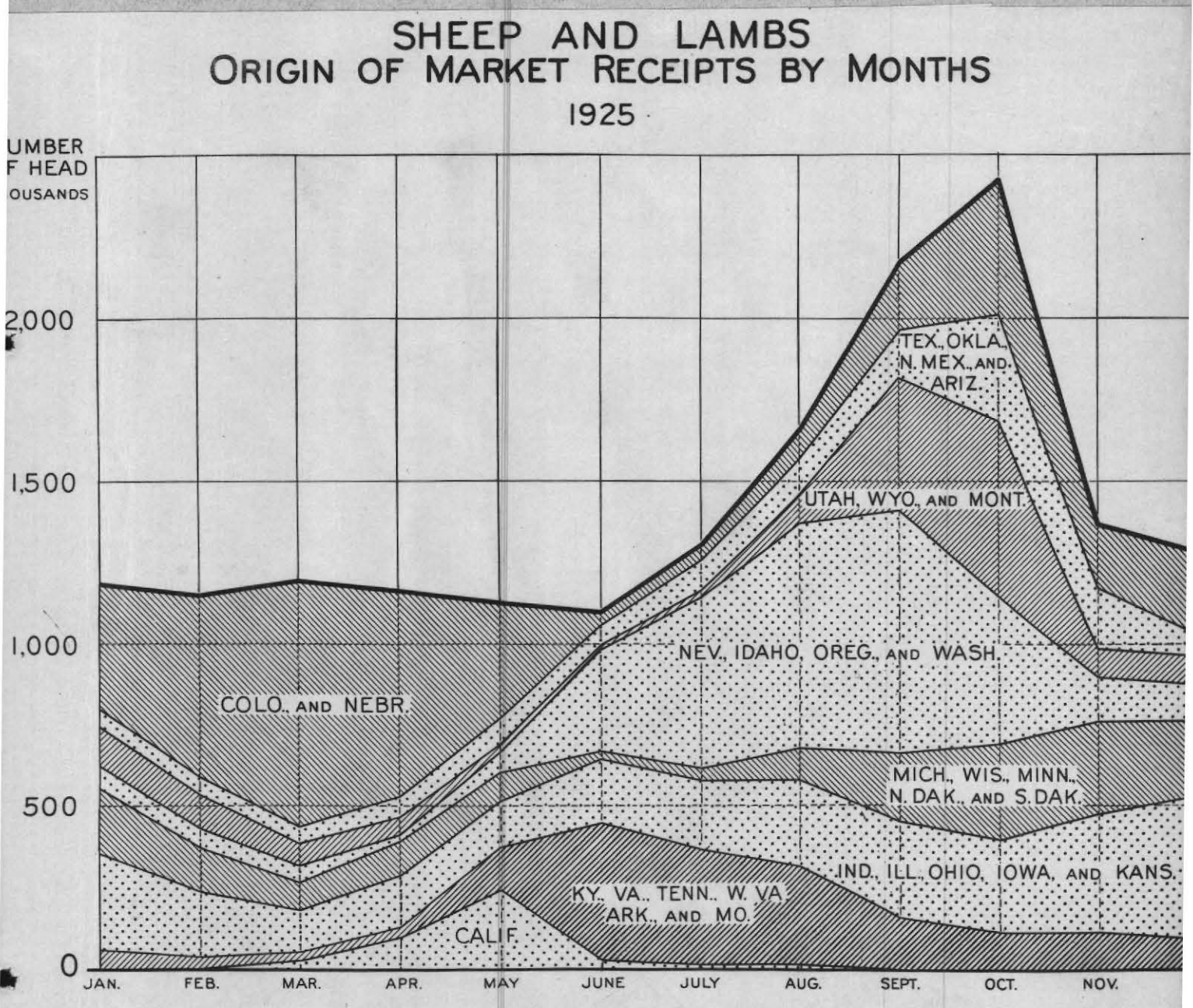
Table No.3.- Sheep and lambs on feed, January 1st
Colorado -- 12 western states -- United States
(thousands)

Year	Colorado	Twelve Western States	United States
1923	1500	2177	4266
1924	1400	2061	4239
1925	1600	2051	4007
1926	1475	2332	4616
1927	770	1585	4259
1928	1580	2277	4463
1929	1520	2233	4792
1930	1990	2793	5490

Figures by F.W. Beier Jr. Livestock Statistician. Bureau of Agricultural Economics, Denver, Colorado.

[1] Special Report of the Sheep Industry, 1921

There has been a tendency toward an increase in the price of lambs during the winter season. This increase in a measure justifies feeding provided the lambs are marketed before becoming too heavy. Lambs are rarely carried over to the second year. The following chart showing the origin of market receipts of sheep and lambs by months for 1925 indicates that a very large part of the Utah sheep and lambs go to market during the peak period of marketing.



Holding lambs in the feed lots for from two to four months would tend to place them on the market at a more favorable time.

NEED FOR STUDY

The change in the market demand toward a lighter, better finished product has made it necessary that lambs be fattened at a very early age. It demands the best of skill and knowledge to take a lamb weighing 50 to 60 pounds and get it properly finished by the time it weighs 80 to 90 pounds, at which weight they are most desirable.

The growth in the lamb feeding business has made it of vast importance in certain sections of Utah as well as in sister states where sheep are produced.

The presence in these sections of an abundance of alfalfa and grain as well as sheep indicates a need that research be conducted in order to find out just which of the many local rations are best adapted to lamb feeding.

HISTORY

Lamb feeding experiments have been carried on in the eleven western states for over three decades, and some valuable information has been obtained thereby, but, inasmuch as conditions generally are so variable in regard to feeds, climatic factors and markets, as well as among the lambs themselves, results have not at all times appeared to be conclusive. It is thot best therefore to limit the historical part of this study to the work conducted under conditions somewhat similar to those of Utah.

Experiments, the objects of which have been to encourage lamb feeding and to determine the value of various rations and systems of management have been conducted by western experiment stations since 1895.[1] Therefore it seems logical that this review deal only with lamb feeding investigations in the eleven western states, and principally with those studies for which this experiment was conceived, the comparison of first, second, and third cuttings

1. Much early and valuable work on phases of lamb feeding, differing from the problems in this study and hence not used herein, has been conducted by the Utah Station since 1892.

of alfalfa, the comparative value of the home-grown grains, the value of grinding barley for lambs and the efficiency of molasses in the ration.

Since some of the results of these feeding trials have at times been contradictory in regard to the value of various rations it is highly desirable to obtain if possible additional data upon the subject.

It was with this idea in mind that this trial was planned by Professor K.C. Ikeler, Dean of the School of Agriculture and Professor A.C. Esplin of the U.S.A.C. To Dean Ikeler and Professor Esplin belongs the credit of planning and supervising this work. Recognition for the careful and thorough way in which the feeding, weighing, record keeping and actual care of the lambs was conducted is accorded Mr. Royal Crook, experimental feeder.

That feeds produced in different localities may not have the same efficiency in the lamb ration, or in fact in their chemical composition, has been established. Greaves and Hurst[1] of the Utah station found considerable variation even in the mineral content of grains grown in different sections.

Alfalfa.- There is a belief among many lamb feeders that there is a variation in the value of the various cuttings of alfalfa.

Henry and Morrison[2] list the different cuttings of alfalfa and the digestible nutrients of each as follows:

Table 4.

	D.N.	Crude Protein	Carbo-hydrates	Fat	Total
Alfalfa	91.4	10.6	39.0	.9	51.6
First cutting	91.5	9.3	39.0	.6	49.7
Second cutting	92.7	11.2	40.2	.7	53.0
Third cutting	91.1	10.2	37.1	.8	49.1

[1] U.S.A.C. Exp. Sta. Bul.210, May, 1929

[2] Henry and Morrison. Feeds and Feeding

In 1906 chemists H.G. Knight and F.E. Hipner with Animal Husbandman G.E. Morton, all of the Wyoming station made studies of first and second cuttings of alfalfa hay. They used a fair sample of hay, of good bright color, and well cured. Analyses were made and the following table shows the results.

Table 5.

	Dry Matter	Protein	Carbo-hydrates	Fat	Total	Nutritive Ratio
First cutting	92.77	12.56	38.43	.66	52.52	3.2
Second cutting	93.56	12.01	42.46	.70	56.05	3.7

They found that alfalfa from the same plat of ground varied in composition and concluded that second cutting was apparently a better feed because of the better balance in the nutritive ratio.

That the time of cutting, and condition of curing, may have a great influence upon the feeding value of alfalfa is quite definitely proved for the Colorado Station found as high as 88 per cent of the hay rejected in the feed lot(Bulletin 187 - 1913).

In an endeavor to study the value of the different cuttings of alfalfa in the lamb ration Hoksdorn, Bean and Satola of the Washington station conducted a series of experiments during 1922-1924. The following tables give the tabulated results and findings of the 1922 experiment.

Table 6

	Lot 1 1st Cutting	Lot 2 2d Cutting	Lot 3 3d Cutting
Initial weight	65.62	62.59	65.44
Final weight	80.38	75.46	79.55
Total gain(60 days)	14.76	12.87	14.11
Daily gain	.246	.214	.235
Daily ration fed			
(Grain - shelled corn)	.745	.745	.745
Hay(fed	2.587	2.444	2.685
(refused	.509	.388	.455
(consumed	2.078	2.056	2.230
Feed cost per 100 pounds gain	$ 6.778	$ 7.624	$ 7.199
Appraised value per 100 pounds	12.00	11.80	12.00

(Washington Bulletin No.170)

Conclusions were as follows:

"The first and third cuttings of alfalfa hay produced practically the same results as far as finish is concerned.

If first cutting alfalfa is worth $5 per ton with corn @ $27.50 per ton, then third cutting hay on the basis of hay fed was worth $4.36 and second cutting $3.17 per ton. Second cutting is 63 per cent, and third cutting 85 per cent as valuable as first cutting alfalfa.

At the end of the test there were fewer fat lambs in the lot receiving second cutting than in those receiving first and third cuttings."

The work of 1922 was combined with that of 1923 and additional work in 1924. The following table is a summary of the average for 1922-23-24.

Table 7

	1st Cutting	2d Cutting	3d Cutting
Number of lambs	200	150	150
Initial weight	68.83	68.17	69.90
Final weight	84.96	83.10	85.61
Total gain	16.13	14.93	15.71
Daily gain	.269	.249	.262
Average daily rations(lbs.)			
Grain	.75	.75	.75
Hay(fed	2.53	2.49	2.55
(refused	.45	.34	.34
Feed per cwt. gain(lbs.)			
Grain	280	306	274
Hay(fed	949	1024	987
(refused	174	141	132
Rating according to condition(percentage)	98.1	98.0	99.6

(Washington Bulletin No.185)

The proportion of leaves in the above feeds was determined to be as follows:

Table 8

	1st Cutting	2d Cutting	3d Cutting
Percentage leaves	44	46	45
Relative coarseness of stems(percentage)	100	81	65

These combined tests indicated that first cutting alfalfa was slightly better than third which in turn excelled second cutting in the feed lot.

pounds

One ton first cutting hay = 2158 (2d) + 58 pounds grain

One ton third cutting hay = 2075 pounds (2d) + 34 pounds grain

The digestible nutrients in feed required per hundred pounds weight gain ~~was~~ were as follows:

Table 9.

	1st Cutting	2d Cutting	3d Cutting
Digestible crude protein	.245	.289	.248
Total digestible nutrients	1.669	1.783	1.700
Pounds digestible nutrients required per cwt. gain	620	716	645

While it may be that any difference which may be shown in the value of various cuttings of alfalfa is mainly due to the difference in time of cutting and the quality of particular cuttings, those studies which have been made seem to indicate that first and third cuttings are superior to second cutting of alfalfa.

Corn vs. Barley.- In 1904-05 at the Wyoming station Professor George Morton conducted tests with lambs fed alfalfa, corn, and barley. The barley-alfalfa fed lambs made better gains on less digestible nutrients than the corn-alfalfa fed lambs, were kept on high feed with less trouble and dressed out a higher perdentage.

Table showing results at Wyoming 1905, Bulletin No.68

Table 10

	Lot 1 Alfalfa, Turnips & Corn	Lot 2 Alfalfa, Turnips & Barley
Initial weight	62.60	62.25
Final weight	93.85	95.30
Gain	31.25	33.05
Feed:		
Alfalfa	192.0	191.0
Grain	84.9	90.35
Turnips	129.6	179.35

On the basis of these results he concluded that Scotch barley was equal to corn when fed with alfalfa.

In the following table is recorded results of a lamb feeding experiment conducted in 1908 by Faville at the Wyoming Station. In this experiment alfalfa and corn were compared with alfalfa and barley.

Table 11

	Lot Fed	
	Alfalfa and Corn	Alfalfa and Barley
Initial weight(lbs.)	59.2	60.5
Final weight(lbs.)	86.7	90.1
Gain	27.5	29.6
Daily gain	.30	.33
Feed per hundred pounds gain		
Alfalfa	855	834
Grain	269	257
(Wyoming Bul.85)		

(Wyoming Bulletin No.79, 1909)

Barley in this test seemed to be a shade better than corn.

At the same station Faville later secured additional data wherein slightly different results were obtained as corn then appeared to be superior to barley. It might be interesting to note that special mention was made of the alfalfa used. It was described as of "exceptionally fine quality". A chemical analysis showed its composition to be; crude protein, 19.17 per cent; ash, 9.3 per cent; crude fiber 24.84 per cent and nitrogen, free extract, 38.63 per cent; and a footnote reads: "This alfalfa is richer in crude protein than any other sample of alfalfa analyzed here".

