

RATIONS FOR FATTENING  
RANGE LAMBS

OHIO  
Agricultural Experiment  
Station

WOOSTER, OHIO, U. S. A., JUNE, 1912.

*BULLETIN 245*



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# BULLETIN

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### RATIONS FOR FATTENING RANGE LAMBS

B. E. CARMICHAEL J. W. HAMMOND

#### INTRODUCTION

The data presented in this bulletin have been gathered in a continuation of the study of lamb feeding under Ohio conditions which was begun by the Ohio Station in 1905, and which has been carried on each year, except one, since that time. For three consecutive years the work was done in cooperation with Mr. S. J. Fryer, at his farm in Wayne county. Increased appropriations have since made it possible to do some lamb feeding work at the Experiment Station. In all, over 800 lambs have been used in these tests.

While market conditions go far toward controlling the profits from lamb feeding operations, yet the kind of rations used is a factor that is of great importance and one which, fortunately, may be controlled by the feeder. Important differences in the efficiency of various rations have been found, as will be noted in the following pages. Bulletins 179 and 187 (which may be had upon request) show the results secured in the work of the first two years. The results of the last four years' work are presented in this bulletin.

#### EXPERIMENT I

CONDUCTED IN 1908

#### OBJECT

This experiment was conducted with two objects in view:

1. To compare a ration of corn and timothy hay with one of corn, linseed oilmeal and timothy hay.
2. To compare heavy and light grain rations.

#### PLAN OF EXPERIMENT

This experiment was conducted on the farm of Mr. S. J. Fryer. Four lots of 40 lambs each were used in the experiment, which lasted from January 14 to March 30, inclusive, a

period of 77 days. In this, as in all other experiments reported in this bulletin, all the lots were made as nearly alike as possible with respect to weight, breeding, conformation, quality and sex, and all lots were given the same treatment except for the difference in the rations.

**Lambs used:** The lambs used in this experiment were choice western feeders, carrying both Merino and Down blood. They were included in a band of feeders purchased on the Chicago market in November, 1907, by Mr. Fryer, for his winter feeding. The lambs were all run together on Mr. Fryer's farm and fed a light grain ration until January 14, when the experiment began.

**Rations:** The rations fed were as follows:

- Lot 1. Corn and timothy hay.
2. Corn, oilmeal and timothy hay.
3. Corn, oilmeal, timothy and alfalfa hay.
4. Corn, oilmeal (three-fourths as much concentrates as Lot 3), timothy and alfalfa hay.

All lots were fed as much roughage as they would consume without unnecessary waste. Lots 3 and 4 were given one feed of timothy and one of alfalfa hay each day. Lots 1, 2 and 3 were fed, when on full feed, all the grain they would consume up to one and one-half pounds daily per head. Lot 2 was fed corn and oilmeal in the proportion of 5 parts, by weight, of corn to 1 part oilmeal. The ratio of corn to oilmeal fed to Lots 3 and 4 was so adjusted that both lots were fed the same amount of oilmeal, although Lot 4 was fed but three-fourths as much total concentrates as was Lot 3. The average proportion for the entire experiment was 8.1 parts corn to 1 part oilmeal for Lot 3, and 5.7 parts corn to 1 part oilmeal for Lot 4. Table I shows the amount of feed consumed by the different lots by weekly periods.

TABLE I, Experiment I. Average feed consumed daily per lamb by weekly periods

Date	Lot 1		Lot 2		Lot 3		Lot 4	
	Corn	Timothy hay	Corn and oilmeal*	Timothy hay	Corn and oilmeal*	Timothy and alfalfa hay	Corn and oilmeal*	Timothy and alfalfa hay
Jan. 14-20.....	Lbs. 1.20	Lbs. 1.31	Lbs. 1.20	Lbs. 1.20	Lbs. 1.20	Lbs. 1.34	Lbs. .90	Lbs. 1.57
Jan. 21-27.....	1.35	1.23	1.35	1.25	1.35	1.34	1.01	1.53
Jan. 28-Feb. 3.....	1.35	1.25	1.35	1.26	1.35	1.35	1.01	1.53
Feb. 4-10.....	1.35	1.26	1.35	1.28	1.35	1.39	1.01	1.64
Feb. 11-17.....	1.35	1.24	1.35	1.24	1.35	1.40	1.01	1.60
Feb. 18-24.....	1.35	1.26	1.35	1.25	1.35	1.43	1.01	1.62
Feb. 25-March 2.....	1.50	1.22	1.50	1.24	1.50	1.41	1.125	1.62
March 3-9.....	1.50	1.11	1.50	1.12	1.50	1.37	1.125	1.62
March 10-16.....	1.49	1.04	1.50	1.09	1.50	1.38	1.125	1.62
March 17-23.....	1.03	.91	1.50	1.04	1.50	1.35	1.125	1.62
March 24-30.....	1.23	.92	1.50	1.06	1.50	1.36	1.125	1.64
Average.....	1.33	1.16	1.40	1.19	1.40	1.37	1.05	1.61

\*See text above for proportions of corn and oilmeal.

**Feeds used:** Shelled corn of good quality, old process finely ground oilmeal, and hay of good quality raised on the farm of Mr. Fryer, were used in this experiment.

**Method of feeding:** The daily ration was fed in two equal portions, morning and evening. The grain was fed first, followed by the hay, and any refuse hay was removed from the racks and weighed before the next feed of grain was given.

**Water, salt and bedding:** Water was supplied by automatically regulated tanks in each pen, so that the lambs had access to it at all times except when it was withheld at night previous to weighing. The lambs were supplied with salt twice weekly. Wheat straw and refused hay were used for bedding.

**Quarters:** The lambs were fed in the barn used in the experiments reported in Bulletins 179 and 187, to either of which the reader is referred for a description. The lambs were confined in pens 12.5x26 feet inside the barn, except when they were driven to the scales to be weighed.

#### WEIGHTS AND GAINS

In this, as in all the experiments reported in this bulletin, the initial and final weights were secured by taking the average of three weights taken on successive days. The lambs were also weighed one morning each week during the experiment to note the progress made by the different lots. The lambs were weighed in the morning before being given feed or water, the water having been withheld during the night previous to weighing. Table II shows the weight of each lot and the gain made by each lot for each week of the experiment.

TABLE II, Experiment I. Weight and gain for each lot by weekly periods; 40 lambs in each lot.

Date	Lot 1		Lot 2		Lot 3		Lot 4	
	Weight	Weekly gain	Weight	Weekly gain	Weight	Weekly gain	Weight	Weekly gain
January 13, 14, 15 ...	Lbs. 2,722	Lbs. ...	Lbs. 2,707	Lbs. ...	Lbs. 2,705	Lbs. ...	Lbs. 2,702	Lbs. ...
January 21.....	2,805	83	2,780	73	2,850	145	2,760	58
January 28.....	2,960	155	2,910	130	2,945	95	2,895	135
February 4.....	3,045	85	3,045	135	3,050	105	3,005	110
February 11.....	3,115	70	3,115	70	3,110	60	3,055	50
February 18.....	3,160	45	3,175	60	3,240	130	3,130	75
February 25.....	3,235	75	3,265	90	3,315	75	3,205	75
March 3.....	3,375	140	3,395	130	3,455	140	3,295	90
March 10.....	3,435	60	3,480	85	3,590	135	3,415	120
March 17.....	3,565	130	3,610	130	3,710	120	3,535	120
March 24.....	3,525	-40	3,695	85	3,795	85	3,585	50
March 30, 31, April 1	3,630	105	3,765	70	3,872	77	3,658	73

Table III shows the total gain and the average daily gain per lamb for each lot. It will be noted that large gains were made by

Lots 2 and 3, and the gains made by Lots 1 and 4 were very fair. An average daily gain of three-tenths of a pound per lamb is considered very good. Lot 1 made slightly less and Lot 4 slightly more than this amount of gain. This shows that very good gains are possible from such a ration as corn and timothy hay, although such a ration will, under market conditions that usually prevail, seldom be the most economical.

TABLE III, Experiment I. Summary of weights and gains; 40 lambs in each lot. Test lasted 77 days, January 14 to March 30, 1908, inclusive.

Lot	Ration	Initial weight	Final weight	Total gain	Average daily gain per lamb
		Jan. 13, 14, 15	Mar. 30, 31, Apr. 1		
1	Corn and timothy hay .....	Lbs. 2,722	Lbs. 3,630	Lbs. 908	Lbs. .295
2	Corn, oilmeal and timothy hay .....	2,707	3,765	1,058	.344
3	Corn, oilmeal, timothy and alfalfa hay.....	2,705	3,872	1,167	.379
4	Corn and oilmeal (light), timothy and alfalfa hay .....	2,702	3,658	956	.310

Lot 2, fed oilmeal in connection with corn and timothy hay, made 150 pounds, or 16.5 percent, more gain than did Lot 1, fed corn and timothy hay. Lot 3, fed alfalfa and timothy hay, made 109 pounds or 10.3 percent more gain than did Lot 2, which was fed the same amount of concentrates as Lot 3 but was fed only timothy hay for roughage. Lot 3, fed a full grain ration, made 211 pounds or 22 percent more gain than did Lot 4, fed a light grain ration.

#### EFFICIENCY OF RATIONS

Table IV shows the efficiency of the different rations measured by the amount of feed *consumed* per 100 pounds gain. Lot 2, fed corn and timothy hay supplemented with oilmeal, consumed less grain and hay per 100 pounds gain than did Lot 1, fed corn and timothy hay alone. Lot 3, fed one feed of timothy and one of alfalfa hay each day consumed less grain and slightly more hay per 100 pounds gain than did Lot 2, fed timothy hay and the same amount of concentrates as was fed Lot 3. Lot 4, fed a light grain ration, consumed 8.4 percent less grain, and 42.7 percent more hay per 100 pounds gain than did Lot 3, fed a full grain ration.

TABLE IV, Experiment I. Feed consumed per 100 pounds gain.