The following table shows the results of this trial:

Table 12

	Lot Fed		
	Alfalfa-corn	Alfalfa-barley	Alfalfa-barley meal
Pounds gain in weight per lamb	39.7	36.9	36.2
*Daily gain	.36	.34	.33
Feed eaten per head(110 days)			
Alfalfa	296.	295.	294.
Corn	75	90	79
Feed per 100 lbs. gain			
Alfalfa	746	799	812
Grain	199	214	218

(Wyoming Bulletin No.103)
*Lambs used weighed 43 pounds at beginning

In 1900, 1902 Buffin and Griffith at the Colorado Station compared corn, and barley. In the following table appears the results of this trial:

Table 13

Lot Fed Alfalfa Plus	Daily Gains	Feed per 100 lbs. Grain		Feed Eaten	
		Alfalfa	Grain	Alfalfa	Grain
Corn	22.6	617	309	161	80
Barley	19.4	759	343	178	80

(Colorado Bulletin No.75)

The corn fed lot made better gains on less feed than those fed barley.

The following table shows results of trials with lambs conducted by G.E. Morton and published in 1913 in Colorado Bulletin 187.

Table 14

	Gain	Lbs. Feed per 100 lbs. Gain	
		Alfalfa	Grain
Lot fed Alfalfa plus corn	31.86	579	357
Lot fed Alfalfa plus Scotch barley	33.52	647	359

Scotch barley was considered equal to corn in this trial.

Corn and Silage vs. Barley and Silage.- In a trial at Wyoming, A.D. Faville compared corn, alfalfa, and silage with barley, alfalfa and silage. The following table summarizes this trial.

Table 15

	Lot 1	Lot 2
	Silage	
	Corn, Alfalfa	Barley, Alfalfa
Initial weight	46	46.3
Final weight	73.3	71.6
Gain	27.3	25.3
Daily gain	.35	.33
Feed for 100 lbs. gain:		
Grain	191	209
Alfalfa	730	802
Silage	284	318
Cost of 100 lbs. gain	$ 7.32	$ 8.04
Corn and barley $1.25 per hundred		
Alfalfa $12		

(Wyoming 1914, Bulletin No.109)

Corn in this trial seemed to have a decided advantage over barley, as it apparently produced larger gains on considerably less feed and at a cost of 72 cents less per 100 pounds gain.

Barley vs. Wheat.- Wheat and barley were compared by W.L. Carlyle and E.J. Iddings at the Idaho station in 1913.

The following table shows the results of this trial:

Table 16

	Barley 3 Parts Oats 1 Part	Wheat 3 Parts Oats 1 Part
Initial weight	73.2	72.3
Final weight	104.6	106.5
Gain	31.4	34.2
Daily gain	.26	.28
Feed per 100 lbs. gain		
Grain	396	379
Hay	926	873
Feed cost per 100 lbs. gain		
Grain	6.27	6.19
Profit per lamb	.57	.52

(Idaho Bulletin 77)

In this trial there was apparently a slight advantage in favor of wheat over barley.

Molasses.- In 1921 at Colorado, Dr. E.J. Maynard conducted a trial wherein molasses was used in the ration with corn and barley. The following table is a summary of this trial.

Table 17

Lot Fed	Corn-Molasses	Barley-Molasses	Corn
Initial weight	71.0	71.1	70.7
Final weight	103.8	100.3	101.8
Gain	32.3	29.2	31.1
Daily gain	.347	.314	33.4
Feed per 100 lbs. gain			
grain	219.6	243.0	309.4
Molasses	85.8	94.9	
Alfalfa	736.5	808.1	749.0
Cost per 100 lbs. gain	$ 8.84	$ 10.18	$ 9.57

(Colorado Bulletin No.266, 1921)

The prices of feeds were as follows:

Cost of shelled corn — $ 1.35 per hundred pounds
Cost of molasses per ton — 15.00 per ton
Cost of barley — 1.50 per hundred pounds

In summarizing this trial Maynard stated that it required 10.7 per cent more grain, 10.6 per cent more molasses and 11.8 more alfalfa to the lot fed barley to make the same gain than for the lot fed corn, molasses and alfalfa. Molasses was considered more than equal to corn pound for pound when fed in limited quantities.

In this trial corn seemed to be more efficient with molasses than did barley. The lambs fed corn and molasses made more rapid gains on less feed per 100 pounds gain and at considerably less cost per hundred pounds gain than did those fed barley and molasses.

The varying results in these tests can be partially explained at least by noting the feeds with which the grains were fed. Barley seemed to excell corn when fed with Wyoming native or wild hay -- hays low in protein. On the other hand corn apparently excells barley when fed with alfalfa -- a feed high in proteins.

Molasses.- Table 17 contains a summary of results of a trial with a lot of lambs fed corn, and a comparison of this lot with those lots which were fed corn with molasses and barley with molasses. Comparing the results in the lot fed corn with those in the lot fed corn and molasses, the corn alone did not seem to do so well as the lot fed corn and molasses. The lot fed molasses with corn made bigger and faster gains on less feed and on less feed cost per 100 pounds gain.

Temperature.- As early as 1895 investigators at the Colorado Station published a report(Bulletin No.32) dealing with daily gains in relation to temperature and feed consumed.

Table showing gains and temperatures and feed fed at Colorado.

Table 18

	Feed Fed			
	Hay per Head	Grain per Head	Total Digestible Nutrient per	Avg. Temp.	Daily Gain
1st 13 days	1.9	0	10.6	45.6	.15
2d 14 days	2.5	0	14.0	40.1	.10
3d 23 days	3.3	0	18.9	34.1	.09
4th 14 days	3.8	.4	27.1	39.8	.36
5th 13 days	3.4	.4	24.6	14.2	.10
6th 15 days	2.5	.37	19.5	30.5	.49
7th 14 days	3.0	.37	21.0	16.7	.14
8th 13 days	3.5	.5	23.1	9.9	.46
9th 28 days	1.6	.67	16.0	31.7	.33
10th 20 days	2.3	.84	20.0	44.7	.37
11th 27 days	2.3		18.0	52.9	.15
AVE.			19.6	31.8	.23

(Colorado Bulletin No.32, 1895)

The conclusions in this trial were that the gains were not affected by cold weather as the greatest gains were made when the temperature was below freezing but the lambs did eat more feed.

This Study

This work is a research study of twelve lots of seventy lambs each fed in a cooperative lamb feeding experiment on the farm of Alma Magleby at Monroe, Utah during a period of 100 days from November 18, 1928 to February 25, 1929. The experiment was planned and supervised by members of the U.S.A.C. Experiment Station, the U.S.A.C. Extension Service and the Monroe Lamb Feeders Association. Dean Kenneth C. Ikeler, and Professor A.C. Esplin of the Station working with County Agent S.R. Boswell of the Extension force planned and supervised the work. Practical feeders helped outline the rations.

Many practical feeders became greatly interested in this experiment, Some of them helped in outlining the rations.

Mr. Alma Magleby furnished the lambs, feed and equipment and Mr. Royal D. Crook, a senior student in Animal Husbandry served as experimental feeder, and kept the records.

The purpose of this experiment was to study the comparative values of the various cuttings and brown cured alfalfa, the efficiency of barley and wheat compared with corn, the value of molasses, and of kelp in the ration.

In addition to the above studies the effects of maximum mean and minimum daily temperatures upon the rate of gains, as well as upon the amount or cost of feed eaten, and the relationship between amount of feed eaten and the rate of gains made were investigated.

A further study was made regarding the effect handling incident to weighing had upon the rate of gains during the weighing periods.

The Lambs Used in This Experiment

The lambs were native southern Utah feeder lambs. Mr. Alma Magleby purchased about 600 of them at Alton, Kane county, while the rest(240) were furnished by Mr. A.W. Magleby. Rambouillet breeding predominated in the lambs. It is estimated that about 8 or 10 per cent were distinctly wrinkled. Some of the 240 lambs furnished by A.W. Magleby were of slightly different type being less wrinkled and lower set and more blocky than the rest. However, they were comparatively few in number and were well distributed among the lots.

The type of lambs used in this experiment.
Rambouillet breeding predominated

Previous Treatment.- The lambs purchased were driven from Alton, Kane county to Monroe and were turned into the fields about October 20th. They were allowed to run in the alfalfa until November 15. The feed at first was rather abundant but it was so nearly gone by November 11 that first crop hay was scattered in the fields for them. On November 15 they were put in the feed lots and fed about 2.5 pounds of first cutting alfalfa per head daily.

Grading.- The 840 lambs were uniformly graded for type, breeding condition and weight by Mr. A.C. Esplin. Mr. Esplin's attempt to get the lambs of each lot near the average weight of about 63 pounds was quite successful as the maximum variation from this figure was .9 of a pound in Lot 1, and the average variation of the different lots from the group average was but .56 pounds.

Each lot of lambs was given a particular brand to insure against inter-change during the test.

The Plant and Equipment

Yards.- The feed yards were on the farm of Mr. Alma Magleby about 1.25 miles south and west of Monroe, Utah. The twelve pens were arranged in line with a tight board fence forming a windbreak from the prevailing winds. The pens were uniform in nearly every respect and with one exception were about 28 x 60 feet in size. This allowed about 24 square feet of ground room to each lamb. Lot 8, the north pen, was just a little smaller, allowing 22 feet of ground room to each lamb. A corner of a shed occupied a portion of this pen. The ground which had been scraped clean before the pens were built was dry. There was no overhead shelter.

The 12 pens were arranged in line, with a tight board fence forming a windbreak against the prevailing winds

The Mangers.- The hay mangers(three in each pen) varied in width from 24 to 32 inches and in the height of the bottom board over which the lambs reached to eat from 12 to about 18 inches. All mangers had tight

board bottoms. There was about 1.5 feet of hay manger room for each lamb. There were three 14-foot grain mangers in each pen. These allowed 1 1/5 feet of manger room to each lamb. Salt boxes holding about 25 pounds of salt were provided.

The Scales.- Scales on which the lambs were weighed were located about 50 yards from the south pen. These scales were in good condition. A small pair of platform scales was fitted with a hay platform on which the hay and grain were weighed.

The Feed Used

The feeds used were alfalfa, first, second and third cuttings, and first cutting brown cured(tobacco), alfalfa, barley, wheat, corn, molasses, kelp and salt.

Barley.- The barley fed was Trebi barley of good quality.

Wheat.- The wheat fed Lot 9 was Dicklow variety.

Corn.- The corn fed Lots 8 and 10 was No.2, white No.2 mixed and No.3 yellow.

Kelp.- The kelp fed Lot 12 was the commercial kelp produced by the Man-A-Mar Company.

Molasses.- The molasses was beet molasses obtained from the beet sugar factory and hauled to the yards in a special tank. It was the regular product and was uniform throughout.

Salt.- The salt used was the common Redmond salt, red in color, perhaps due to iron-oxide but fairly pure, very little sand or clay being present.

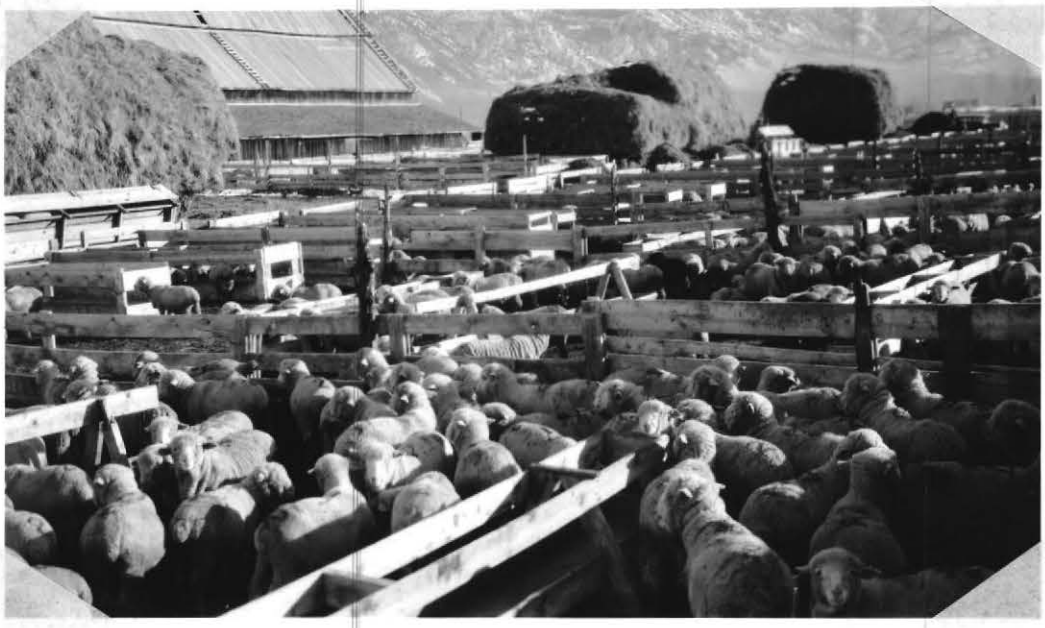
Alfalfa.- Samples of the alfalfa were graded by Mr. Heber J. Webb, Supervising Inspector for the U.S.D.A. Bureau of Agricultural Economics. Regarding these samples he states as follows:

"I am herewith enclosing for your information the results of analyses on the four samples of hay which I graded and forwarded from Monroe: Sample No.1: Leafiness, 37 per cent; color, 80 per cent; foreign material, 9 per cent; grass, 7 per cent. This sample grades U.S. No.2, extra green alfalfa, light grass mixed. This was taken from the stack of first crop hay. Had this sample possessed 3 per cent more leaves it would have been graded No.2 on account of foreign material but inasmuch as it is under 40 per cent leaves and has also more than 5 per cent foreign material which is the minimum allowed for No.1 grade, the grade must be stated as above.