Lot	Corn	Oilmeal	Timothy hay	Alfalfa hay	Total
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1	451.7	...	393.0	.....	844.7
2	340.7	68.1	347.4	.....	766.2
3	329.3	41.4	176.3	186.7	733.7
4	288.9	50.5	250.2	267.9	857.5

## COST OF GAINS

Table V shows the cost of feed fed per 100 pounds gain for each lot. It shows that with feeds at the prices indicated in the table, the addition of oilmeal to a corn and timothy hay ration resulted in a material reduction in the cost of gain, as may be seen by comparing Lots 1 and 2. It also shows that a full grain ration was more economical than a light one, which will be noted by a comparison of Lots 3 and 4. It should be borne in mind that a change in the price of feeds would result not only in a difference in the cost of gain, but would affect the relative cost of gains produced by the different rations; that is, the ration that produces the cheapest gain at a given combination of prices for feeds, might not produce the cheapest gain with any other of the many possible combinations of prices.

TABLE V, Experiment I. Feed given; gains produced; cost of gains.

Feeds and prices	Lot 1		Lot 2		Lot 3		Lot 4	
	Amt.	Value	Amt.	Value	Amt.	Value	Amt.	Value
Corn, 63c per bushel.....	Lbs. 4,101	\$46.14	Lbs. 3,605	\$40.56	Lbs. 3,843	\$43.23	Lbs. 2,761.5	\$31.06
Oilmeal, \$36 per ton.....	.....	.....	721	12.98	453	8.69	433	8.69
Timothy hay, \$10 per ton.....	4,215	21.07	4,350	21.70	2,300	11.50	2,685	13.42
Alfalfa hay, \$10 per ton.....	.....	.....	.....	.....	2,305	11.52	2,685	13.42
Total cost of feed.....	.....	\$67.21	.....	\$75.24	.....	\$74.94	.....	\$66.59
Total gain.....	908	.....	1,058	.....	1,167	.....	956	.....
Cost of feed per 100 pounds gain on basis of above prices.....	.....	7.40	.....	7.11	.....	6.42	.....	6.97

The manner in which the cost of gain is affected by the price of feeds is illustrated by Table VI, which shows the cost of the feed required by each lot to produce 100 pounds of gain, with corn at five different prices varying from 28c to 84c per bushel, and timothy and alfalfa hay at six different prices, varying from \$5.00 to \$17.50 per ton. The figures in bold type in this table indicate the lowest combinations of these prices which would, under the conditions of this experiment, permit a profit from the addition of oilmeal (at \$36 per ton) to a ration of corn and timothy hay. With hay worth from \$15.00 to \$17.50 per ton, the addition of oilmeal to such a ration would be profitable with corn worth 42c or more per bushel, but with hay worth from \$5.00 to \$12.50 per ton, the addition of oilmeal would not be profitable until corn is worth 56c or more per bushel. It may thus be seen that whether or not it is profitable to add oilmeal worth \$36 per ton to a ration of corn and timothy hay for fattening lambs depends upon the prices of corn and hay. With a lower price for oilmeal it could be used at a profit with lower prices for corn and hay than are shown in the table.

TABLE VI, Experiment I. Cost of feed fed per 100 pounds gain with feeds at varying prices.\*

Corn per bushel	Lot	Price of hay per ton					
		\$5.00	\$7 50	\$10.00	\$12.50	\$15.00	\$17.50
28c	1	\$3 42	\$4 00	\$4 58	\$5 16	\$5 74	\$6 32
	2	3 96	4 47	4 99	5 50	6 01	6 53
	3	3 88	3 87	4 36	4 86	5 35	5 84
	4	3 76	4 46	5 16	5 86	6 57	7 27
42c	1	4 55	5 13	5 71	6 29	6 87	7 45
	2	4 81	5 32	5 84	6 35	6 86	7 38
	3	4 20	4 69	5 19	5 68	6 17	6 67
	4	4 48	5 18	5 88	6 59	7 29	7 99
56c	1	5 68	6 26	6 84	7 42	8 00	8 58
	2	5 66	6 17	6 69	7 20	7 72	8 23
	3	5 02	5 52	6 01	6 50	7 00	7 49
	4	5 20	5 90	6 61	7 31	8 01	8 71
70c	1	6 81	7 39	7 97	8 55—	9 13	9 71
	2	6 81	7 03	7 64	8 05	8 67	9 08
	3	6 85	6 84	6 83	7 33	7 82	8 31
	4	6 92	6 63	7 33	8 03	8 73	9 44
84c	1	7 94	8 52	9 10	9 68	10 26	10 84
	2	7 36	7 88	8 39	8 91	9 42	9 93
	3	6 67	7 16	7 66	8 15	8 64	9 14
	4	6 65	7 35	8 05	8 75	9 46	10 16

\*In computing this table, oilmeal was valued at \$36 per ton.

By comparing the cost of gains made by Lots 3 and 4 it may be seen that with feeds at any of the prices given in this table, the only combination of these prices which would result in the light grain ration (Lot 4) producing cheaper gains than the full grain ration (Lot 3) would be with corn worth 84c per bushel and hay worth \$5.00 per ton—a combination of prices that seldom prevails in Ohio.

#### CONSUMPTION OF ROUGHAGE

Table VII shows the amount of roughage fed and the amount and percentage consumed. Lot 2, fed oilmeal in addition to corn and timothy hay, consumed more hay than did Lot 1, not fed oilmeal. There was no striking difference in the percentage of the roughage consumed by Lots 1 and 2. Lot 3, fed one feed of timothy and one of alfalfa hay each day consumed more roughage than did Lot 2, fed the same amount of concentrates as was fed Lot 3, but fed timothy hay alone as a roughage. Lot 4, fed the light grain ration, consumed more roughage than did Lot 3, fed the full grain ration, although there was very little difference in the percentage of roughage consumed by these two lots. Lots 3 and 4, fed one feed of timothy and one of alfalfa hay each day, consumed a larger percentage of the timothy hay than did Lots 1 and 2, fed timothy hay alone as a roughage.



TABLE VII, Experiment I. Roughage fed and consumed.

Lot	Timothy hay			Alfalfa hay		
	Fed	Consumed	Percent consumed	Fed	Consumed	Percent consumed
	Lbs.	Lbs.	Percent	Lbs.	Lbs.	Percent
1	4,215	3,568	84.65	.....	.....	.....
2	4,370	3,675	84.49	.....	.....	.....
3	2,300	2,057.5	89.46	2,305	2,178.5	94.51
4	2,685	2,392	89.09	2,685	2,561.5	95.40

SHRINKAGE IN SHIPPING

Table VIII shows no decided difference in the amount of shrinkage of the different lots in shipping from Big Prairie to Pittsburgh, a distance of 149 miles.

TABLE VIII, Experiment I. Shrinkage in shipping.

Lot	Ration	Home weight*	Pittsburg weight**	Shrinkage	
				Total	Per cwt.
		Lbs.	Lbs.	Lbs.	Lbs.
1	Corn and timothy hay .....	3,630	3,470	160	4.41
2	Corn, oilmeal and timothy hay .....	3,765	3,600	165	4.38
3	Corn, oilmeal, timothy and alfalfa hay .....	3,872	3,700	172	4.44
4	Corn, oilmeal (light), timothy and alfalfa hay .....	3,653	3,500	158	4.32

\* Weighed before feed and water were given.  
 \*\* Weighed after feed and water were given.

EXPENSE OF SHIPPING AND MARKETING

Table IX shows a detailed statement of the various items of expense incidental to marketing the lambs in Pittsburgh.

TABLE IX, Experiment I. Expense\* of shipping and marketing.

	Lot 1	Lot 2	Lot 3	Lot 4
Freight .....	\$3.79	\$3.94	\$4.04	\$3.82
Commission .....	2.26	2.26	2.26	2.26
Feed, yardage, etc .....	3.44	3.44	3.44	3.44
Total .....	\$9.49	\$9.63	\$9.74	\$9.52

\* Freight charges based on weight. Commission, feed and yardage charges based on number of lambs in each lot.



Lot 1. Experiment I.



Lot 2. Experiment I.



Lot 3. Experiment I.



Lot 4. Experiment I.

## EXPERIMENT II

CONDUCTED 1909-1910, AT THE EXPERIMENT STATION

## OBJECT

The objects of this experiment were as follows:

1. To compare clover and alfalfa hay for fattening lambs when fed with shelled corn.
2. To compare corn stover and soybean straw for fattening lambs when fed with shelled corn and linseed oilmeal.
3. To compare all four rations as described above.

## PLAN OF EXPERIMENT

Four lots of 25 lambs each were used in the experiment which lasted from December 22, 1909 to March 1, 1910, inclusive, a period of 70 days.

Lambs used: The lambs used in this experiment were strictly choice western feeders—uniform, thrifty, vigorous and of good quality, showing a mixture of some of the long wool and Down breeds with Merino or Rambouillet. They were purchased on the Chicago market in December, 1909.

Rations: The rations fed the four lots were as follows:

- Lot 1 Corn, oilmeal and corn stover.
- 2 Corn, oilmeal and soybean straw.
- 3 Corn and clover hay.
- 4 Corn and alfalfa hay.

It was planned to feed as much grain as the lambs would eat, up to one and one-half pounds per head daily. Lots 1 and 2 were fed corn and oilmeal in the proportion of five parts, by weight, of corn to one part of oilmeal. Sufficient roughage was fed to allow the lambs to eat all they desired without excessive waste. Table X shows the average daily feed consumed by each lot by weekly periods.

TABLE X, Experiment II. Average feed consumed daily per lamb by weekly periods.

Date	Lot 1		Lot 2		Lot 3		Lot 4	
	Corn, 5; oilmeal, 1	Corn stover	Corn, 5; oilmeal, 1	Soybean straw	Corn	Clover hay	Corn	Alfalfa hay
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Dec. 22-28 .....	1.05	1.18	1.05	1.10	1.04	1.37	1.04	1.37
Dec. 29-Jan. 4 .....	1.29	1.19	1.29	1.10	1.29	1.25	1.29	1.28
Jan. 5-11 .....	1.41	1.21	1.41	1.14	1.41	1.24	1.41	1.14
Jan. 12-18 .....	1.44	1.12	1.44	1.07	1.44	1.24	1.06	1.24
Jan. 19-25 .....	1.44	1.19	1.44	1.04	1.44	1.21	1.44	1.24
Jan. 26-Feb. 1 .....	1.44	1.21	1.44	1.14	1.44	1.18	1.44	1.37
Feb. 2-8 .....	1.44	1.25	1.44	1.25	1.44	1.22	1.44	1.40
Feb. 9-15 .....	1.44	1.24	1.44	1.26	1.44	1.33	1.44	1.47
Feb. 16-22 .....	1.44	1.21	1.44	1.25	1.44	1.36	1.44	1.50
Feb. 23-March 1 .....	1.44	1.26	1.44	1.28	1.44	1.39	1.44	1.48
Average.....	1.38	1.21	1.38	1.16	1.38	1.28	1.34	1.35

**Feeds used:** The shelled corn used in this experiment was of good quality. The oilmeal was coarsely ground, somewhat finer than the regular pea size. The clover hay was of the mammoth red variety, raised on the Experiment Station farm during the summer of 1909. It was cut early, well cured, and of excellent quality. The alfalfa hay was also grown on the Experiment Station farm during the same season, and was more fibrous and woody than alfalfa hay of the best quality. The soybean straw, as the name indicates, was that part of the soybean plant which remained after the beans had been removed by threshing. It was composed of the stems, leaves and pods, and was very woody and coarse, although it was well cured and was not damaged by rains.

Table XI gives the analyses of the feeds and of the refuse from each kind of roughage used in the experiment, as reported by the Department of Chemistry of the Experiment Station.

TABLE XI, Experiment II. Percentage composition of feeds.

Feed ration	Water	Ash	Protein	Fiber	Nitrogen-free extract	Ether extract
	Percent	Percent	Percent	Percent	Percent	Percent
Corn.....	18.45	1.41	18.87	1.73	65.74	3.80
Oilmeal.....	10.73	5.12	53.66	8.17	36.45	5.87
Alfalfa hay.....	19.35	6.00	13.02	28.33	31.73	1.57
Alfalfa hay refuse.....	20.07	6.88	8.16	37.19	26.72	.98
Clover hay.....	17.11	4.99	9.65	36.50	30.61	1.14
Clover hay refuse.....	20.71	5.25	7.44	32.92	31.97	1.71
Corn stover.....	23.67	4.57	5.28	28.04	37.19	1.25
Corn stover refuse.....	19.75	3.71	3.07	33.40	38.86	1.21
Soybean straw.....	19.07	5.37	6.85	33.21	34.04	1.36
Soybean straw refuse.....	18.79	7.00	6.85	34.56	31.37	1.43

**Quarters:** The lambs were fed in a shed with a cement floor. Windows and hinged doors supplied ample light and ventilation. The windows were kept open at all times except when it became necessary to close them to prevent rain and snow from blowing in on the lambs.

Each pen contained approximately 240 square feet of floor space with a feed rack in the center. The lambs were confined to these pens at all times except when taken out to be weighed. The rack in which both hay and grain were fed had a tight bottom, with a board coming up about eight inches on the sides to prevent the feed from being worked out between the vertical slats.

**Method of giving feed, water, salt and bedding:** What has been said in the discussion of Experiment I regarding water, salt and bedding and the method of feeding will apply to this experiment, except that oat straw instead of wheat straw was used for bedding when the refused roughage was insufficient, and instead of water being given the lambs in automatically regulated tanks, and the lambs having access to it at all times except nights previous to weighing, it was given in the morning after feeding and removed after feeding time at night.

WEIGHTS AND GAINS

TABLE XII Experiment II. Weight and gain for each lot by weekly periods; 25 lambs in each lot.

Date	Lot 1		Lot 2		Lot 3		Lot 4	
	Weight	Weekly gain	Weight	Weekly gain	Weight	Weekly gain	Weight	Weekly gain
Dec. 20, 21, 22.....	Lbs. 1,822	Lbs.	Lbs. 1,834	Lbs.	Lbs. 1,831	Lbs.	Lbs. 1,847	Lbs.
Dec. 29 .....	1,840	18	1,783	-46	1,880	49	1,874	27
Jan. 5.....	1,906	66	1,870	82	1,948	68	1,948	74
Jan. 12.....	1,930	24	1,900	30	1,980	32	1,978	28
Jan. 19.....	1,980	50	1,970	70	2,040	60	2,006	30
Jan. 26.....	2,020	40	2,016	46	2,110	70	2,086	90
Feb. 2.....	2,110	90	2,112	96	2,210	100	2,200	104
Feb. 9.....	2,120	10	2,126	14	2,256	46	2,230	30
Feb. 16.....	2,184	64	2,210	84	2,324	68	2,288	68
Feb. 23.....	2,230	46	2,260	50	2,420	96	2,390	92
Feb. 28, March 1, 2..	2,276	46	2,318	58	2,460	40	2,422	32

The weight and gain for each lot by weekly periods is shown in Table XII. A summary of the weights and gains is shown in Table XIII.

TABLE XIII, Experiment II. Summary of weights and gains. 25 lambs in each lot. Test lasted 70 days, Dec. 22, 1909, to March 1, 1910, inclusive.

Lot	Ration	Initial weight Dec. 20, 21, 22	Final weight Feb. 28; Mch. 1, 2	Total gain	Average daily gain per head
		Lbs.	Lbs.	Lbs.	Lbs.
1	Corn, oilmeal and corn stover.....	1,822	2,276	454	.259
2	Corn, oilmeal and soybean straw.....	1,834	2,318	484	.277
3	Corn and clover hay.....	1,831	2,460	629	.359
4	Corn and alfalfa hay.....	1,847	2,422	575	.329

The last column in Table XIII, showing the average daily gain per lamb, shows that fattening lambs may make very good gains when fed corn and corn stover or corn and soybean straw, supplemented with linseed oilmeal. This should not be interpreted, however, to indicate that the use of these roughages is advisable or profitable under all conditions, (Tables XIV and XV) but it is intended to show that, by their use, a fair rate of gain is possible. Table XIII also shows that mammoth clover hay and corn produced slightly greater gain than did alfalfa hay and corn.

EFFICIENCY OF RATIONS

Table XIV furnishes data for a comparison of the efficiency of the different rations as measured by the amount of feed consumed per 100 pounds gain.

TABLE XIV, Experiment II. Feed consumed per 100 pounds gain.

Lot	Ration	Corn	Oilmeal	Roughage	Total
		Lbs.	Lbs.	Lbs.	Lbs.
1	Corn, oilmeal and corn stover.....	444.5	88.3	464.6	997.4
2	Corn, oilmeal and soybean straw.....	416.9	82.8	420.0	919.7
3	Corn and clover hay.....	384.3	....	356.4	740.7
4	Corn and alfalfa hay.....	408.9	....	410.7	819.6

Lot 2, fed soybean straw consumed less grain and roughage per 100 pounds gain than did Lot 1, fed corn stover. Lots 3 and 4, fed clover and alfalfa hay, respectively, consumed less grain and roughage per 100 pounds gain than did Lots 1 and 2. Lot 3, fed clover hay, consumed less of both grain and hay per 100 pounds gain than did Lot 4, fed alfalfa hay. The production of greater gains at a smaller consumption of feed per 100 pounds gain by the lot fed clover hay than by the lot fed alfalfa hay is a rather unusual circumstance, and is probably due, in this case, to the fact that the clover hay was of exceptionally good quality on account of having been cut early and cured well. It was unusually bright, clean and palatable, while the alfalfa hay was somewhat woody and was not of the best quality.

#### COST OF GAINS

Table XV shows the cost of feed required to produce 100 pounds gain. With the prices for feeds given in the table, the cheapest gain was produced by clover hay (Lot 3), while alfalfa hay (Lot 4) produced the most expensive gain. With both roughages valued at the same price, the gain produced by corn stover cost 31c per 100 pounds more than did that produced by soybean straw.

While, in this experiment, clover hay produced greater gain than did alfalfa hay, probably on account of the clover hay being of better quality than the alfalfa, the difference in the cost of the gains produced is not all due to the greater gain produced by the clover, but is partly due to the higher valuation given the alfalfa. If alfalfa is given a valuation of \$12.50 per ton, the same as clover hay, the cost per 100 pounds gain produced by alfalfa hay would be \$7.13 instead of \$7.83. A table showing the cost of gains produced by different rations is very liable to be misleading, and the reader is cautioned to bear in mind the fact that the relative economy of different rations may be greatly changed by a variation in the price of feeds.

TABLE XV, Experiment II. Feed given; gains produced; cost of gains.

Feeds and prices	Lot 1		Lot 2		Lot 3		Lot 4	
	Amt.	Value	Amt.	Value	Amt.	Value	Amt.	Value
Corn, 56c per bushel .....	Lbs. 2,018.	\$20.18	Lbs. 2,018.	\$20.18	Lbs. 2,417	\$24.17	Lbs. 2,351	\$23.51
Oilmeal, \$36 per ton.....	400.8	7.21	400.8	7.21	.....	.....	.....	.....
Corn stover, \$5 per ton .....	3,130.	7.82	.....	.....	.....	.....	.....	.....
Soybean straw \$5 per ton .....	.....	.....	3,460.	8.65	.....	.....	.....	.....
Clover hay \$12.50 per ton.....	.....	.....	.....	.....	2,800	17.50	.....	.....
Alfalfa hay \$18 per ton .....	.....	.....	.....	.....	.....	.....	2,800	21.50
Total cost of feed.....		\$35.21		\$36.04		\$41.67		\$45.01
Total gain .....	454		484		629		575	
Cost of feed per 100 pounds gain on basis of above prices.....		7.76		7.45		6.72		7.83

Table XV indicates that it is not economical to use corn stover or soybean straw, even when supplemented with oilmeal, as the sole roughage for fattening lambs when clover hay can be had for \$12.50 per ton. This table shows that in this experiment, in which alfalfa hay of rather inferior quality was used, and the gain produced was smaller than would be expected from alfalfa hay of good quality, corn stover and soybean straw both produced cheaper gains than did alfalfa hay, with feeds at the prices indicated in the table. However, the results of Experiments III and IV, reported in this bulletin, indicate that alfalfa hay, at prices which ordinarily prevail on the farm, is a more economical roughage than is corn stover for fattening lambs. (See pages 703 and 715).