Sample No.2 which is second crop alfalfa has 33 per cent leaves, 40 to 45 per cent color and 8 per cent foreign material which makes it grade the straight U.S. No.2 alfalfa. Some mustiness is also apparent in this sample of alfalfa.

Sample No.3 was taken from third crop stack: Leafiness, 53 per cent; color, 70 per cent; foreign material, 14 per cent. This hay grades U.S. No.3 alfalfa on account of foreign material otherwise it would be U.S. No.1, extra leafy alfalfa. The foreign material in all three of these cases consisted very largely of old, dead, dry rakings that were left on the field the previous year.

Sample No.4: Leafiness, 42 per cent; color, 5 per cent; foreign material, 10 per cent; grass, 4 per cent. This sample grades U.S. No.3, leafy alfalfa. It is graded No.3 on account of its almost total lack of green color which was produced by heavy fermenting in the stack. It is commonly called tobacco brown. This sample shows a slight indication of must and mold."



The lots were located as near as possible to the hay which they were to be fed.

Excepting the brown cured hay which was hauled to pen 6 the hay was in stacks along the east side of the pens. The various lots were located as near as possible to the hay they were to receive.

Water.- The water was piped from a spring and was kept running at all times into wooden V-shaped troughs located in the pens.

Table 19. The various lots received the following feeds:

Lot 1	1st crop alfalfa	whole barley	oats	salt
2	2d crop "	"	"	"
3	3d " "	"	"	"
4	(1st crop alfalfa 45 days (2d " " 55 "	"	"	"
5	(2d crop alfalfa 45 days (1st " " 55 "	"	"	"
6	Brown cured alfalfa	"	"	"
7	1st crop alfalfa	"	"	" molasses
8	1st crop alfalfa	shelled corn	"	"
9	1st crop alfalfa	whole wheat	"	"
10	1st crop alfalfa	shelled corn	"	" "
11	1st crop alfalfa	ground barley	"	"
12	1st crop alfalfa	barley	"	" kelp

The table below shows the total amount and cost of the various feeds used.

Table 20. Weight and cost of feeds fed

	Pounds	Cost
Alfalfa 1st crop	124,134	$ 620.67
Alfalfa 2d crop	31,592	157.96
Alfalfa 3d crop	15,854	79.27
Alfalfa (tobacco)	15,980	79.90
Whole barley	51,176.4	895.58
Ground barley	5,527.3	92.61
Corn	13,517.0	370.34
Wheat	5,916.0	98.80
Oats	3,510.5	6.144
Molasses	5,234.0	38.61
Kelp	240.0	No value given
Salt	2,163.0	21.63
Total:		
Hay	187,560	$ 937.80
Grain	79,647.2	1428.42
Cost of all feeds		2436.44

Method of Management

Weighing.- The weighing periods were every 15 days during the 100 days feeding period. The average weight of three successive daily weighings was taken as the weight on the middle day. The time that weighing began was 10 A.M. for the first two periods and afterwards 9:30 A.M. It was necessary to make two drafts of each lot.

Feeding

Grain.- The grain was fed in two daily feeds -- at 6 A.M. and 4:30 P.M. It was fed in small quantities at first. The ration began with but 1/10 of a pound and gradually increased in amount for about 30 days when the lambs were receiving one pound per head daily. For the first 15 days oats were mixed with all grain(except corn) in equal proportion. The second 15 days the mixture was two parts of barley or wheat to one of oats. After 30 days no oats were mixed with the barley or wheat. It was thought that this mixture would help to get the lambs on full feed sooner and with less trouble from sickness or loss.

Mr. Royal D. Crook, the experimental feeder, weighing feed.

Hay.- The alfalfa was fed after the grain morning and afternoon and in the same lot sequence as the grain was fed. The hay was weighed on platform scales and distributed in the three mangers in each lot. The amount of hay fed was determined by the lamb's appetite.

Molasses.- The molasses was diluted with about 1/4 water to facilitate spreading upon the hay. The lambs were kept from the mangers until the molasses had been carefully sprinkled on the hay.

Salt.- Salt was kept in the boxes at all times.

Time Required to Consume Rations.- The time necessary for the lambs to consume their ration was measured every ten days. It was difficult to time the hay consumption as some lambs were picking at the feed most of the time during the day. The time required to consume the grain varied little throughout, increasing from 13 minutes for 5/10 of a pound per head to 20 minutes for 5/8 of a pound per head.

The Rations Fed

The following table shows the rations fed as well as the amount of each feed eaten by the various lots of lambs.

The lambs were bedded with straw at needed intervals, to provide comfort for the lambs.

Table 23.

Lot	1	2	3	4	5	6	7	8	9	10	11	12	Total Amt.
1st Crop: Alfalfa:	2.25			1st 45 days: 2.24	2d 45 days: 2.25:		2.14:	2.27:	2.26:	2.12:	2.22:	2.22:	2.23
2d Crop: Alfalfa:	2.27			2d 45 days: 2.24	1st 45 days: 2.25:								2.25
3d Crop: Alfalfa:			2.26:										2.26
Brown Alfalfa:						2.28							2.28
Whole Barley	.964	.964	.964:	.964	.964:	.964:	.962:					.965	.964
Ground Barley											.84		.84
Corn								.966:		.965:			.965
Wheat									.895:				.895
Molasses							.375:			.373:			.374
Kelp												1.07: 1% ration	1% ration

Care of Pens and Mangers

Pens were bedded with straw whenever they became wet. However the first bedding was delayed until the second or third light storm on about January 8.

Grain mangers were turned upside down after every feed and cleaned if necessary.

Notes.- Each evening Mr. Crook wrote down all observations thought to be of any significance. Daily feed records, notes and weights were kept in duplicate. Estimated hours of sunshine each day, weights of refused feed, death losses, lambs "off feed" health and vigor and various conditions were recorded in a permanent record.

Slaughter Data.- Although efforts were made to obtain shipping and slaughter data it is not complete because of unforeseen conditions which developed

during the shipment from Monroe to Los Angeles. Some interesting data was obtained although it is not entirely accurate.

Special Notes.- Lot 6 receiving brown cured alfalfa seemed to urinate more freely than the other lots, keeping that pen more damp. This pen seemed to have a peculiar odor.

It is estimated that about 20 per cent of the weight of the waste hay from Lots 7 and 10 was molasses.

Appreciable amounts of grain was left in only two cases, once in Lot 9 and once in Lot 11. These were the only lots of lambs which went off feed. Lot 11 scoured considerably as did Lot 4. Lot 7 seemed sluggish or indifferent toward their feed. Three lambs died in Lot 4 -- one each in lots 1, 2, 3, 7, 8, 9, 10 and 12. More hay was left in those mangers having the higher boards over which the lambs ate, and in those mangers of greatest width.

More stems of second crop alfalfa were left than of the other crops. Although the lambs seemed to relish the molasses, many stems of hay on which molasses had been sprinkled were left even though the allowance was cut down to where other lots were cleaning up all the hay.

Mangers were cleaned when necessary and the waste hay was weighed back.

Winter Conditions.- The winter was unusually cold and probably more snow fell than normally. This tended to hold back the gains and increase the amount of feed consumed.

Meteorological Record (Richfield observations)

Monroe Lamb Feeding Experiment

(November 18, 1929 to February 25, 1930 inclusive)

Table 22.

Number of clear days	49
Number of partly clear days	19
Number of cloudy days	32
Latitude	38°.4
Longitude	112°6.
Total precipitation	1.8 inches
Number of days with .01 inch or more precipitation	16
Total number of inches of snow	17
Maximum temperature	67°F. on Dec.27th
Minimum temperature	-17°F. on Feb.9th (below zero)

	Maximum Temperature Total	Minimum Temperature Total	Mean	Mean
November 18-30	631	251	19.3	35.9
December 1-30	1324	388	12.5	27.6
January 1-31	1251	326	10.5	25.5
February 1-25	922	278	11.1	25.
Total	4128	1243		

Mean maximum 100 days 41.28°
Mean minimum 100 days 13.43°
Mean temperature 100 days 26.85°

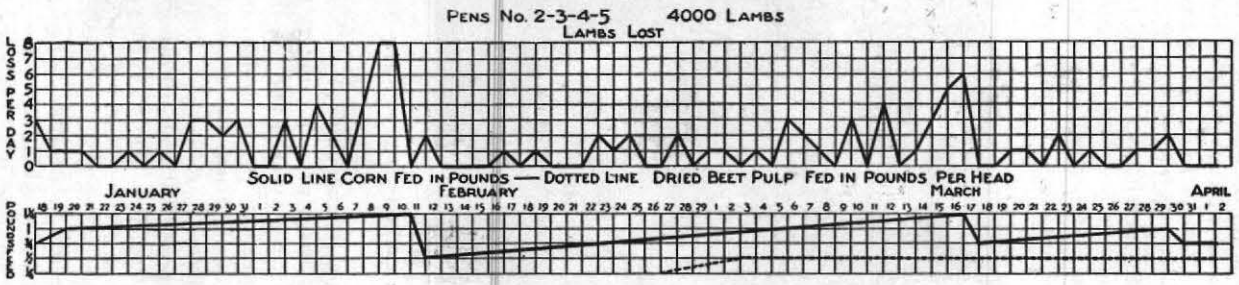
41.28
13.43
2)55.71
26.855 = mean temperature for 100 days

Death Losses.- In the study of these data it was noted that a large part of the death losses occurred during the first six weeks of the feeding period. The question then arose, are lamb losses relatively high in any part of the feeding period and if so in what period? A letter of inquiry about the time of lamb losses was addressed to Dr. John M. Evvard of the Iowa State College at Ames, Iowa, Dr. E.J. Maynard of the Colorado Agricultural College, Fort Collins, Colorado; Professor H.N. Vaughan of the Montana State University at Bozeman, Montana; Dr. Fred Hultz of the University of Wyoming, Laramie, Wyoming, and E.F. Rinehart, Field Animal Husbandman of the University of Idaho.

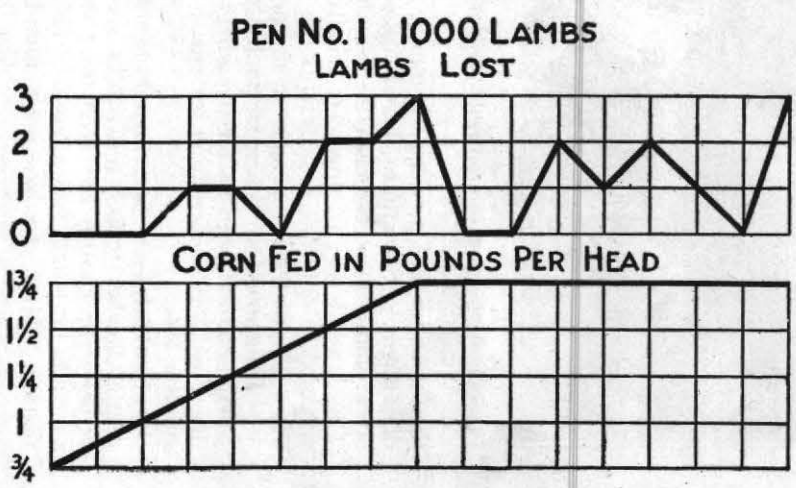
In reply to my letter Dr. Maynard referred me to Colorado bulletin No.305 entitled "Diseases of Colorado Feeding Lambs" by I.E. Newsome, and Floyd Cross, 1926. This bulletin states that over eating probably causes more losses in Colorado feed lots than all other troubles combined.

The following is a page from the above bulletin and shows graphically the relation of amount of corn fed to lamb losses.

GRAIN FED IN RELATION TO LAMBS LOST



In four other lots, aggregating 4,000 head, fed slowly under observation for 76 days, the total loss was 91 head, or at a rate less than a third of the heavy corn fed lot No. 1. When the corn ratio was lowered the death losses dropped off.



SUMMARY

Pen No. 1—1000 lambs sorted and fed out quickly—17 days.

Total loss, in time under observation, 18 head, 1 per 1000 per day.

Pens 2, 3, 4, 5, 4000 head fed slowly under observation for 76 days.

Total loss, 91 head; .3 per 1000 per day.

Loss in whole 5000 on different amounts of corn figured per 1000 lambs per day.

½ lb.	¾ lb.	1 lb.	1¼ lb.	1 ¾ lb.
.125	.167	.345	.754	1.333

Or same figure in % loss for a feeding period of 100 days.

½ lb.	¾ lb.	1 lb.	1¼ lb.	1 ¾ lb.
1¼ %	1⅔ %	3½ %	7½ %	13⅓ %

Mr. Louis Vinke, Associate Animal Husbandman of the University of Montana Agricultural Experiment Station, answering my letter to Professor Vaughan states:

"We fed 510 lambs at Huntley and lost 16. Six of those losses occurred the first three weeks these lambs were on feed. Very few losses then occurred until about the close of the feeding trial of 110 days. The last three weeks a number of lambs died from what is commonly called uremic poisoning. However, we are not satisfied with the latter diagnosis and will probably have more information on that later.

At Chinook we fed 530 lambs with a 1-3/10 per cent death loss. Most of the loss occurred during the first three weeks of the trial. However, we lost two lambs during the last month."

Professor R.F. Rinehart of Idaho answered as follows:

" . . . The bulk of our losses on lambs occur on fall pasture. This is especially true where they are on alfalfa alone. These losses usually range around 2 per cent. With beet tops or grain stubble for a part of the ration we are able to keep it down.