#### CONSUMPTION OF ROUGHAGE

Table XVI shows the amount and percentage of roughage consumed by each lot. The percentage of clover and alfalfa hay consumed is lower than would be expected from hay of good quality. It was planned to feed the lambs all the roughage they would consume, and to insure their having all they cared to eat at all times, a sufficient amount was fed to result in a higher percentage of waste than would usually occur in feeding practice. The percentage of corn stover and soybean straw consumed was not quite so high as is shown by the figures in this table, as a small amount of these materials was pulled from the racks by the lambs and could not be weighed with the refuse.

TABLE XVI, Experiment II. Roughage fed and consumed.

Lot	Kind of roughage	Roughage		
		Fed	Consumed	Percent consumed
		Lbs.	Lbs.	Lbs.
1	Corn stover.....	3,130	2,109.3	67.39
2	Soybean straw.. . . .	3,460	2,033.	58.76
3	Clover hay.....	2,800	2,241.8	80.06
4	Alfalfa hay.....	2,800	2,361.3	84.33

#### SHRINKAGE IN SHIPPING

The amount of shrinkage per 100 pounds live weight in shipping from Wooster to Pittsburg, a distance of 135 miles, as shown in Table XVII, is unusually low, except for Lot 3, which more nearly corresponds with the usual amount of shrinkage in shipping lambs this distance. The reasons for this unusually light shrinkage and for the difference in the amount of shrinkage for the four lots are not evident.

TABLE XVII, Experiment II. Shrinkage in shipping.

Lot	Ration	Home weight,* Mch. 3	Pittsburgh weight** Mch. 4.	Shrinkage	
				Total	Per cwt.
1	Corn, oilmeal and corn stover. . . . .	Lbs. 2,270	Lbs. 2,240	Lbs. 30	Lbs. 1.32
2	Corn, oilmeal and soybean straw.....	2,320	2,280	40	1.72
3	Corn and clover hay.....	2,460	2,400	60	2.44
4	Corn and alfalfa hay.....	2,450	2,410	40	1.63

\*Weighed before feed and water were given.

\*\*Weighed after feed and water were given.

## FINISH AND MARKET PRICE

Although the buyer at market made no distinction between the lots as to finish, and all lots sold on the Pittsburgh market for the same price, \$9.50 per hundredweight, yet there seemed to be a difference in finish in favor of Lots 3 and 4, and the rate and amount of increase in live weight show that there was a difference in time required to produce good market finish.

## EXPENSE OF SHIPPING AND MARKETING

Table XVIII gives a detailed account of the expenses incurred in shipping and marketing the lambs. The freight charges are apportioned on the basis of the weights of each lot at Pittsburgh; other charges are based on the number of lambs in each lot.

TABLE XVIII, Experiment II. Expense of shipping and marketing.

	Lot 1	Lot 2	Lot 3	Lot 4
Freight... . . . .	\$2.54	\$2.58	\$2.72	\$2.73
Commission.....	2.00	2.00	2.00	2.00
Feed and yardage.....	3.01	3.01	3.01	3.01
Total.....	\$7.55	\$7.59	\$7.73	\$7.74

## EXPERIMENT III

CONDUCTED 1911, AT THE EXPERIMENT STATION

## OBJECT

The preceding experiment, conducted in 1909-10, furnished a not altogether satisfactory basis for comparing corn stover with alfalfa and clover hay for fattening lambs, on account of the different grain rations that were used. This third experiment was planned for the purpose of securing further data regarding roughages for lamb feeding by comparing clover hay, alfalfa hay, oat straw and corn stover when each roughage was fed with corn alone and when each was fed with a mixture of corn and linseed oilmeal.



## PLAN OF EXPERIMENT

The experiment began January 3 and lasted until April 5, 1911, inclusive, a period of 93 days. The lambs arrived at the Experiment Station December 2, 1910, and were divided into eight lots of fourteen lambs each, and each lot was gradually started on its experimental ration so as to be accustomed to the feed by the time the experiment began. During this preliminary feeding, one lamb in Lot 3 and one in Lot 4 showed marked signs of unthriftiness and were removed from the lots, so that when the experiment began Lots 3 and 4 contained but 13 lambs each. On March 9, one lamb in Lot 4, weighing 88.5 pounds, died from an unknown cause. The lambs were shorn March 22 to 24.

**Lambs used:** The range lambs used in this experiment were wethers, showing a mixture of Down and Merino or Rambouillet blood. A majority of them showed a predominance of fine wool blood and a number carried more neck folds and heavier pelts than is consistent with the best quality. Otherwise, they were very desirable feeders. They were purchased on the Chicago market November 30, 1910.

**Rations:** The rations fed were as follows:

- Lot 1 Corn and clover hay.
- 2 Corn and alfalfa hay.
- 3 Corn and oat straw.
- 4 Corn and corn stover.
- 5 Corn, oilmeal and clover hay.
- 6 Corn, oilmeal and alfalfa hay.
- 7 Corn, oilmeal and oat straw.
- 8 Corn, oilmeal and corn stover.

When on full feed, all lots were fed as much grain as they would consume up to one and one-half pounds daily per head. Lots 5, 6, 7 and 8 were fed a grain ration of 5 parts, by weight, of corn to 1 part oilmeal. All lots were fed as much roughage as they would consume. Table XIX shows the amount of feed consumed daily per lamb by weekly periods.

**Feeds used:** The corn used was yellow dent, of good quality. The linseed oilmeal was old process, pea size. The clover hay was of the mammoth red variety, bright, clean, well cured and of excellent quality, but somewhat coarser than hay from ordinary medium red clover, which probably accounts for the rather large percentage of waste, as shown on page 707. The alfalfa was raised on the Experiment Station farm during the season of 1910, and was of good quality, aside from being a little woody. The oat straw was raised on the Experiment Station farm in 1910, and made a much ranker growth than is usual, and on account of its "lodging" and having been cut with a mowing machine it contained the most of the lower and coarser part of the straw which is ordinarily left in the field.

TABLE XIX, Experiment III. Average feed consumed daily per lamb by weekly periods.

Date	Lot 1		Lot 2		Lot 3		Lot 4		Lot 5		Lot 6		Lot 7		Lot 8	
	Corn	Clover hay	Corn	Alfalfa hay	Corn	Oat straw	Corn	Corn stover	Corn, 5; oilmeal 1	Clover hay	Corn, 5; oilmeal 1	Alfalfa hay	Corn, 5; oilmeal 1	Oat straw	Corn, 5; oilmeal 1	Corn stover
Jan. 3-9.....	Lbs. .89	Lbs. 1.52	Lbs. .89	Lbs. 1.59	Lbs. .96	Lbs. 1.38	Lbs. .96	Lbs. 1.84	Lbs. .89	Lbs. 1.61	Lbs. .89	Lbs. 1.67	Lbs. .89	Lbs. 1.35	Lbs. .89	Lbs. 1.59
Jan. 10-16.....	1.00	1.36	1.00	1.32	.96	.84	1.01	1.46	1.00	1.43	1.00	1.37	1.00	1.26	1.00	1.48
Jan. 17-23.....	1.00	1.45	1.00	1.56	1.00	1.32	1.00	1.70	1.00	1.43	1.00	1.61	1.00	1.33	1.00	1.66
Jan. 24-30.....	1.11	1.38	1.11	1.50	1.13	1.23	1.13	1.53	1.11	1.36	1.11	1.50	1.11	1.30	1.11	1.63
Jan. 31-Feb. 6.....	1.33	1.19	1.33	1.23	1.32	.95	1.32	1.34	1.33	1.15	1.33	1.27	1.33	1.02	1.33	1.71
Feb. 7-13.....	1.13	1.02	1.33	1.15	1.29	.90	1.23	1.31	1.33	1.03	1.33	1.13	1.33	.94	1.33	1.35
Feb. 14-20.....	1.29	1.14	1.29	1.18	1.25	.99	1.24	1.27	1.29	1.09	1.29	1.19	1.29	.98	1.29	1.20
Feb. 21-27.....	1.43	1.12	1.43	1.13	1.38	1.04	1.38	1.35	1.43	1.11	1.43	1.12	1.43	1.00	1.43	1.25
Feb. 28-Mar. 6.....	1.50	1.05	1.50	1.10	1.49	.94	1.49	1.13	1.50	1.08	1.50	1.05	1.50	1.03	1.50	1.18
Mar. 7-13.....	1.50	1.04	1.47	1.11	1.50	1.02	1.48	1.26	1.50	1.01	1.50	1.13	1.50	1.05	1.50	1.22
Mar. 14-20.....	1.50	1.02	1.47	1.11	1.50	.97	1.50	1.22	1.50	.97	1.50	1.15	1.50	1.01	1.50	1.24
Mar. 21-27.....	1.50	1.13	1.49	1.18	1.50	.96	1.49	1.16	1.50	1.06	1.50	1.09	1.50	.90	1.50	1.13
Mar. 28-Apr. 5.....	1.50	1.43	1.50	1.48	1.50	1.21	1.50	1.35	1.50	1.40	1.50	1.48	1.50	1.20	1.50	1.46
Average.....	1.29	1.22	1.30	1.29	1.29	1.06	1.29	1.38	1.30	1.21	1.30	1.29	1.30	1.11	1.30	1.37

The corn stover was also from corn that had been raised on the Experiment Station farm in 1910. It was stored in the barn and cut as needed, and was bright and clean and free from mold.

Table XX shows the analyses of the different feeds used and of the manger refuse from each kind of roughage. These analyses were made by the Department of Chemistry of the Experiment Station.

TABLE XX, Experiment III. Percentage composition of feed used and of manger refuse from roughage.

Feeds	Water	Ash	Protein	Crude fiber	Nitrogen free extract	Ether extract
	Percent	Percent	Percent	Percent	Percent	Percent
Mammoth clover hay used in first part of experiment	15.43	6.47	9.72	33.63	33.23	1.51
Refuse from clover hay used in first part of experiment	19.42	5.86	7.93	34.36	31.10	1.33
Mammoth clover hay used in last part of experiment	15.42	5.33	7.50	33.43	37.27	1.05
Refuse from clover hay used in last part of experiment	16.48	4.84	5.69	40.47	31.38	1.14
Alfalfa hay.....	16.42	6.64	13.04	25.02	37.40	1.48
Alfalfa hay refuse.....	20.51	5.29	9.30	35.13	28.73	1.04
Oat straw.....	14.76	6.76	3.68	35.47	37.27	2.06
Oat straw refuse.....	15.63	6.69	3.13	38.69	34.77	1.09
Corn stover.....	24.67	6.24	6.39	24.78	36.84	1.03
Corn stover refuse.....	19.29	6.03	4.96	34.06	34.63	1.03
Shelled corn.....	13.33	1.69	8.27	2.19	72.25	2.27
Linseed oilmeal.....	13.53	5.44	37.81	9.78	23.04	5.40

Method of feeding; quarters, water, salt and bedding: What has been said regarding these subjects in the discussion of Experiment II will also apply to Experiments III and IV, with the exception that the pens contained approximately 120 square feet of floor space, being but one-half the size of those used in Experiment II.

#### WEIGHTS AND GAINS

Table XXI shows the weight and gain for each lot by weekly periods. Table XXII gives a summary of the weights and gains. It shows that the largest average daily gain per head was made by Lots 2 and 6, fed alfalfa hay, closely followed by Lots 1 and 5 fed clover hay. Lots 7 and 8, fed oat straw and corn stover, respectively, in connection with corn and oilmeal, made fairly good gains, while Lots 3 and 4, fed oat straw and corn stover, respectively, with corn alone, made too small gains to be considered satisfactory. This is particularly true of Lot 3, fed oat straw.

The addition of oilmeal to a ration of corn and clover hay or corn and alfalfa hay resulted in smaller gains, as will be observed by comparing Lots 5 and 6 with Lots 1 and 2. However, when oilmeal was added to rations in which the roughage consisted of oat straw or corn stover, both of which are low in protein, larger gains were secured. Lot 7, fed corn, oilmeal and oat straw produced 29.9 percent greater gain than did Lot 3, fed corn and oat straw. Lot 8, fed corn, oilmeal and corn stover produced 14.9 percent greater gain than did Lot 4, fed corn and corn stover.

TABLE XXI, Experiment III. Weight and gain for each lot by weekly periods.

Date	Lot 1 Corn and clover hay		Lot 2 Corn and alfalfa hay		Lot 3 Corn and oat straw		Lot 4 Corn and corn stover		Lot 5 Corn, 5; oilmeal, 1 and clover hay		Lot 6 Corn, 5; oilmeal, 1 and alfalfa hay		Lot 7 Corn, 5; oilmeal, 1 and oat straw		Lot 8 Corn, 5; oilmeal, 1 and corn stover	
	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain
Jan. 2-3-4.....	Lbs. 899	Lbs. ..	Lbs. 880	Lbs. ..	Lbs. 824	Lbs. ..	Lbs. 844	Lbs. ..	Lbs. 899	Lbs. ..	Lbs. 895	Lbs. ..	Lbs. 885	Lbs. ..	Lbs. 873	Lbs. ..
Jan. 10.....	932	33	920	40	840	16	864	20	922	23	942	47	900	15	824	49
Jan. 17.....	946	14	930	10	824	-16	872	8	938	16	950	8	900	0	898	74
Jan. 24.....	970	24	966	36	842	18	882	10	968	30	980	30	912	12	934	36
Jan. 31.....	1,004	34	1,000	34	860	18	900	18	992	24	1,005	25	940	28	958	24
Feb. 7.....	1,010	6	1,006	6	870	10	920	20	1,000	8	1,010	5	950	10	960	2
Feb. 14.....	1,060	50	1,082	76	910	40	948	28	1,054	54	1,090	80	1,020	70	1,016	56
Feb. 21.....	1,080	20	1,100	18	930	20	960	12	1,090	36	1,110	20	1,030	10	1,034	18
Feb. 28.....	1,120	40	1,150	50	950	20	1,000	40	1,112	22	1,144	34	1,060	30	1,064	30
Mar. 7.....	1,164	44	1,170	20	970	20	1,010	10	1,146	34	1,162	18	1,094	34	1,094	30
Mar. 14.....	1,218	54	1,208	38	1,006	36	956*	34.5	1,178	32	1,218	56	1,136	42	1,128	34
Mar. 21.....	1,252	34	1,252	44	1,025	19	985	29	1,200	22	1,256	38	1,160	24	1,168	40
Mar. 28.....	Not weighed															
Apr. 5-6-7**.....	1,313	61	1,327	75	1,043.5	18.5	1,021.5	36.5	1,281	81	1,335	79	1,192	32	1,210	42

\* One lamb died March 9, weight 88.5 lbs.

\*\* Includes weight of wool removed March 22-24.

TABLE XXII, Experiment III. Summary of weights and gains. Test lasted 93 days, January 3 to April 5, 1911, inclusive.

Lot	Number in lot	Ration	Initial weight	Final weight**	Total gain, 93 days	Average daily gain per head
	Lbs.		Lbs.	Lbs.	Lbs.	Lbs.
1	14	Corn and clover hay .....	899	1,313	414	.318
2	14	Corn and alfalfa hay .....	880	1,327	447	.343
3	13	Corn and oat straw .....	824	1,043.5	219.5	.182
4	13*	Corn and corn stover .....	844	1,021.5	266	.225
5	14	Corn, 5; oilmeal, 1, and clover hay.....	899	1,281	382	.293
6	14	Corn, 5; oilmeal, 1, and alfalfa hay . .	895	1,335	440	.338
7	14	Corn, 5; oilmeal, 1, and oat straw . . .	885	1,192	307	.236
8	14	Corn, 5; oilmeal, 1, and corn stover....	873	1,210	337	.259

\* One lamb died March 9, weight 88.5 lbs.

\*\* Final weight includes weight of wool.

## EFFICIENCY OF RATIONS

Table XXIII shows the efficiency of the various rations as measured by the amount of feed consumed per 100 pounds gain. Lots 2 and 6, fed alfalfa hay, consumed less hay and grain per 100 pounds gain than did Lots 1 and 5, fed clover hay. Lots 4 and 8, fed corn stover consumed less grain and but slightly more roughage per 100 pounds gain than did Lots 3 and 7, fed oat straw. The lots fed either oat straw or corn stover consumed a much larger amount of grain per 100 pounds gain than did the lots fed either clover or alfalfa hay. Whether or not this extra amount of grain is sufficient to offset the saving which results from feeding a cheaper roughage, such as oat straw or corn stover, depends upon the price of both grain and roughage. This point will be discussed later in this bulletin. (See page 704.)

TABLE XXIII, Experiment III. Feed consumed per 100 pounds gain.

Lot	Ration	Feed consumed per 100 pounds gain			
		Corn	Oilmeal	Roughage	Total
		Lbs.	Lbs.	Lbs.	Lbs.
1	Corn and clover hay ... ..	405.0	....	384.5	789.5
2	Corn and alfalfa hay.....	377.6	....	374.6	752.2
3	Corn and oat straw.....	713.2	....	584.4	1,297.6
4	Corn and corn stover .....	571.4	....	613.5	1,184.9
5	Corn, 5; oilmeal, 1, and clover hay .....	369.9	74.0	413.4	857.3
6	Corn, 5; oilmeal, 1, and alfalfa hay .....	321.1	64.2	382.3	768.1
7	Corn, 5; oilmeal, 1, and oat straw .....	460.2	92.1	469.4	1,021.7
8	Corn, 5; oilmeal, 1, and corn stover. . . .	419.3	88.9	528.3	1,031.5

## COST OF GAINS

Table XXIV shows the amount of feeds fed, the gains made and the cost of gains with feeds at the prices indicated in the table. The cheapest gains were made by Lots 1 and 2, fed clover and alfalfa hay, respectively, the difference in economy of gain being slightly in favor of Lot 1, fed clover hay. The addition of oilmeal to a ration of

corn and clover or alfalfa hay increased the cost of gain, as may be seen by comparing Lots 5 and 6 with Lots 1 and 2. Lots 4 and 8, fed corn stover, made cheaper gains than did Lots 3 and 7, fed oat straw. The addition of oilmeal to rations in which the roughage consisted of oat straw or corn stover resulted in the production of cheaper gains than were produced by these roughages when fed with corn alone, as may be observed by comparing Lots 3 and 4 with Lots 7 and 8.

Table XXIV shows that it is not economical to use corn stover or oat straw as the entire roughage for fattening lambs when clover or alfalfa hay are to be had at ordinary farm prices. Even when these roughages are not available or when the price prohibits their use, the use of oat straw or corn stover as substitutes, even when supplemented with a nitrogenous concentrate, results in gains which are too costly to permit of satisfactory profit at ordinary prices for lambs, unless straw and stover are valued at considerably less than \$5 per ton, and unless corn is worth less than 56c per bushel.

The reader may ask "What is the feeding value of corn stover for fattening lambs?" This is a question that can be answered only in relative terms, that is, in comparison with the price of other feed stuffs, as is done in Table XXV. It is impossible to assign any definite value to oat straw or corn stover except by comparing them with some other material which may be taken as a standard, and since clover hay is perhaps the roughage most commonly used for fattening lambs, it is taken as a standard for comparison in Table XXV.

Table XXV is computed on the basis of the amount of feed given and the gains produced in this experiment. It shows the value, on the above basis, of a ton of oat straw and a ton of corn stover, both with and without oilmeal, with corn varying in price from 28c to 84c per bushel and clover hay from \$5 to \$17.50 per ton. It should be clearly understood that this table deals merely with substitutional values, that is, it shows the value of a ton of oat straw or a ton of corn stover when substituted for a ton of clover hay. In calculating such a table it is necessary to assume that all the rations under consideration will produce the same degree of market finish and in the same length of time. This experiment indicated that it is not possible to secure as good finish from oat straw or corn stover as from clover hay, and even if this were possible, it would require a longer time. Since it is not possible to take this factor into account in a tabular statement, Table XXV shows a higher value for oat straw and corn stover than they really have.