Of 3000 lambs we had on pasture this year, losses varied as follows:

703 lambs, two months on alfalfa stubble, loss 46 head	6.5 per cent
1050 lambs on alfalfa and grain stubble six weeks, loss 19 head	1.7 per cent
1534 lambs on alfalfa and clover stubble, grain stubble and beet tops, free choice of all, loss 17 lambs	1.1 per cent
Feed lot lambs, 513 on full grain, loss three, from too much grain	.06 per cent
510 head on hay, syrup, pulp and barley, loss three, stolen	
486 lambs, hay grain and syrup, death loss three	.6
752 lambs, grain and hay, death loss six	.8

Most of the death losses come from a lamb eating grain somewhat to excess."

In the Monroe study while the lamb loss was very light almost 64 per cent of the loss came in that period from the 19th day to the 44th day or during a period of 25 days. During this time the grain fed was being gradually increased from .47 of a pound per day to 1.07 pounds per day, per lamb.

Just what causes these lamb losses in feed lots is perhaps not definitely established, but authorities seem to be fairly agreed that the trouble is associated with heavy feeding of rich feeds to young animals.

Discussion of Results

Table 23. First crop alfalfa vs. second crop alfalfa

No. of Lot	Ration	Initial Weight	Final Weight	Gain	Feed Cost 100 lbs. Gain	Cost Feed	Total Cost	Selling price	Profit per Lamb
1	1st crop alfalfa and barley	63.9	96.9	33	$ 8.60	$2.84	$9.92	$14.50	$ 4.13
2	2d crop alfalfa and barley	62.5	94.1	31.6	8.98	2.84	9.77	14.59	3.96

Lot No.1 receiving 1st cutting alfalfa made slightly larger gains (lot 2) at the same feed cost per head. This saved 38 cents in feed cost per 100 pounds gain. Although Lot 1 sold for 9 cents less per hundred pounds they made a profit of $4.13 as compared with $3.96 for Lot No.2 which was fed 2d cutting.

Table 24. First crop alfalfa vs. third crop alfalfa

No. of Lot	Ration	Initial Weight	Final Weight	Gain	Feed Cost 100 lbs. Gain	Cost Feed	Total Cost	Selling price	Profit per Lamb
1	1st crop alfalfa and barley	63.9	96.9	33	8.60	2.84	9.92	14.50	4.13
3	3d crop alfalfa and barley	63.5	98.0	34.5	8.26	2.85	9.89	15.12	4.93

In this test 3d cutting seemed more efficient than 1st cutting. Lambs fed 3d cutting made 1.5 pounds heavier gains per head on practically the same feed cost. They sold for 62 cents more per hundred pounds and made 80 cents more profit per head than did the lambs fed first cutting.

Table 25. Second cutting alfalfa vs. third cutting alfalfa

No. of Lot	Ration	Gain	Feed Cost per 100 lbs. Gain	Selling Price	Profit per Lamb
2	2d crop alfalfa and barley	31.6	8.98	14.59	3.96
3	3d crop alfalfa and barley	34.5	8.26	15.12	4.93

Apperently third cutting seemed superior to 2d cutting alfalfa in this trial as the lambs receiving 3d cutting made 2.9 pounds more gain at 72 cents less feed cost per hundred pounds gain, and sold for 53 cents more per hundred pounds returning a profit of 97 cents more per lamb than those ~~finishing~~ receiving 2d cutting.

Table 26. First crop vs. tobacco hay(brown cured)

No. of Lot	Ration	Initial Weight	Final Weight	Gain	Feed Cost 100 lbs. Gain	Cost Feed	Total Cost	Selling	Profit per Lamb
1	1st crop alfalfa and barley	63.9	96.9	33	8.60	2.84	9.92	14.5	4.13
6	Brown cured or tobacco hay and barley	63.7	98.2	34.5	8.20	2.83	9.89	14.83	4.64

The lambs in Lot 6 fed brown cured(tobacco) alfalfa excelled those on regular 1st cutting alfalfa by making one and a half pounds more gain per head on practically the same feed cost, selling for 33 cents more per hundred pounds and returning 51 cents per head more of profit.

Table 27. First crop 45 days, 2d, 55 days vs. 2d crop 45 days and 1st, 55 day

No. of Lot	Ration	Initial Weight	Final Weight	Gain	Feed Cost 100 lbs. Gain	Cost Feed	Total Cost	Selling	Profit per Lamb
1	1st crop	63.9	96.9	33	8.60	2.84	9.92	14.50	4.13
4	1st-1st 45 days	62.8	96.2	33.4	8.41	2.81	9.80	14.40	4.05
5	2d -1st 45 days	63.7	95.6	31.9	8.84	2.82	9.91	14.64	4.09
2	2d crop alfalfa	62.5	94.1	31.6	8.92	2.82	9.77	~~11.59~~ 14.59	3.96

The indications, although very slight, bear out the saying "Keep the feed just a little better than the animals. The change from 2d cutting alfalfa to first cutting apparently resulted in 24 cents higher selling price per hundred pounds which returned 4 cents per head more profit compared with a change from 1st to 2d cutting. The feeding of 1st cutting hay during part of the feeding period seemed to raise the profit above that returned by straight 2d cutting alfalfa. At the same time the feeding of 2d cutting alfalfa during a part of the feeding period seemed to lower the profit from that for 1st cutting alfalfa throughout.

Table 28. Whole barley vs. ground barley

No. of Lot	Ration	Initial Weight	Final Weight	Gain	Feed Cost 100 lbs. Gain	Cost Feed	Total Cost	Selling	Profit per Lamb
1	Alfalfa and whole barley	63.9	96.9	33	8.60	2.84	9.92	14.50	4.15
11	Alfalfa and Ground barley	62.3	90.5	28.2	9.50	2.68	9.59	13.92	3.01

A comparison of Lot 1 fed whole barley with Lot 11 fed ground barley indicated that lambs could grind their grain to better advantage than the farmer. The lambs receiving whole barley made 4.8 pounds more gains on 90 cents lower feed cost per 100 pounds gain, sold for 58 cents more per hundred pounds and returned a profit of $1.12 more per lamb than did those lambs receiving ground barley. The lambs fed whole barley were able to eat more grain without going off feed, a fact which may explain the 16 cents higher feed cost per head for Lot No.1 over the feed cost for Lot No.11 receiving ground barley.

Table 29. Whole barley vs. shelled corn

No. of Lot	Ration	Initial Weight	Final Weight	Gain	Feed Cost 100 lbs. Gain	Cost Feed	Total Cost	Selling	Profit per Lamb
1	Alfalfa and whole barley	63.9	96.9	33	8.60	2.84	9.92	14.50	4.15
8	Alfalfa and corn	62.6	98.0	35.4	8.76	3.10	10.04	15.22	4.88

In this comparison the lambs in Lot 8 fed corn, made 2.4 pounds more gain per head than those in Lot 1 fed whole barley. Although it cost 26 cents per head more to feed these lambs they returned 75 cents more per lamb than those fed barley. This may be due to the fact that they sold for 72 cents more per lamb. This lot was the highest in selling price of any of the twelve lots.

Table 30. Whole barley vs. wheat

No. of Lot	Ration	Initial Weight	Final Weight	Gain	Feed Cost 100 lbs. Gain	Cost Feed	Total Cost	Selling	Profit per Lamb
1	Alfalfa and whole barley	63.9	96.9	33	8.60	2.84	9.98	14.50	4.13
9	Alfalfa and wheat	63.6	94.8	31.2	8.52	2.66	9.70	14.74	4.27

Wheat appeared to be highly efficient as a lamb feed in this test. Lambs in Lot 9 fed wheat made 14 cents per head more profit than did those in Lot 1 fed barley. Perhaps this was due to higher finish and cheaper feed cost per head. Lambs in Lot 9 outsold those in Lot 1, 24 cents per head. Feed cost was 18 cents less per lamb. They made their gain for 8 cents less per hundred pounds although their total gains were 1.8 pounds less per lamb.

Table 31. Corn vs. wheat

No. of Lot	Ration	Initial Weight	Final Weight	Gain	Feed Cost 100 lbs. Gain	Cost Feed	Total Cost	Selling	Profit per Lamb
8	Alfalfa and corn	62.6	98.0	35.4	8.76	3.10	10.04	15.22	4.88
9	Alfalfa and wheat	63.6	94.8	31.2	8.52	2.66	9.70	14.74	4.27

Lambs fed corn excelled those fed wheat in this test, making 4.2 pounds more gain per head, selling for 48 cents more per lamb and returning a profit of 61 cents more per lamb. Those lambs fed wheat made cheaper gains than did those fed corn. This difference amounted to 24 cents per hundred pounds and 44 cents per head.

Table 33. Alfalfa and barley vs. alfalfa barley and molasses

No. of Lot	Ration	Initial	Final	Gain	Feed Cost 100 lbs. Gain	Cost Feed	Cost	Total	Selling	Profit per lamb
1	Alfalfa and barley	63.9	96.9	33	8.60	2.84	9.92	14.50		4.13
7	Alfalfa, barley and molasses	62.6	96.8	34.2	8.92	3.05	9.99	15.02		4.55

From this table it would seem that molasses added to alfalfa and barley increased the gains 1.2 pounds per lamb, the selling price 52 cents per lamb and the profits 42 cents per lamb. The cost of feed, however, was 21 cents more per head and 32 cents more per 100 pounds gain for the lambs of Lot 7 fed molasses alfalfa and barley than for those in lot 1 not receiving molasses. If may be that we should credit molasses for increasing the value of the lamb from $14.03 to $14.54. This 51 cents in favor of molasses would buy 37.62 pounds of alfalfa and 16.942 pounds of barley. If this is considered as feed saved then it may be that molasses saved the equivalent of 116.02 pounds of alfalfa and 37.54 pounds of barley which in dollars and cents would amount to $.58 for the alfalfa and 71 cents for the barley, a total of $1.29 for both. The 114.3 pounds of molasses cost $.84. Therefore 84 cents worth of molasses in the ration apparently saved $1.29 worth of alfalfa and barley. It has been estimated[1] that one pound of grain is equal to three pounds of alfalfa for fattening lambs. On this basis the 114.3 pounds of molasses then would seem to be equal to the equivalent of 228.64 pounds of alfalfa or the equivalent of 76.21 pounds of grain when fed as was lot 7.

It seems that more work could profitably be done in establishing just what value molasses, which is a by-product in the sugar-beet industry, so prominent in Utah, has in the lamb ration. It was considered by Nelson at

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[1] Oregon Bul.198. 1923. Lamb Feeding Experiments

Washington[1] that 1.14 pounds of molasses were equal to 1 pound of corn in feeding trials. Investigators at Colorado[2] in feeding trials concluded that beet molasses in the ration apparently decreased the feed cost 11 cents per head and the loss 4 cents per head when fed with corn and alfalfa. Hakendorn[3] concluded that ½ pound of molasses per lamb per day was equal to the same amount of corn in feed value. If these findings hold for Utah where molasses costs but 3/8 as much as corn then there is undoubtedly profit in feeding molasses as a substitute for part of the grain ration.

Table 33. Barley-molasses vs. corn-molasses

No. of Lot	Ration	Initial Weight	Final Weight	Gain	Feed Cost 100 lbs. Gain	Cost Feed	Total Cost	Selling	Profit per Lamb
7	Alfalfa, barley and molasses	62.6	96.8	34.2	8.93	3.05	9.99	15.02	4.55
10	Alfalfa, corn and molasses	62.9	97.0	34.1	9.62	3.28	10.26	14.93	4.22

Molasses ~~fed~~ with alfalfa and barley fed Lot 7 seemed to make a little better showing than it did fed with alfalfa and corn to Lot 10. Lot 7 made a profit of 33 cents per head more than Lot 10. This was by reason of the cheaper feed cost and slightly higher selling price for the lambs of Lot 7 as against those in Lot 10.

In a former table corn seemed to excell barley, when fed with alfalfa. This apparently does not hold if molasses is added to the ration.

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[1] Washington Bul.179. 1922. Lamb Feeding Experiments

[2] Colorado Bul.266. 1921. Beet By-products for Fattening Lambs

[3] Washington Bul.185. 1924. Lamb Feeding Experiments

Table 34. Alfalfa-corn vs. alfalfa-corn and molasses

No. of Lot	Ration	Initial Weight	Final Weight	Gain	Feed Cost 100 lbs. Gain	Cost Feed	Total Cost	Selling	Profit per Lamb
8	Alfalfa and corn	62.6	98.0	35.4	8.76	3.10	10.04	15.22	4.88
10	Alfalfa, corn and molasses	62.9	97.0	34.1	9.62	3.28	10.26	14.93	4.22

Apparently the adding of molasses to corn did not increase the returns as in the case where molasses was added to barley. In fact molasses with alfalfa and corn seemed to lower the returns compared with those of a ration of alfalfa and corn without the molasses. The lambs of Lot 8 fed alfalfa and corn excelled those of Lot 10 fed alfalfa, corn and molasses by 1.3 pounds per head gain, by 86 cents per head in economy of feed, and by 66 cents per head in profit.

Table 35. Alfalfa-barley vs. alfalfa-barley and kelp

No. of Lot	Ration	Initial Weight	Final Weight	Gain	Feed Cost 100 lbs. Gain	Cost Feed	Total Cost	Selling	Profit per Lamb
1	Alfalfa-barley	63.9	96.9	33	8.60	2.84	9.92	14.50	4.13
12	Alfalfa-barley-kelp	62.5	94.6	32.1	8.79	2.82	9.75	13.68	3.19

When kelp was added to alfalfa and whole barley in Lot 12 gains were .9 of a pound lower per head, the cost of gains 19 cents higher per hundred pounds, the selling price 17 cents lower per hundred pounds, and the profits 94 cents per lamb less than for those in lot 1 not receiving kelp.