TABLE XXIV, Experiment III. Feed given; gains produced; cost of gains.

Feeds and prices	Lot 1 Corn and Clover hay		Lot 2 Corn and alfalfa hay		Lot 3 Corn and oat straw		Lot 4 Corn and corn stover		Lot 5 Corn, 5; oilmeal, 1 and clover hay		Lot 6 Corn, 5; oilmeal, 1 and alfalfa hay		Lot 7 Corn, 5; oilmeal, 1 and oat straw		Lot 8 Corn, 5; oilmeal, 1 and corn stover	
	Amt.	Value	Amt.	Value	Amt.	Value	Amt.	Value	Amt.	Value	Amt.	Value	Amt.	Value	Amt.	Value
Corn, 56c per bushel...	Lbs. 1676.5	\$16.76	Lbs. 1688.	\$16.88	Lbs. 1565.5	\$15.65	Lbs. 1520.	\$15.20	Lbs. 1412.9	\$14.13	Lbs. 1412.9	\$14.13	Lbs. 1412.9	\$14.13	Lbs. 1412.9	\$14.13
Oilmeal, \$36 per ton...	.....	.....	.....	.....	.....	.....	.....	.....	282.6	5.09	282.6	5.09	282.6	5.09	282.6	5.09
Clover hay, \$12.50 per t.	1917.	11.98	.....	.....	.....	.....	.....	.....	1917.	11.98	.....	.....	.....	.....	.....	.....
Alfalfa hay, \$15 per ton	.....	.....	1917.	14.38	.....	.....	.....	.....	.....	.....	1917.	14.38	.....	.....	.....	.....
Oat straw, \$5 per ton..	.....	.....	.....	.....	2735.5	6.84	.....	.....	.....	.....	.....	.....	2905.	7.26	.....	.....
Corn stover, \$5 per ton	.....	.....	.....	.....	.....	.....	2703.5	6.76	.....	.....	.....	.....	.....	.....	2905.	7.26
Total cost.....	.....	\$28.74	.....	\$31.26	.....	\$22.49	.....	\$21.96	.....	\$31.20	.....	\$33.60	.....	\$26.48	.....	\$26.48
Total gain.....	414.	.....	447.	.....	219.5	.....	266.	.....	382.	.....	440.	.....	307.	.....	337.	.....
Cost of feed per 100 lbs. gain on basis of above prices.....	...	6.94	...	6.99	....	10.25	....	8.26	....	8.17	...	7.64	...	8.63	....	7.86

TABLE XXV, Experiment III. Value of oat straw and corn stover per ton with and without oilmeal, with clover hay as a basis of comparison.\*

Corn per bu.		Clover hay per ton					
		\$5 00	\$7.50	\$10.00	\$12.50	\$15.00	\$17.50
28c	Oat straw with corn.....	-.62	.31	1.24	2.17	3.10	4.03
	Oat straw with corn and oilmeal.....	-1.64	-.41	.81	2.03	3.26	4.48
	Corn stover with corn.....	.64	1.78	2.92	3.65	5.20	6.33
	Corn stover with corn and oilmeal.....	-.98	.36	1.70	3.04	4.39	5.73
35c	Oat straw with corn.....	-1.23	-.30	.62	1.55	2.48	3.41
	Oat straw with corn and oilmeal.....	-1.78	-.56	.66	1.89	3.11	4.33
	Corn stover with corn.....	.23	1.37	2.51	3.65	4.79	5.93
	Corn stover with corn and oilmeal.....	-1.03	.32	1.66	3.00	4.35	5.69
42c	Oat straw with corn.....	-1.85	-.92	-.01	.93	1.86	2.79
	Oat straw with corn and oilmeal.....	-1.93	-.71	.52	1.74	2.96	4.19
	Corn stover with corn.....	-.18	.96	2.10	3.24	4.38	5.52
	Corn stover with corn and oilmeal.....	-1.07	.28	1.62	2.96	4.30	5.65
49c	Oat straw with corn.....	-2.47	-1.54	-.61	.32	1.24	2.17
	Oat straw with corn and oilmeal.....	-2.07	-.85	.37	1.60	2.82	4.04
	Corn stover with corn.....	-.59	.55	1.69	2.85	3.97	5.11
	Corn stover with corn and oilmeal.....	-1.11	.23	1.58	2.92	4.26	5.61
56c	Oat straw with corn.....	-3.09	-2.16	-1.23	-.30	.63	1.56
	Oat straw with corn and oilmeal.....	-2.22	-1.00	.23	1.45	2.67	3.90
	Corn stover with corn.....	-1.00	.14	1.28	2.42	3.56	4.70
	Corn stover with corn and oilmeal.....	-1.15	.19	1.54	2.88	4.22	5.56
63c	Oat straw with corn.....	-3.71	-2.78	-1.85	-.92	.01	.94
	Oat straw with corn and oilmeal.....	-2.37	-1.14	.08	1.30	2.53	3.75
	Corn stover with corn.....	-1.41	-.27	.87	2.01	3.15	4.29
	Corn stover with corn and oilmeal.....	-1.19	.15	1.49	2.84	4.18	5.52
70c	Oat straw with corn.....	-4.33	-3.40	-2.47	-1.54	-.61	.32
	Oat straw with corn and oilmeal.....	-2.51	-1.29	-.07	1.16	2.38	3.60
	Corn stover with corn.....	-1.82	-.68	.46	1.60	2.74	3.88
	Corn stover with corn and oilmeal.....	-1.23	.11	1.45	2.80	4.14	5.48
77c	Oat straw with corn.....	-4.94	-4.01	-3.09	-2.16	-1.23	-.30
	Oat straw with corn and oilmeal.....	-2.66	-1.43	-.21	1.01	2.24	3.46
	Corn stover with corn.....	-2.22	-1.09	.05	1.19	2.33	3.47
	Corn stover with corn and oilmeal.....	-1.27	.07	1.41	2.75	4.10	5.44
84c	Oat straw with corn.....	-5.56	-4.63	-3.70	-2.78	-1.85	-.92
	Oat straw with corn and oilmeal.....	-2.80	-1.58	-.36	.87	2.09	3.31
	Corn stover with corn.....	-2.63	-1.50	-.36	.78	1.92	3.06
	Corn stover with corn and oilmeal.....	-1.32	.03	1.37	2.71	4.06	5.40

\*In computing this table oilmeal was valued at \$36 per ton.  
Minus sign (-) indicates loss.

Table XXV is introduced primarily to show how the feeding value of oat straw and corn stover is influenced by the price both of hay and corn, or whatever grain is used as a concentrate. It will be observed that as the price of clover hay increases the feeding value of oat straw and of corn stover *increases*, but as the price of corn increases the value of oat straw and of corn stover *decreases*.

Table XXV also furnishes some interesting data relative to the advisability of adding oilmeal to a ration of corn and oat straw or corn and corn stover for fattening lambs. The figures in bold faced



type in this table indicate approximately the prices which must prevail for corn and for clover hay before a ton of oat straw or of corn stover has a higher feeding value when fed with corn and oilmeal than when fed with corn alone.

#### CONSUMPTION OF ROUGHAGE

Table XXVI shows the amount of roughage fed and the amount and percentage consumed.

TABLE XXVI, Experiment III. Roughage fed and consumed.\*

Lot	Kind of roughage	Amount fed	Amount consumed	Percentage consumed	Amount consumed daily per lamb
		Lbs.	Lbs.	Percent	Lbs.
1	Clover hay .....	1,917.	1,591.8	83.04	1.22
2	Alfalfa hay.....	1,917.	1,674.3	87.34	1.29
3	Oat straw.....	2,735.5	1,282.8	46.89	1.06
4	Corn stover.....	2,705.5	1,632.	60.37	1.38
5	Clover hay.....	1,917.	1,579.3	82.38	1.21
6	Alfalfa hay.....	1,917.	1,684.5	87.87	1.29
7	Oat straw.....	2,905.	1,441.	49.60	1.11
8	Corn stover.....	2,905.	1,780.3	61.28	1.37

\*The amount and percentage of oat straw and corn stover consumed was not quite as large as is shown in this table on account of a small amount being pulled from the racks and wasted.

As in Experiment II, reported in this bulletin, the percentage of all kinds of roughage consumed, and particularly of clover and alfalfa hay, was lower than should be expected, due to the lambs being fed plenty of roughage to insure their having all they cared to eat. There is no striking difference either in the amount or percentage of roughage consumed by the lots fed corn and oilmeal and by those fed corn alone.

#### FINISH AND MARKET PRICE

When the lambs were sold at Pittsburgh they were divided into lots as they were in the experiment, and were inspected by a committee of three sheep buyers, who placed a value upon each lot on a basis of what they were worth on the day's market. Lots 1 and 2 were valued alike at \$5.50 per hundredweight. They were considered to be right in condition, but a little too heavy. Lot 3 was valued at \$5, on account of being much too low in condition. Lots 4 and 5 did not show quite as good condition as did Lots 1 and 2, and were each valued at \$5.40. Lot 6 was valued at \$5.25, on account of being in slightly too high condition and being too heavy. Lot 7 was valued at \$5.25, on account of a lack of finish. Lot 8 showed slightly lower condition than did Lots 1 and 2, and was valued at \$5.40.

#### SHRINKAGE IN SHIPPING

Table XXVII shows the amount of shrinkage in shipping from Wooster to Pittsburgh, Pa. The table does not show any striking

and consistent difference in the amount of shrinkage for the different lots, except that the lots fed oilmeal shrank .98 pound less per hundredweight than did the lots receiving no oilmeal.

TABLE XXVII, Experiment III. Shrinkage in shipping.

Lot	Home weight* April 11	Pittsburgh weight,** April 12	Shrinkage	
			Total	Per hundredweight
	Lbs.	Lbs.	Lbs.	Lbs.
1	1,282	1,230	52	4.06
2	1,296	1,230	66	5.09
3	994	940	54	5.43
4	990	930	60	6.06
5	1,262	1,200	62	4.91
6	1,290	1,240	50	3.88
7	1,164	1,110	44	3.81
8		1,120	44	3.78
Average for clover hay lots.....				4.48
Average for alfalfa hay lots.....				4.49
Average for oat straw lots.....				4.56
Average for corn stover lots.....				4.83
Average for lots receiving no oilmeal.....				5.09
Average for lots receiving oilmeal.....				4.11

\*Weighed before feed and water were given.