The following table shows the relative standing of all lots in regards to total gain, feed cost, cost of feed per 100 pounds gain, selling price per 100 pounds and profit per lamb.

Table 37.

Lot No.		Total Gain	Economy of Feed	Economy of Gain	Selling Price	Profit per Lamb	Composite Ranking
1	1st cutting alfalfa and barley	7th*	4th	5th	9th	7th*	7th (32)
2	2d cutting alfalfa and barley	10th	4th	10th	8th	10th	11th (42)
3	3d cutting alfalfa and barley	2d	8th	1st	2d	1st	1st (14)
4	1st crop 45 days 2d crop 55 days and barley	6th	4th	3d	10th	4th	4th (27)
5	2d crop 45 days 1st crop 55 days and barley	9th	4th	8th	7th*	8th	8th (36)
6	Brown cured alfalfa and barley	2d	9th*	2d	5th	3d	2d (21)
7	1st crop alfalfa barley and molasses	4th	10th	9th	3d	4th	6th (30)
8	1st crop alfalfa and corn	1st	4th	6th	1st	2d	2d (21)
9	1st crop alfalfa and wheat	11th	1st	4th	6th	5th	4th (27)
10	1st crop alfalfa, corn and molasses	5th	last	last	4th	6th	9th (39)
11	1st crop alfalfa and ground barley	last	2d	11th	11th	last	last (48)
12	1st crop alfalfa, barley and kelp	8th	3d	7th*	last	11th	10th (41)

The figures at the extreme right show the score of each lot. The score is determined by giving 1 point for first, 2 points for second, 3 points for third, etc. for each column and adding the total for each lot. The lower scores give the higher rankings.

Table 36. Amount of salt consumed by the lambs in each lot

Lot No.	1	2	3	4	5	6	7	8	9	10	11	12	Total
Total	194	155	193	188	178	218	164	206	195	170	160	142	2165
Percentage of Total	8.97	7.16	8.93	8.69	8.23	10.08	7.58	9.52	9.03	7.87	7.38	6.57	100

Average percentage for lots = 8.33

Lot 6 receiving the brown cured alfalfa ate the most salt. They consumed 218 pounds which was 23.3 per cent more than the average salt consumption for the rest; Lot 12 receiving kelp ate the least salt, 140 pounds.

SUPPLEMENTARY STUDIES

Temperature in Relation to Gains

The conclusions reached in Colorado Bulletin No.32, that temperature was not a great factor in determining gains in lamb feeding prompted a study of temperature in relation to gain in this work. This problem was attacked along three lines.

The relation of rate of gains to

A. Maximum temperature
B. Minimum temperature
C. Mean temperature

The records of the U.S.D.A. Weather Bureau at Richfield, Utah were used. This daily record took into consideration both the maximum and minimum temperature reached each day. Inasmuch as the gains could be computed only periodically, that is from the weighings which were made every 15 days, it was deemed wise to average the maximum temperature for those days corresponding with each weighing period. The same was done for the minimum temperature and also for the mean temperature which of course was an average of the maximum and minimum recordings.

The following table shows the average maximum, mean and minimum temperatures for the seven periods.

Table 38.

	Nov. 18 - 28	Nov.29-Dec.12	Dec. 13-27	Dec.28-Jan.11	Jan.12 -26	Jan.27-Feb.10	Feb. 11-25	Nov.18-Feb.25
Maximum Avg.	48.4	41.1	43.4	41.5	39.3	33.9	41.3	41.3
Minimum Avg.	19.3	15.1	8.5	7.7	15.1	7.8	16.1	12.5
Mean Avg.	34.0	28.1	26.1	24.6	26.2	20.9	28.7	26.9

Below is a plot of the temperature. The upper margin of the shaded part represents the maximum daily reading. The low margin represents the minimum daily reading, and the heavy blue line represents the mean daily temperature. The average mean temperature for the winter is represented by the straight line.

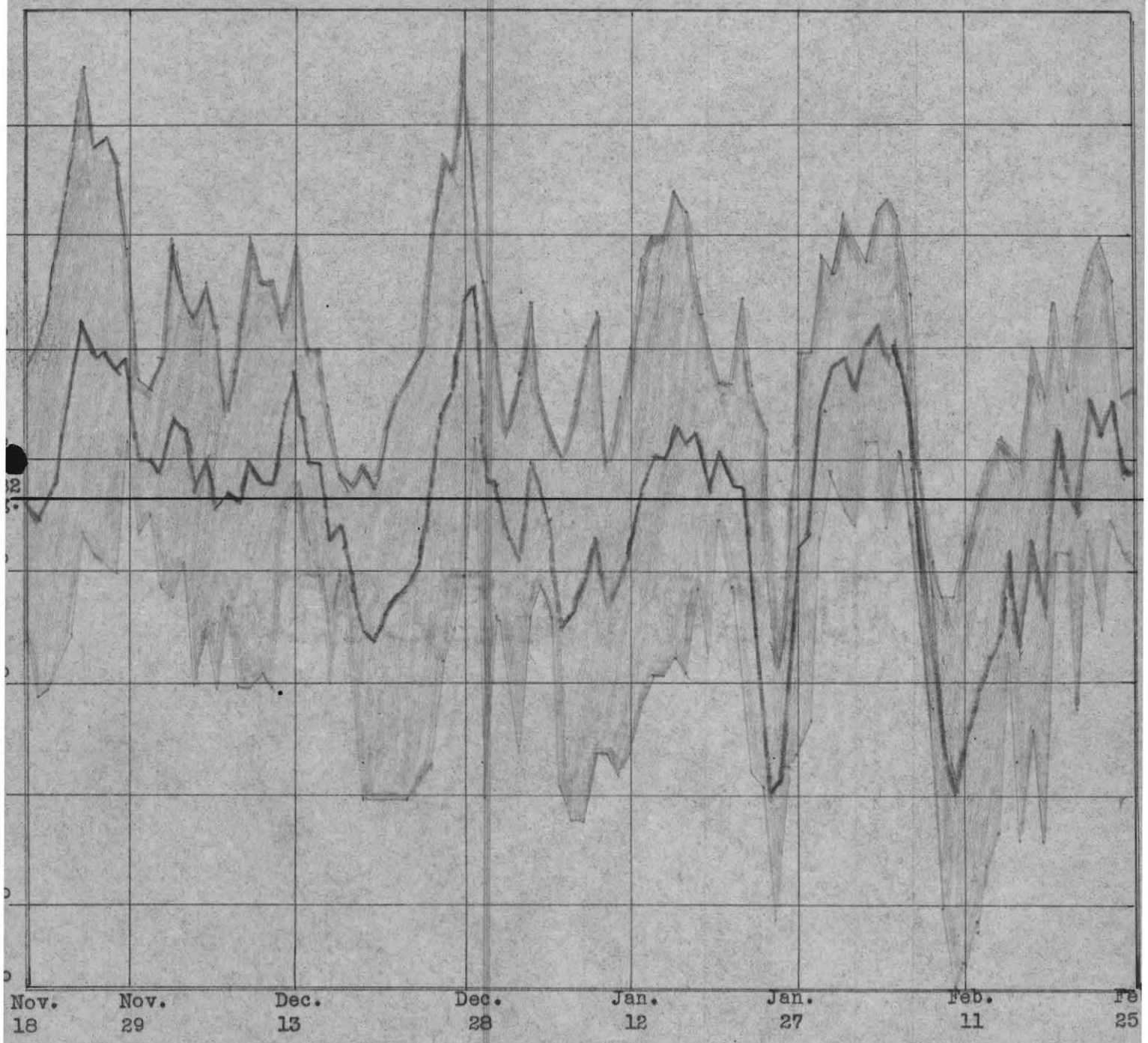
hart The following graph shows a plot of the rate of gains and the mean temperature in comparison with the average gain and average temperature for each of the different periods. It shows for instance that in the first ten day period that the mean temperature was 34.4 per cent above the average and that the gains were 30.8 per cent above the average for the entire feeding period, and during the fourth period the gains were 24.34 per cent and the temperature 38.4 per cent below the average for the entire feeding period.

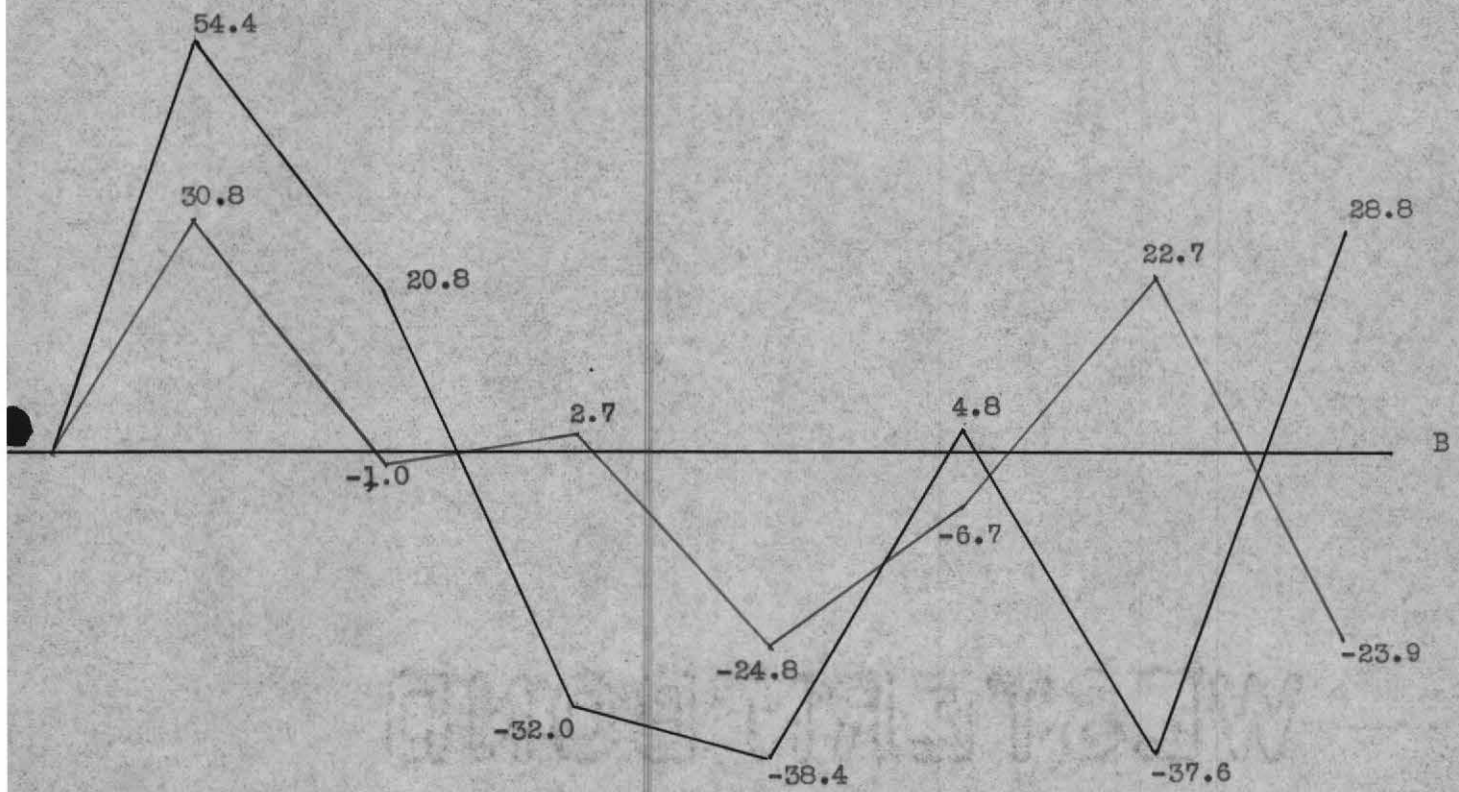
graph In working out correlation figures[1] it was necessary to first eliminate the effect of the rations. This was done by taking each lot of lambs seperately. The average gain per lamb for each lot during the feeding period was divided by 7 — the number of weighings — in order to get the average gain per lamb per period. This average was considered as 100 and given that value as an index. Then the actual gain for each period was compared to the index figure of 100, and the gain for each period given a relative figure. Thus for lot 1 the average gain of 4.71 pounds was considered as 100. Each period then was given a figure

[1] To Dr. Geo Stewart for his help in the correlation tables contained herein acknowledgement is hereby made.

Chart Showing Temperature Range For The

100 Days During Feeding Period





Line A - B represents the average temperature and average rate of gains.

The black line represents the temperature by periods. The red line represents the rate of gains by periods. The figures express the percentage above or below the average.

according to its value in relation to the average of 4.71. The gain during the 1st period for Lot 1 was 6.6 pounds, this is 140 per cent of 4.71 pounds, so 140 is given Lot 1, period 1 as the figure of relative gains.

The following table shows the gains during each period made by an average lamb in each lot. The second table shows the relative gains upon which the correlation computations were based.

Each of the 12 lots of 70 lambs was weighed three times, at the end of each of the seven periods. The average of these three weighings was used as the weight for that period. The difference in weighings at different periods was the gains made.

Table 39. Gains by 15 day periods

Lot No.	PERIOD 1	2	3	4	5	6	7	Total
1*	6.6	4.5	4.6	2.9	5.1	5.1	4.2	33.
2	4.9	4.	5.3	5.	.7	9.2	2.5	31.6
3	5.2	5.	5.2	4.9	5.	6.6	2.6	34.5
4	6.7	4.6	4.5	5.0	4.5	6.4	2.7	33.4
5	4.7	4.5	5.1	3.7	2.3	7.8	3.8	31.9
6	5.8	5.5	5.2	4.2	5.8	5.2	2.8	34.5
7	6.5	4.5	5	4.2	5.2	4.8	4.	34.2
8	7.1	4.9	5.1	2.9	6.5	5.7	3.2	35.4
9	6.5	4.3	4.3	1.7	6.4	3.8	4.2	31.2
10	6.7	4.9	5.5	3.9	4.5	4.3	4.3	34.1
11	6.4	4.	3.9	1.9	3.2	4.7	4.1	28.2
12	6.4	5.1	4.1	3.2	3.6	5.6	4.1	32.1
Total	75.50	55.8	57.8	42.5	52.8	69.2	42.50	

Table 40. Relative gains

Lot No.	PERIOD 1	2	3	4	5	6	7	Avg.
1	140	95.4	97.6	61.5	108.2	108.2	89.1	4.71
2	180.5	88.6	117.4	110.7	15.5	203.8	55.4	4.51
3	105.5	101.4	105.5	99.4	101.4	123.9	58.8	4.93
4	140	96.4	94.3	83.8	94.3	134.1	56.6	4.77
5	103.1	98.7	111.9	81.2	50.5	171.2	83.4	4.56
6	117.7	111.6	107.5	87.2	117.7	107.5	56.8	4.93
7	133.0	93.1	102.3	85.9	106.4	98.2	81.9	4.9
8	140.4	96.9	100.8	57.3	128.5	112.7	63.6	5.06
9	145.8	96.5	96.5	38.1	143.6	85.3	94.2	4.46
10	137.5	100.6	112.9	80	92.4	88.3	88.3	4.87
11	158.9	99.3	96.8	47.1	79.4	116.7	101.8	4.03
12	139.6	111.2	89.4	69.8	78.5	122.1	89.4	4.6
Avg.	130.8	99.1	102.7	75.2	93.3	122.7	76.1	100 per cent

* Seventh period for 10 days only

There were 84 weight figures. Three of the figures, were thrown out because of their extreme divergence from the group average. This left 81 figures to plot.

The following correlations are: A - correlation between maximum temperature and rate of gains; B - correlation between mean temperature and rate of gains; C - correlation between minimum temperature and rate of gains.

In Table 39 the gains in the seventh period are for 10 days only. In the following computations these figures are increased by 50 per cent, thus placing them upon a 15-day basis comparable with other periods.

Correlation A shows the relationship between the average maximum temperature(higher recording daily) and the rate of gains. Apparently the maximum temperature exerted very little effect upon the gains. Any correlation shown is too small to be of practical significance.

In correlation B a very strong correlation shows up between the average mean temperature recorded daily and the rate of gains made by the lambs. In this case the correlation coefficient is 9.78 times the probable error.

Correlation C shows a very high correlation between the average minimum temperature(lowest daily reading) and the rate of gains. A correlation coefficient of 7.2 times the probable error proves this high correlation.

This study indicates that the mean and the minimum daily temperatures exert a direct influence upon the rate of gains, while the effect of the maximum daily temperature appeared insignificant.

CORRELATION BETWEEN AVERAGE MAXIMUM DAILY TEMPERATURE AND THE RATE OF GAINS

A

1	2	3	4	5	6	7	8	9	10	11	12	13		Σ(yX)	Σ(yX)	Σ(YX)
					2	1	2	2	2	1			10	84	732	84
		1		2		2	3	1	1		1		11	82	674	164
					1	7	2	2					12	89	669	267
				1	3	1			2	3	1	1	12	108	1058	432
1	1	1	2		5	1		1					12	60	356	300
					1	4	4	3					12	93	731	558
							3	1		3	4	1	12	127	1381	889
													81	643	5601	2694

	1	2	3	4	5	6	7	8	9	10	11	12	13
(n)	1	1	2	2	3	12	16	14	10	5	7	6	2
Σ(xY)	5	5	7	10	8	48	59	52	40	12	34	34	11
Σ(xY)²	25	25	29	50	24	220	257	323	206	38	196	216	65
Σ(XY)	5	10	21	40	40	288	413	472	360	120	374	408	143

Σ(xY) = 332 = 1674 = 2694

Σ(xY)/n = 4.0988

Σ(xY)²/n = 20.6667

Σ(yX)/n = 7.9383

Σ(yX)²/n = 69.1480

Σ(YX)/n = 33.2593

$$\frac{33.2593 - (7.9383 \times 4.0988}{\sqrt{69.1480 - (7.9383)^2}\quad\sqrt{20.6667 - (4.0988)^2}} =$$

$$\frac{.7218}{\sqrt{6.1314}\quad\sqrt{3.8665}} = r$$

$$r = \frac{.7218}{2.4762 \times 1.9663} = .1483 = .0733$$

P.E. = .0733

$$\frac{r}{P.E.} = 2.02$$

CORRELATION BETWEEN AVERAGE MEAN TEMPERATURE AND GAINS

B

Table 42

	1	2	3	4	5	6	7	8	9	10	11	12	13		Σ(yX)	Σ(yX)²	Σ(YX)
1	1	1	1	2		5	1		1					12	60	356	60
2						2	1	2	2	2	1			10	84	752	168
3						1	4	4	3					12	93	731	279
4			1		2		2	3	1	1		1		11	82	674	328
5						1	7	2	2					12	89	669	445
6					1	3	1			2	3	1	1	12	108	1058	648
7								3	1		3	4	1	12	127	1361	889
n	1	1	2	2	3	12	19	14	10	5	7	6	2	81	643	5601	2817
Σ(xY)	1	1	5	2	14	55	64	59	35	20	41	33	15	328			
Σ(xX)	1	1	17	2	69	155	224	229	151	96	259	249	85	1656			
Σ(XX)	1	2	15	8	70	210	449	472	315	200	451	456	169	2817			

$\Sigma(xX)/n = 4.0494 = 7$

$\Sigma(x^2)/n = 20.4444$

$\Sigma(yX)/n = 7.9383 = \overline{X}$

$\Sigma(yX)^2/n = 69.148$

$\Sigma(YX)/n = 34.7778$

$$\frac{34.7778 - (7.9383 \times 4.0494)}{\sqrt{69.1480 - (7.9383)^2}\ \sqrt{20.4444 - (4.0494)^2}}$$

$$\frac{34.7778 - 32.1453}{\sqrt{69.1481 - 63.0166}\ \sqrt{20.4444 - 16.3976}}$$

$$\frac{2.6324}{\sqrt{6.1315}\ \sqrt{4.0468}}$$

$$\frac{2.6324}{2.4762 \times 2.0117} = r$$

$r = .5334 \mp .044$

P.E. = .054

$\frac{r}{P.E.} = 9.78$

CORRELATION BETWEEN THE AVERAGE OF THE MINIMUM DAILY TEMPERATURE AND RATE OF GAINS

Table 43

	1	2	3	4	5	6	7	8	9	10	11	12	13		Σ(yX)	Σ(yX)²	Σ(YX)
1						2	1	2	2	2	1			10	84	732	84
2	1	1	1	2		5	1		1					12	60	356	120
3						1	4	4	3					12	93	731	279
4			1		2		2	3	1	1		1		11	82	674	328
5						1	7	2	2					12	89	669	445
6					1	3	1			2	3	1	1	12	108	1068	648
7								3	1		3	4	1	12	127	1381	889
														81	643	5601	2793

1	1	2	3	12	14	12	5	4	6	2	61
2	2	6	4	24	28	24	57	24	18	40	15	330
4	4	20	8	48	104	224	285	144	90	250	245	85	1408
2	4	12	15	70	228	448	456	306	180	440	456	192	2793

$\Sigma(xX)/n = 4.0741$

$\Sigma(xX)^2/n = 20.5185$

$\Sigma(yX)/n = 7.9383$

$\Sigma(yX)^2/n = 69.1481$

$\Sigma(YX)/n = 34.4815$

$$\frac{34.4815 - (7.9383 \times 4.0741}{\sqrt{69.1481-(7.9383)^2}\ \sqrt{20.5185-(4.0741)}}$$

$$\frac{34.4815 - 32.3414}{\sqrt{6.1515}\ \sqrt{3.9202}} =$$

$$\frac{2.1401}{2.4762 \times 1.9799} =$$

$$r = \frac{2.1401}{4.9028} = .4365 = r$$

$r = .4365 \mp .0605$

$$P.E. = \frac{.6745(1-r^2)}{\sqrt{n}} = .0605$$

$$\frac{r}{P.E.} = 7.21$$

Effect of Temperature Upon Feed Cost

The following three graphs are plottings of: A, the maximum daily temperature and the cost of feed; B, the mean daily temperature in relation to cost of feed, and C, the minimum daily temperature in relation to the cost of feed.

The figures express the variation above or below the average for the feeding period.

The following correlation tables, D, E, and F (tables 46, 47 and 48) show the relationships existing between the maximum daily, mean daily, and minimum daily temperatures and the amount of feed eaten. The amount of feed is expressed as feed cost.

These correlation tables show exceptionally high negative correlations between temperature and feed cost. They show that as the temperature went up, feed cost decreased and that when the temperature dropped feed cost increased.

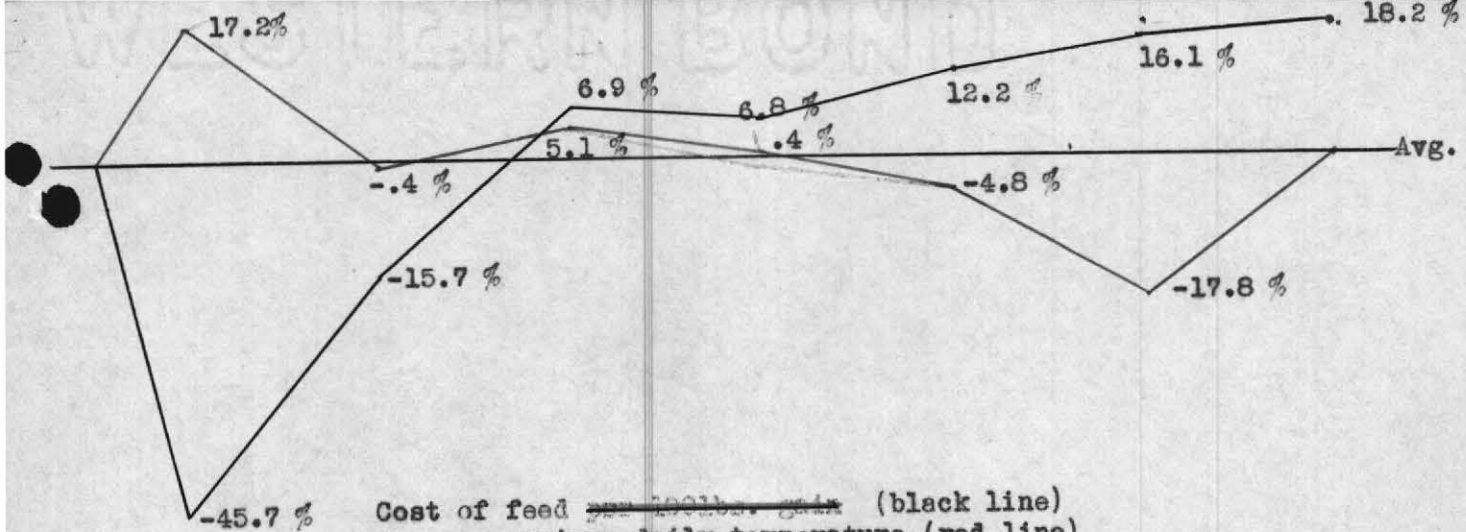
Tables 40, 44 and 45 supply the data for these correlations.