\*\*Weighed after feed and water were given.

## EXPENSE OF SHIPPING AND MARKETING

Table XXVIII shows the expense of shipping the lambs and marketing them at Pittsburgh. The freight for each lot was apportioned on the basis of the weights at Pittsburgh. The feed and yardage charge was based on the number of lambs in each lot. No commission was charged, as the lambs were sold direct to the killer and not through a commission firm.

TABLE XXVIII, Experiment III. Expense of shipping and marketing.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6	Lot 7	Lot 8
Freight.....	\$1.88	\$1.88	\$1.44	\$1.42	\$1.84	\$1.90	\$1.70	\$1.72
Feed and yardage...	.75	.75	.70	.64	.75	.75	.75	.75
Total.....	2.63	2.63	2.14	2.06	2.59	2.65	2.45	2.47

## SLAUGHTER TEST

A slaughter test of all the lots was made, the results of which are shown in Table XXIX. The most striking difference in this table is in the percentage of caul fat. The lots fed alfalfa hay had the highest percentage of caul, averaging 3.93 percent, followed closely by the lots fed clover hay, averaging 3.75 percent. The lowest percentage of caul fat was found in the lots fed oat straw, which averaged only 1.67 percent. There was a striking difference in the amount of caul fat produced by the lots fed corn alone and the

lots fed corn and oilmeal; the four lots fed corn alone averaging 3.63 percent, and the four lots fed corn and oilmeal averaging but 2.46 percent. There was a difference in the appearance as well as in the weight of the caul fat of the lots fed corn alone and of those fed corn and oilmeal. In the former lots the caul was almost solid, while in the latter it was much more open, having a netted or veiled appearance.

TABLE XXIX, Experiment III. Results of slaughter test at Pittsburg, April 12, 1911.

Lot	No. in lot	Live weight, Pittsburg	Blood	Pelts	Feet	Heads	Plucks	Caul fat	Intestines, including contents	Dressed weight		Yield*
										Warm	Cold	
		Lbs.	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Lbs.	Lbs.	Percent
1	14	1,230	2.85	9.02	1.79	4.92	3.72	4.69	21.38	685	670	54.47
2	14	1,230	3.31	10.08	1.71	3.49	3.96	4.98	19.67	701	690	56.10
3	13	940	3.51	9.68	2.02	4.36	3.88	1.75	26.09	474	465	49.47
4	12	930	3.87	9.30	1.93	5.43	4.09	2.34	21.07	508	501	53.87
5	14	1,200	3.06	8.71	1.75	5.00	3.83	2.79	21.33	663	650	54.17
6	14	1,240	3.31	8.27	1.77	4.80	3.79	2.88	19.50	713	701	56.53
7	14	1,110	3.20	8.74	1.85	5.56	3.96	1.60	24.08	570	561	50.54
8	14	1,120	3.30	9.19	1.92	4.69	3.82	2.50	21.54	608	599	53.48
Average, clover hay lots . . . . .			2.95	8.87	1.77	4.96	3.78	3.75	21.36	Loss in cooling, Percent 2.03		54.32
Average, alfalfa hay lots . . . . .			3.31	9.17	1.74	4.15	3.88	3.93	19.58	1.63		56.32
Average, oat straw lots . . . . .			3.34	9.17	1.93	5.01	3.93	1.67	25.00	1.72		50.05
Average, corn stover lots . . . . .			3.57	9.24	1.93	5.02	3.94	2.43	21.33	1.43		53.66
Average, corn lots . . . . .			3.34	9.53	1.85	4.50	3.90	3.63	21.85	1.77		53.72
Average, corn and oilmeal lots.			3.22	8.72	1.82	5.00	3.85	2.46	21.54	1.68		53.77

\*The percentage yield is based on cold weight of carcass.

Table XXIX shows a detailed account and Table XXX gives a summary of the yield of the different lots based on the weights of the carcasses after remaining over night in the cooler. The first vertical column in Table XXX shows the dressing percent of the lots fed the various roughages and corn alone, and the second column shows the dressing percent of the lots fed corn and oilmeal. The third column is an average of the first two columns. In the bottom row, the first number to the left is the average of all the lots fed corn alone and the second number is the average of all lots fed corn and oilmeal. The third number is the general average of all lots.

A study of this table will show a wide variation in the percentage of dressed carcass to live weight for lots fed the different roughages, but in no case was there more than a very slight difference between the lots fed corn alone and those fed corn and oilmeal when fed with the same roughage. The average yield of carcass was 53.72 percent

from the lots fed corn alone, and 53.77 percent from the lots fed corn and oilmeal, a difference so slight as to be unimportant. The addition of oilmeal to rations composed of oat straw and of corn stover resulted in larger gain and better finish, and it might be supposed that it would also result in a higher yield of carcass per unit of live weight, but Table XXX shows very little evidence to indicate that this is true. With oat straw there was a difference of 1.07 percent in favor of corn and oilmeal, but with corn stover there was a slight difference, .39 percent, in favor of corn alone.

TABLE XXX, Experiment III. Summary of percentage of carcass (cold weight) based on live weight.

Roughage fed	Corn alone	Corn, 5; oilmeal, 1	Average
	Percent	Percent	Percent
Clover hay .....	54.47	54.17	54.32
Alfalfa hay .....	56.10	56.53	56.32
Oat straw .....	49.47	50.54	50.05
Corn stover .....	53.87	53.48	53.66
Average.....	53.72	53.77	53.74

## EXPERIMENT IV

CONDUCTED 1911-1912, AT THE EXPERIMENT STATION

### OBJECT

The object of this experiment was to secure further data concerning the problems under consideration in Experiment III.

### PLAN OF EXPERIMENT

The plan of this experiment was practically the same as that of Experiment III and it was carried out in the same manner. Eight lots of fifteen lambs each were used in this experiment, which lasted from November 18, 1911, to February 8, 1912, inclusive, a period of 83 days. On their arrival at the Experiment Station the lambs were placed in the barn where they were all fed clover hay and slowly started on corn. On November 7 they were divided into eight lots, and on November 9 each lot was started on its experimental ration, so that the lambs would become accustomed to their rations by the time the experiment began—November 18. When the lambs were divided into lots on November 7, there were but very slight differences in the weight of the various lots, but during the preliminary feeding period, between November 9 and 18, some of the rations produced larger gains than did the others, so that by November 18, the different lots showed quite a variation in weight.

TABLE XXXI, Experiment IV. Average feed consumed daily per lamb by weekly periods.

Date	Lot 1		Lot 2		Lot 3		Lot 4		Lot 5		Lot 6		Lot 7		Lot 8	
	Corn	Clover hay	Corn	Alfalfa hay	Corn	Oat straw	Corn	Corn stover	Corn, 5; oilmeal, 1	Clover hay	Corn, 5; oilmeal, 1	Alfalfa hay	Corn, 5; oilmeal, 1	Oat straw	Corn, 5; oilmeal, 1	Corn stover
Nov. 18-24 . . . . .	Lbs. .69	Lbs. 1.43	Lbs. .69	Lbs. 1.54	Lbs. .69	Lbs. 1.37	Lbs. .69	Lbs. 1.67	Lbs. .69	Lbs. 1.44	Lbs. .69	Lbs. 1.52	Lbs. .69	Lbs. 1.33	Lbs. .69	Lbs. 1.90
Nov. 25-Dec. 1 . . . . .	.95	1.36	.95	1.54	.93	1.16	.91	1.62	.95	1.56	.95	1.55	.94	1.21	.95	1.74
Dec. 2-8 . . . . .	1.03	1.40	1.03	1.54	1.04	1.10	1.02	1.11	1.04	1.57	1.04	1.51	1.04	1.10	1.04	1.44
Dec. 9-15 . . . . .	1.07	1.37	1.07	1.49	.99	.95	1.06	1.06	1.06	1.47	1.05	1.45	1.07	.92	1.07	1.38
Dec. 16-22 . . . . .	1.09	1.40	1.09	1.47	1.03	1.05	1.09	1.24	1.09	1.50	1.11	1.66	1.08	1.00	1.09	1.34
Dec. 23-29 . . . . .	1.21	1.42	1.21	1.45	1.15	1.12	1.21	1.31	1.21	1.49	1.22	1.70	1.21	1.13	1.21	1.51
Dec. 30-Jan. 5 . . . . .	1.31	1.35	1.31	1.45	1.32	1.07	1.31	1.14	1.31	1.46	1.32	1.61	1.31	1.00	1.31	1.23
Jan. 6-12 . . . . .	1.42	1.22	1.42	1.25	1.28	.97	1.22	1.03	1.42	1.31	1.42	1.46	1.42	1.00	1.42	1.17
Jan. 13-19 . . . . .	1.50	1.12	1.50	1.15	1.31	1.03	1.30	1.05	1.50	1.20	1.50	1.33	1.50	1.00	1.50	1.23
Jan. 20-26 . . . . .	1.64	1.01	1.59	1.01	1.31	.95	1.33	1.03	1.64	1.12	1.64	1.23	1.64	.89	1.64	1.17
Jan. 27-Feb. 2 . . . . .	1.50	.93	1.37	1.04	1.22	.99	1.34	1.06	1.50	1.17	1.50	1.27	1.50	.96	1.50	1.10
Feb. 3-9 . . . . .	1.50	1.11	1.50	1.17	1.36	.96	1.50	.99	1.50	1.32	1.50	1.49	1.50	.93	1.50	1.09
Average . . . . .	1.24	1.27	1.22	1.35	1.13	1.07	1.17	1.19	1.24	1.39	1.23	1.48	1.24	1.04	1.24	1.36

**Lambs used:** The lambs used in the experiment were strictly choice feeders. Their entire freedom from wrinkles, compact, blocky form, and dark faces, indicated a very large percentage of Down blood. They were Idaho lambs raised on one of the ranches of a large breeding firm and were purchased on the Chicago market October 30, 1911, averaging 61 pounds at the time of purchase.