Amount of Feed and Rate of Gains

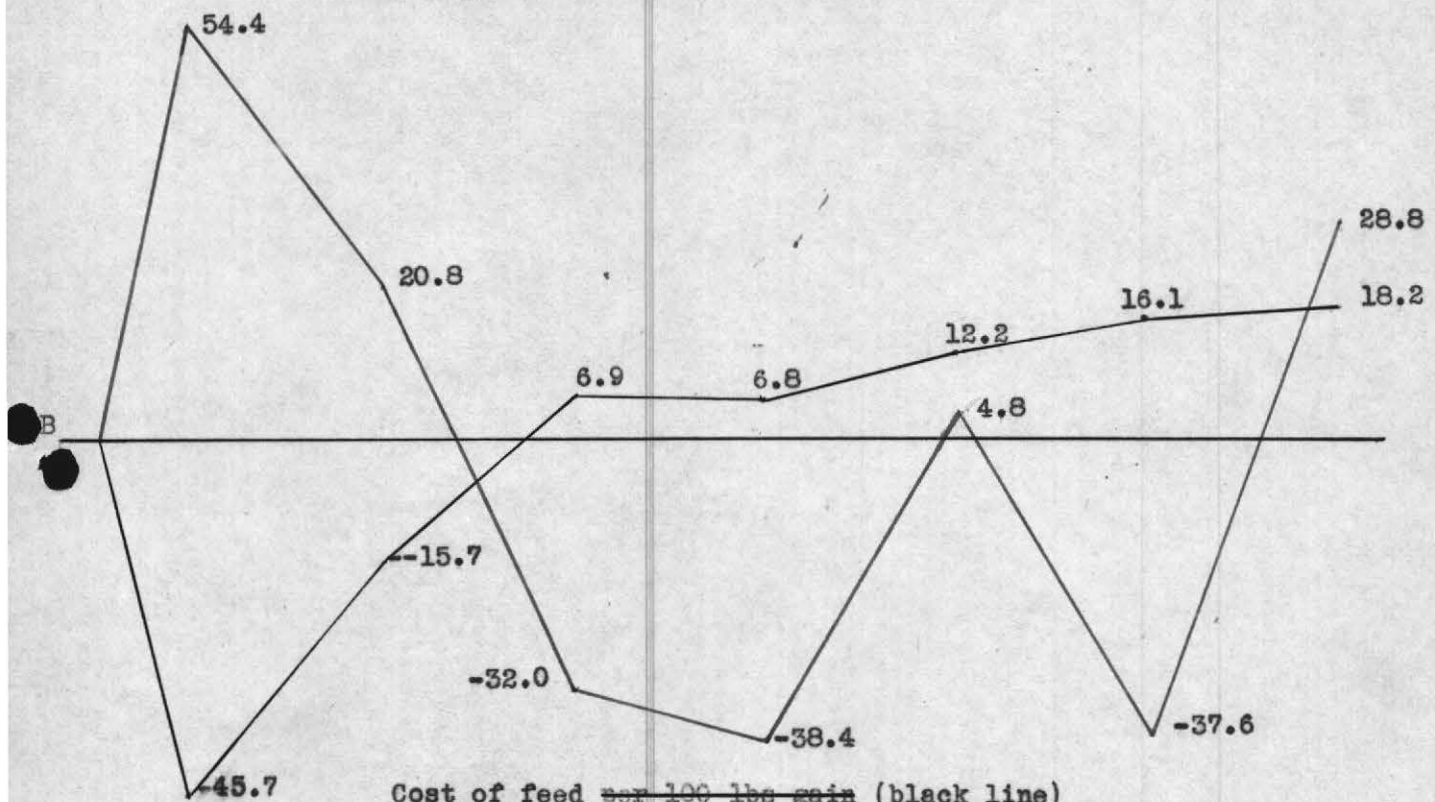
Tables 42 and 43 show a high correlation to exist between mean daily and minimum daily temperature and rate of gains. Tables 46, 47 and 48 show that a very high negative correlation exists in this experiment between temperature and feed cost. The question naturally arises, what relationship exists between feed cost (amount of feed eaten) and the rate of gains. From the data in Tables 40 and 45 the following correlation table was made. Correlation Table G (Table 49) shows that in this study there apparently was no correlation between feed cost and rate of gains.

It would appear from these tables that the increased feed in certain periods was made necessary by colder temperature.

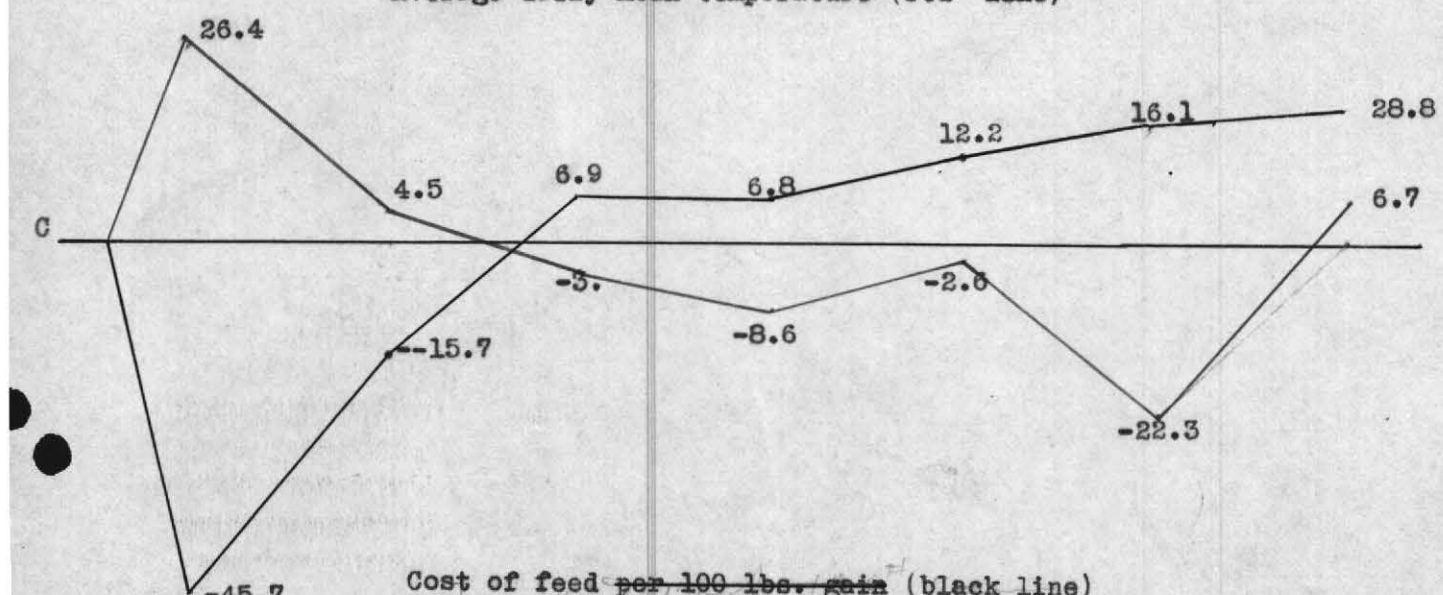
The idea that lambs do better during cold weather is not borne out in this study, but the study does indicate that feed costs are higher during cold weather, that is that lambs eat more feed but that increased gains do not necessarily result.



Cost of feed ~~per 100lbs. gain~~ (black line)
Average maximum daily temperature (red line)



Cost of feed ~~per 100 lbs gain~~ (black line)
Average daily mean temperature (red line)



Cost of feed ~~per 100 lbs. gain~~ (black line)
Average minimun daily temperature (red line)

Table 44. Cost of feed by periods

	1	2	3	4	5	6	7 (10-day)	Total
1	16.63	25.33	31.66	32.20	33.95	35.07	23.86	198.72
2	16.51	25.27	32.42	32.34	33.74	35.23	23.51	199.02
3	16.66	25.20	32.61	32.36	33.98	35.04	23.42	199.29
4	16.62	25.27	31.66	32.24	33.74	35.19	23.59	198.33
5	16.51	25.27	32.69	32.36	33.64	34.80	23.64	198.80
6	16.59	25.45	32.35	32.61	33.84	35.56	23.82	200.22
7	16.63	27.12	34.74	35.74	36.66	37.53	25.26	213.69
8	16.86	26.86	34.92	35.56	37.57	39.07	26.16	216.81
9	16.57	24.90	28.65	27.80	30.83	34.24	23.18	186.17
10	16.90	28.87	37.90	38.84	39.57	40.75	27.57	230.39
11	16.70	25.71	32.27	28.84	31.58	30.44	22.55	187.89
12	16.56	25.27	31.57	32.24	33.94	34.38	23.27	197.11
Daily:	199.76	310.52	393.48	392.82	413.84	427.20	289.84	$2426.44
	17.76	20.70	26.23	26.19	27.58	28.48	19.32	24.26
Daily Avg. per lot	1.65	1.72	2.19	2.18	2.29	2.37	1.61	
Per Lamb	2.35¢	2.46¢	3.12¢	3.12¢	3.28¢	3.39¢	3.3¢	

Table 45. Relative feed cost for all lots by periods

	1	2	3	4	5	6	7
1	55.27	84.18	105.39	107.0	112.83	116.55	118.94
2	54.92	83.62	107.64	107.34	112.06	117.94	117.1
3	54.78	83.84	108.20	107.37	112.74	116.86	116.56
4	55.36	84.18	105.53	107.4	112.30	117.22	117.9
5	55	84.18	108.91	107.46	112.06	115.92	118.12
6	54.7	84.0	106.8	107.6	111.7	117.3	119.9
7	51.4	83.8	107.3	110.4	113.3	116	117.0
8	51.4	81.2	106.4	107.8	112.6	119.1	119.6
9	58.6	88.2	101.4	101.4	109.1	121.2	123.1
10	48.5	82.8	106.7	111.4	113.4	116.8	118.5
11	58.7	90.4	113.45	101.4	103	107.0	119.1
12	55.5	84.7	105.9	108.1	113.8	114.9	117
	199.76	310.32	393.48	392.82	413.84	427.81	434.76
Percentage	-45.7	-15.7	106.9	106.8	112.2	116.11	118.2

The average feed cost per period for each lot was taken as 100 (the index figure).

CORRELATION BETWEEN MAXIMUM DAILY TEMPERATURE AND FEED COST

Table 46

	1	2	3	4	5	6	7	8	9	
1							1	10	1	12
2							2	10		12
3					11	1				12
4								11	1	12
5							10	2		12
6							11	1		12
7	1	11								12
										84

	1	11	0	0	11	24	36
Σ(xY)	7	77	0	0	33	121	60
Σ(xY)²	49	859	0	0	99	845	312
Σ(XY)	7	154	0	0	165	847	720

2	84
5	336
12	1080
45	1956

Σ(xY)/n = 4.0000 = $\overline{Y}$

Σ(xY)²/n = 20.0000

D

Σ(yX)	Σ(yX)²	Σ(YX)
96	770	96
94	738	188
61	311	183
97	785	388
86	618	430
85	603	510
23	45	161
542	3870	1956

Σ(yX)/n = 6.4524 = $\overline{X}$

Σ(yX)²/n = 46.0714

Σ(XY) = 23.2857

$$\frac{23.2857 - (6.4524 \times 4.2143)}{\sqrt{46.0714-(6.4524)^2}\ \sqrt{20-(4.0000)^2}} = r$$

$$\frac{23.2857 - 27.1925}{\sqrt{46.0714(41.6335)}\ \sqrt{20.0 - 16.0}} = r$$

$$\frac{-3.9068}{\sqrt{4.4379} \times \sqrt{4.0}} = r$$

$$\frac{-3.9068}{2.1066 \times 2.0} = r$$

$$\frac{-3.9068}{4.2132} =$$

r = - .9272 = .0394

$$P.E. = \frac{.6745\,(1 - r^2)}{\sqrt{r^2}} = \frac{.66092}{9.1651} =$$

P.E. = .0394

$$\frac{r}{P.E.} = -23.5$$

CORRELATION BETWEEN MINIMUM TEMPERATURE AND FEED COST PER HEAD

Table 47

	1	2	3	4	5	6	7	8	9	
1							10	2		12
2							1	10	1	12
3							11	1		12
4							2	10		12
5					11	1				12
6								11	1	12
7	1	11								12
										84

$\Sigma(xX)$	7	154	0	275	30	371	1043	72	1957
$\Sigma(xX)^2$	49	538	0	275	25	345	007	40	1680
$\Sigma(xX)$	7	77	0	55	5	55	131	0	330
x	1	11	0	0	11	1	24	36	84

$\Sigma(xX)/n = 4.00 = \bar{X}$

$\Sigma(xX)/n = 20.00$

E

$\Sigma(yX)$	$\Sigma(yX)^2$	$\Sigma(YX)$
86	618	86
96	770	192
85	603	255
94	736	376
61	311	305
97	785	582
23	45	161
542	3870	1957

$\Sigma(yX)/n = 6.4524 = \bar{X}$

$\Sigma(yX)^2/n = 46.0714$

$\Sigma(yX)/n = 23.2976$

$$\frac{23.2976 - (6.4524 \times 4.0000)}{\sqrt{46.0714-(6.4524)^2}\ \sqrt{20. -(4.)^2}} = r$$

$$\frac{23.2976 - 25.8096}{\sqrt{46.0714-(41.6335}\ \sqrt{20 - 16}} = r$$

$$\frac{-2.5120}{\sqrt{4.4379}\ \sqrt{4}} = r$$

$$\frac{-2.5120}{2.1066 \times 2} = r$$

$$\frac{-2.5120}{4.2132} = -.59622$$

$$\text{P. E.} = \frac{.6745(1-r^2)}{\sqrt{n}} = .047$$

$$\frac{r}{\text{P.E.}} = -12.51$$

CORRELATION BETWEEN AVERAGE TEMPERATURE AND FEED COST

TABLE 48

	1	2	3	4	5	6	7	8	9	
1							1	10	1	12
2							10	2		12
3							11	1		12
4							2	10		12
5					11	1				12
6								11	1	12
7	1	11								12
										84

$\Sigma(yX)$	96	86	85	94	61	97	23	542
$\Sigma(yX)^2$	770	618	603	738	311	785	45	3870
$\Sigma(YX)$	96	172	255	376	305	582	161	1947

$\Sigma(yX)/n = 6.4524 = \bar{X}$

$\Sigma(yX)^2/n = 46.0714$

$\Sigma(YX)/n = 23.1786$

$\Sigma(XY)$	7	77	0	55	5	62	125	7	336
$\Sigma(XY)^2$	49	539	0	275	25	172	625	57	1680
$\Sigma(XY)^2$	7	154	0	275	30	434	864	65	1947

$\Sigma(XY)/n = 4.0000 = \bar{Y}$

$\Sigma(XY)^2/n = 20.0000$

$$\frac{23.1786 - (6.4524 \times 4)}{\sqrt{46.0714 - (6.4524)^2}\sqrt{20.0000 - (4)^2}} =$$

$$\frac{-2.6310}{\sqrt{46.0714 - 41.6335}\sqrt{20.0 - 16.0}} =$$

$$\frac{-2.6310}{\sqrt{4.4379}\sqrt{4}} =$$

$$\frac{-2.6310}{121966 \times 2} = -.6345 = r$$

$$P.E. = \frac{.6745(1-r^2)}{\sqrt{n}} = .02797$$

$$r = -.6345 \mp .02797$$

$$\frac{r}{P.E.} = -22.32$$

CORRELATION BETWEEN RATE OF GAINS AND FEED COST

Table 29 G

	1	2	3	4	5	6	7	8	9	10	11	12	13		Σ(yX)	Σ(yX)²	Σ(YX)
1								3	1		3	4	1	12	127	1361	127
2						1	7	2	2					12	69	669	178
3	1	1	1	2		5	1		1					12	60	356	180
4						1	4	4	3					12	93	751	372
5			1		3		2	3	1	1		1		11	82	674	410
6						2	1	2	2	2	1			10	84	732	504
7					1	3	1			2	3	1	1	12	108	1058	756
														81	645	5601	2527

	1	1	2	2	3	12	16	14	10	5	7	6	2	81
Σ(XY)	3	3	8	6	17	54	56	60	57	51	50	18	6	319
Σ(yX)²	1	9	64	18	66	324	256	225	169	196	196	72	50	1575
Σ(yX)	3	6	24	24	85	324	392	400	333	310	350	192	104	2527

$\Sigma(XY)/n = 3.9383 = \overline{X}$

$\Sigma(yX)^2/n = 19.4444$

$\Sigma(yX)/n = 7.9383 = \overline{Y}$

$\Sigma(yX)^2/n = 69.1481$

$\Sigma(YX)/n = 31.1975$

$$\frac{31.1975 - (7.9383 \times 3.9383)}{\sqrt{69.1481 - (7.9381)^2}\ \sqrt{19.4444 - (3.9381)^2}}$$

$$\frac{31.1975 - 31.2634}{\sqrt{69.1481 - 63.0166}\ \sqrt{19.4444 - 15.5102}}$$

$$\frac{- .0659}{\sqrt{6.1305}\ \sqrt{3.9342}} = r$$

$$\frac{- .0659}{2.4759 \qquad 1.9835} = r$$

$$\frac{- .0659}{4.9109} = - .0134 = r$$

P. E. = .0675

$r = -.0134 \pm .0675$

$\frac{r}{P.E.} = - .2$

(P.57 follows)

Effect of Handling

To determine what effect handling incident to weighing had upon the rate of gains a brief study was made.

In order to determine if the lambs either gained or lost during the three days of the weighing process all the weights taken on the first day of the eight different weight periods were totaled for each lot separately. The same was done for the second and for the third day's weights of the eight weight periods. Column I of Table 50 shows the totals of eight first day's weighings; Column II the totals of the second day's weighings and Column III gives the total of all weights taken on the third days, for each lot separately.

Table 50. Totals for first, second and third day's weighings for each lot

Lot	1st Weighing	2d Weighing	3d Weighing	Avg.
1	45,356	45,528	45,530	45,406.7
2	43,970	43,956	43,902	43,942.6
3	45,570	45,416	45,652	45,546.0
4	44,961	45,154	45,206	45,107.0
5	44,430	44,654	44,520	44,534.7
6	45,852	45,876	46,152	45,953.3
7	45,042	44,852	45,390	45,094.7
8	45,564	45,372	45,774	45,570.0
9	44,746	44,628	44,867	44,747.0
10	45,426	45,230	45,664	45,430.0
11	43,167	43,226	43,268	43,317.0
12	44,329	44,568	44,402	44,439.3
Total	538,412	538,280	540,307	538,997
Avg.	44,867	44,857	45,026	4,471.6

Table 51 gives the first, second, and third day's weighings of all lambs(840 head) at the different weighing periods.

Table 51. Weights of all lots and weights by periods

Beginning of Period	1st Weighing	2d Weighing	3d Weighing	Avg.
1	52,657	52,818	53,398	52,957.6
2	58,252	57,916	58,138	58,102
3	61,875	61,968	62,220	62,021.0
4	65,712	66,082	66,382	66,058.6
5	68,832	69,172	69,072	69,025.3
6	72,840	72,764	72,560	72,720.9
7	77,550	77,454	77,716	77,572.9
End of Period 7	80,694	80,106	80,821	80,539.4
Total all Lots:	538,412	538,280	540,307	538,997
	44,868	44,857	45,026	
Avg. Wgt.	5609.50	5627.5	5628.2	5614.5

Table 54 shows the average gain or loss between the first and the second days weights and between the second and third days weights for each of the seven periods.

Table 52. Table showing average gain or loss during the weighing days for the 840 lambs

Weighing Period No.	Date	Between 1st and 2d Day: Actual Gain	Between 1st and 2d Day: Expected Gain	Between 2d to 3d Day: Actual Gain	Between 2d to 3d Day: Expected Gain	1st to 3d Day: Actual	1st to 3d Day: Expected
1	Nov.19, 1928	161		580		741	
2	Dec. 2, 1928	-337		222		-114	
3	Dec.17, 1928	93		252		345	
4	Jan. 1, 1929	370		300		670	
5	Jan.16, 1929	340		-100		240	
6	Jan.31, 1929	- 76		-204		-280	
7	Feb.15, 1929	- 96		262		166	
Final	Feb.24,26,1929	-588		715		126	
Total		-132	2207.2	2027	2207.2	1895	4414.4
Avg. Gain or Loss		- 16.5	275.9	253.4	275.9	236.9	551.8

Between the average of the first days weighings and the average for the second days weighings there is an apparent shortage of 293.4 pounds from the weight expected had the normal rate of gains been maintained. Between the second and the third day's weights there was an apparent shortage of 22.5 pounds from the expected weights had normal gains been made. There was a shortage of

314.9 pounds as compared with the expected weight had the normal rate of gain been maintained.

This study indicates that handling lambs as is necessary in weighing shows down the gains during the days of weighing.

Table 53. Table of weights for one average lambs in each lot

Lot	Wgt. at Beginning	Period 1st (15-day)	2d (15-day)	3d (15-day)	4th (15-day)	5th (15-day)	6th (15-day)	7th (10-day)
1	63.9	70.5	75.0	79.6	82.5	87.6	92.7	96.9
2	62.5	67.4	71.4	76.7	81.7	82.4	91.6	94.1
3	63.5	68.7	73.7	78.9	83.8	88.8	95.4	98.0
4	62.8	69.5	74.1	78.6	82.6	87.1	93.5	96.2
5	63.7	68.4	72.9	78	81.7	84	91.8	95.6
6	63.7	69.5	75.0	80.2	84.4	90.2	95.4	98.2
7	62.6	69.1	73.6	78.6	82.8	88.0	92.8	96.8
8	62.6	69.7	74.6	79.7	82.6	89.1	94.8	98.0
9	63.6	70.1	74.4	78.7	80.4	86.8	90.6	94.8
10	62.9	69.6	74.5	80	83.9	88.4	92.7	97.0
11	62.3	68.7	72.7	76.6	78.5	81.7	86.4	90.5
12	62.5	68.9	74.0	78.1	81.3	84.9	90.5	94.6
	756.6	825.1	885.9	943.7	988.2	1039.	1108.2	1150.7
Lamb Avg.	62.0	68.76	73.74	78.64	82.35	86.58	92.35	95.9

Table 54. Feed cost per 100 lbs. gain

Lot	1	2	3	4	5	6	7	Avg.
1	3.58	8.13	9.88	15.65	9.50	9.90	8.08	8.08
2	4.76	8.96	8.84	9.89	67.48	5.48	15.10	14.74
3	4.61	7.16	8.99	9.43	9.74	7.60	12.92	7.56
4	3.59	7.74	10.19	11.35	10.84	7.82	12.68	8.03
5	4.96	7.98	9.13	12.66	20.60	6.36	8.89	8.82
6	4.08	6.58	8.85	11.30	8.28	9.79	12.28	7.64
7	3.65	8.60	9.87	12.24	10.15	11.13	9.06	8.09
8	3.41	7.72	9.83	17.56	8.25	9.64	11.82	8.53
9	3.64	8.34	9.50	23.05	6.90	12.71	7.95	9.01
10	3.59	8.47	9.75	14.18	12.63	13.46	9.17	8.91
11	3.76	9.05	11.84	22.41	13.80	9.37	5.72	9.49
12	3.70	6.99	11.14	14.31	13.43	8.70	8.18	8.31
Total	47.35	96.70	117.81	173.40	191.60	111.96	119.87	123.78

Table 55. Relative feed cost per 100 lbs. gain

Lot	1	2	3	4	5	6	7
1	44.4	100.6	122.1	193.2	117.4	122.3	99.9
2	32.14	60.8	59.97	65	457.8	37.2	83.9
3	60.9	94.7	118.9	124.7	128.8	100.5	170.9
4	44.7	96.4	126.9	141.3	135.	97.3	157.9
5	56.2	90.5	103.5	145.5	233.5	72.1	100.7
6	53.4	86.1	115.8	147.9	108.4	128.1	160.7
7	45.1	63.0	122.0	151.3	125.5	137.6	112.
8	40	90.5	115.2	205.8	96.7	112.	136.6
9	40.4	92.6	105.4	255.6	76.6	141.6	88.2
10	40.2	95.	109.4	159.1	141.7	151.1	102.9
11	39.6	95.2	134.7	236.1	145.4	98.7	60.5
12	44.5	84.1	134	172.2	161.6	104.7	98.4

Table 56. Percentage of total feed cost as represented by each feed

	Alfalfa	Grain	Molasses	Salt	Total Cost
Lot 1 (1st crop alfalfa)	78.69	118.09		1.94	198.72
Lot 2 (2d crop alfalfa)	79.35	118.14		1.55	199.02
Lot 3 (3d crop alfalfa)	79.27	118.09		1.93	199.29
Lot 4 (1st and 2d)	78.38	118.07		1.88	198.33
Lot 5 (2d and 1st)	78.68	118.14		1.78	198.80
Lot 6 (Tobacco cured alfalfa)	79.90	118.14		2.18	200.22
Lot 7 (Molasses)	74.81	117.88	19.36	1.64	213.69
Lot 8 (Corn)	79.35	135.22		2.06	216.81
Lot 9 (Wheat)	79.28	104.95		1.95	186.18
Lot 10 (Corn-molasses)	74.32	135.12	19.25	1.70	230.39
Lot 11 (Ground barley)	77.88	108.76		1.60	187.89
Lot 12 (Kelp)	77.55	118.16		1.42	197.11
Total	937.98	1428.42	38.61	21.63	2426.44
Percentage of Total	38.64	58.88	1.59	.89	100.00

Table 57.

FINAL REPORT--COOPERATIVE LAMB FEEDING EXPERIMENT--MONROE, UTAH

100 Days, November 18, 1928 to February 25, 1929--12 lots of 70 Lambs Each.

Data and Financial Statement based on average cost of lambs and feeds--Table based on one average lamb.

Lot Number	1	2	3	4	5	6	7	8	9	10	11	12	Avg.
	1st Crop	2d Crop	3d Crop	1 45Day:2 55 "	2 45Day:1 55 "	Brown Crop	1st Crop	1st Crop	1st Crop	1st Crop	1st Crop	1st Crop	All
The Rations Fed	Barley	Barley	Barley	Barley	Barley	Barley	Molasses: Barley	Corn	Wheat	Molasses: Corn	Ground: Barley	Kelp: Barley	Lots
Initial Weight(lbs.)	63.9	62.5	63.5	62.8	63.7	63.7	62.6	62.6	63.6	62.9	62.3	62.5	63.05
Final Weight(lbs.)	96.9	94.1	98.0	96.2	95.6	98.2	96.8	98.0	94.8	97.0	90.5	94.6	95.9
Gain in Weight(lbs.)	33.0	31.6	34.5	33.4	31.9	34.5	34.2	35.4	31.2	34.1	28.2	32.1	32.84
Avg. Daily Ration(lbs.):													
Hay	2.25	2.27	2.26	2.24	2.25	2.28	2.14	2.27	2.26	2.12	2.22	2.22	2.23
Grain	.964	.964	.964	.964	.964	.964	.962	.966	.895	.965	.84	.965	.948
Molasses							.375			.373			.374
Amt.Feed per cwt.Gain													
Hay	681.3	717.3	656.5	670.5	706.5	661.7	625.0	641.9	726.0	622.7	789.1	690.1	682.40
Grain	292.1	305.1	279.4	288.6	302.3	279.5	281.4	272.8	287.0	283.2	297.8	300.5	289.10
Molasses							114.3			113.7			114.00
Initial Cost,$11 cwt.	6.75	6.60	6.71	6.63	6.73	6.73	6.61	6.61	6.72	6.64	6.58	6.60	6.66
Int.on Invest. @ 8%	.21	.21	.21	.21	.21	.21	.21	.21	.20	.22	.20	.21	.2092
Cost of Feed ($)	2.84	2.84	2.85	2.84	2.84	2.86	3.05	3.10	2.66	3.28	2.68	2.82	2.89
Total Cost(death loss incl.)	9.92	9.77	9.89	9.80	9.91	9.92	9.99	10.04	9.70	10.28	9.58	9.75	9.88
Selling Price Per cwt.	14.50	14.59	15.12	14.40	14.64	14.83	15.02	15.22	14.74	14.93	13.92	13.68	14.63
Return per Lamb	14.05	13.73	14.82	13.85	14.00	14.56	14.54	14.92	13.97	14.48	12.60	12.94	14.04
Profit Per Lamb	4.13	3.96	4.93	4.05	4.09	4.64	4.55	4.88	4.27	4.22	3.01	3.19	4.15
Cost of Feed per Cwt. Gain ($)	8.60	8.98	8.26	8.50	8.90	8.29	8.92	8.76	8.52	9.62	9.50	8.79	8.83

1. Price of feed: Alfalfa, $10; Barley, $1.75; Grinding 10¢ cwt.; Wheat, $1.67; Corn, $2.; Salt, $30 per ton; Molasses, $14.75 per ton. No value given to kelp which was fed at 1.07 per cent of entire ration (340 lbs.)

2. Average death loss 12%

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Statistics from Yearbooks for years 1920 to 1928, inclusive, were also used in connection with this thesis.