**Rations:** The same rations were fed in this experiment as were fed in Experiment III, an outline of which is shown on page 699. All lots were fed as much roughage as they would consume and, when on full feed, as much grain as they would consume up to one and one-half pounds daily per head. For a few days during the tenth week of the experiment all lots except 3 and 4 were fed more than this amount of grain, but after the tenth week the daily grain ration for these lots was dropped back to one and one-half pounds per head, and they were fed this amount until the close of the experiment. Table XXXI shows the amount of feed eaten daily per lamb by weekly periods.

**Feeds used:** The corn used during the first seven weeks of the experiment contained a rather high percentage of moisture when purchased, consequently it molded slightly in a few places in the bin. The corn used during the remaining five weeks of the experiment was of excellent quality. The linseed oilmeal was old process, pea size. All the roughages used were raised on the Experiment Station farm in 1911. The clover hay used was of the medium red variety and of good quality. The alfalfa hay was also of good quality. The oat straw did not make such a rank growth as did that used in Experiment III. The corn stover used was stored in the barn early in the fall, and was fed whole, instead of being cut as was that used in Experiment III. On account of the unusually wet weather in the autumn of 1911, the stover was somewhat blackened, and while it was free from mold, it was not of the best quality.

TABLE XXXII, Experiment IV. Percentage composition of feeds used and of refuse from roughages.

Feeds	Water	Ash	Protein	Crude fiber	Nitrogen free extract	Ether extract
	Percent	Percent	Percent	Percent	Percent	Percent
Clover hay.....	15.46	5.24	9.20	31.26	37.39	1.35
Clover hay refuse ..	15.59	4.59	6.04	35.79	37.16	.83
Alfalfa hay.....	13.55	6.31	12.25	29.82	36.43	1.64
Alfalfa hay refuse.....	13.62	6.55	8.61	32.85	32.43	.94
Oat straw.....	14.67	6.42	4.82	31.97	40.51	1.61
Oat straw refuse.....	16.31	6.05	3.75	33.10	39.89	.90
Corn stover.....	23.72	5.14	5.53	28.70	36.58	.28
Corn stover refuse.....	19.61	4.51	3.95	32.17	39.48	.28
Corn used during first seven weeks.....	19.16	1.36	9.11	2.84	64.65	2.88
Corn used during last five weeks.....	15.33	1.64	8.81	3.10	69.03	2.09
Linseed oilmeal.....	9.74	5.38	38.21	10.67	30.86	5.14

TABLE XXXIII, Experiment IV. Weights and gains for each lot by weekly periods; 15 lambs in each lot.

Date	Lot 1 Corn and clover hay		Lot 2 Corn and alfalfa hay		Lot 3 Corn and oat straw		Lot 4 Corn and corn stover		Lot 5 Corn, 5; oilmeal, 1 and clover hay		Lot 6 Corn, 5; oilmeal, 1 and alfalfa hay		Lot 7 Corn, 5; oilmeal, 1 and oats straw		Lot 8 Corn, 5; oilmeal, 1 and corn stover	
	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain
Nov. 17, 18, 19 ....	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Nov. 25 .....	919	..	824	..	889	..	865	..	939	..	921	..	927	..	899	..
Dec. 2 .....	950	31	960	36	912	23	912	46	972	33	968	47	944	17	946	47
Dec. 9 .....	974	24	998	38	934	22	942	30	1,000	28	1,000	32	965	21	980	34
Dec. 16 .....	988	14	1,048	50	964	30	950	8	1,026	26	1,034	34	987	22	992	12
Dec. 23 .....	1,028	40	1,075	27	*894	4	960	10	1,068	42	1,068	34	1,010	23	1,020	28
Dec. 30 .....	1,076	48	1,114	39	908	14	996	36	1,108	40	**1,108	99	1,022	12	1,060	40
Jan. 6 .....	1,100	24	1,160	46	920	12	1,020	24	1,140	32	1,160	52	1,060	36	1,100	40
Jan. 13 .....	1,144	44	1,212	52	952	32	1,050	30	1,190	60	1,150	—10	1,064	34	1,142	42
Jan. 20 .....	1,190	46	1,248	36	980	28	1,020	—30	1,220	50	1,196	46	1,122	28	1,174	32
Jan. 27 .....	1,210	20	1,270	22	1,000	20	1,100	80	1,245	25	1,220	24	1,150	28	1,190	16
Feb. 3 .....	1,260	50	1,326	56	1,040	40	1,140	40	1,282	37	1,260	40	1,190	40	1,240	50
Feb. 8-9-10 .....	1,282	22	1,342	16	1,050	10	1,176	36	1,320	38	1,290	30	1,210	20	1,258	18
Feb. 8-9-10 .....	1,332	50	1,387	45	1,075	25	1,187	11	1,361	41	1,323	53	1,234	24	1,283	25

\*One lamb died December 10, weight 74 pounds.

\*\*One lamb taken out December 16, weight 59 pounds.

Table XXXII gives the composition of the feeds used in this experiment, and of the refuse from the roughage, as determined by the Department of Chemistry of this Station.

#### WEIGHTS AND GAINS

Table XXXIII shows the weight and gain for each lot by weekly periods.

TABLE XXXIV, Experiment IV. Summary of weights and gains.  
15 lambs in each lot; test lasted 83 days, November 18, 1911 to  
February 9, 1912, inclusive.

Lot	Ration	Initial weight Nov. 17, 18, 19, 1911	Final weight Feb. 8, 9, 10, 1912	Total gain	Average daily gain per head
		Lbs.	Lbs.	Lbs.	Lbs.
1	Corn and clover hay.....	919	1,332	413	.332
2	Corn and alfalfa hay.....	924	1,387	463	.372
3	Corn and oat straw.....	889	1,075*	260	.220
4	Corn and corn stover.....	866	1,187	321	.258
5	Corn, 5; oilmeal, 1, and clover hay.....	939	1,361	422	.339
6	Corn, 5; oilmeal, 1, and alfalfa hay.....	921	1,323**	461	.387
7	Corn, 5; oilmeal, 1, and oat straw.....	927	1,234	307	.247
8	Corn, 5; oilmeal, 1, and corn stover.....	899	1,283	384	.308

\*One lamb died December 10, weight 74 pounds.

\*\*One lamb taken out December 16, weight 89 pounds.

Table XXXIV gives a summary of the weights and gains for the entire feeding period. As in Experiment III, the largest average daily gains per head were made by Lots 2 and 6, fed alfalfa hay, closely followed by Lots 1 and 5, fed clover hay. Very good gains were made by Lots 4 and 8, fed corn stover. The smallest gains were made by Lots 3 and 7, fed oat straw. The results of Experiment IV differ from those of Experiment III in that the addition of oilmeal to a ration of corn and clover hay and of corn and alfalfa hay resulted in slightly greater gains than were secured from these roughages with corn alone. These differences, however, are too small to be taken as evidence that the addition of oilmeal to such rations will produce greater gains, especially since Experiment III shows that greater gains were produced when the oilmeal was omitted. Experiments to date indicate that a ration composed of corn and such nitrogenous roughages as clover or alfalfa hay is sufficient to give the best results and that the addition of nitrogenous concentrates to the ration produces very little, if any, larger gain. Both Experiments III and IV show that the addition of oilmeal to rations composed of corn and oat straw or corn and corn stover resulted in decidedly larger gains. Whether or not the extra amount of gain thus secured is sufficient to compensate for the additional cost of the ration is a point which is discussed elsewhere in this bulletin. (See pages 706 and 715.)



## EFFICIENCY OF RATIONS

Table XXXV shows the efficiency of the rations as measured by the amount of feed consumed per 100 pounds gain. The results of this experiment agree rather closely with the results of Experiment III, with a single exception. In Experiment III, Lot 4 consumed more roughage per 100 pounds gain than did Lot 3, while in Experiment IV the amount of roughage consumed per 100 pounds gain was smaller for Lot 4 than for Lot 3. With this exception, the discussion of the efficiency of rations under Experiment III (page 703) will also apply to Experiment IV.

TABLE XXXV, Experiment IV. Feed consumed per 100 pounds gain.

Lot	Ration	Feed consumed per 100 pounds gain.			
		Corn	Oilmeal	Roughage	Total
		Lbs.	Lbs.	Lbs.	Lbs.
1	Corn and clover hay.....	373.5	....	321.6	755.1
2	Corn and alfalfa hay.....	329.2	....	361.8	691.0
3	Corn and oat straw.....	514.2	....	455.5	999.5
4	Corn and corn stover.....	452.2	....	462.8	915.0
5	Corn, 5; oilmeal, 1, and clover hay.....	304.6	66.9	408.6	774.1
6	Corn, 5; oilmeal, 1, and alfalfa hay.....	265.5	53.1	382.4	701.0
7	Corn, 5; oilmeal, 1, and oat straw.....	418.4	83.7	423.7	925.8
8	Corn, 5; oilmeal, 1, and corn stover.....	335.0	67.0	441.4	843.4

## COST OF GAINS

Table XXXVI shows the amount of feeds fed, the gains made and the cost of gains at the prices for feeds indicated in the table. The cheapest gains were made by Lots 1 and 2, fed corn and clover hay and corn and alfalfa hay, respectively. The addition of oilmeal to a ration of corn and clover or alfalfa hay resulted in more expensive gains than were produced when the oilmeal was omitted, as may be seen by comparing Lots 5 and 6 with Lots 1 and 2. Lots 4 and 8, fed corn stover, made cheaper gains than did Lots 3 and 7, fed oat straw. The addition of oilmeal to a ration of corn and corn stover resulted in the production of cheaper gains, as may be seen by comparing Lots 4 and 8. In Experiment III the addition of oilmeal to a ration of corn and oat straw produced cheaper gain but in Experiment IV the gain produced by corn, oilmeal and oat straw cost slightly more than did the gain produced by corn and oat straw, as may be seen by comparing Lots 3 and 7.

## CONSUMPTION OF ROUGHAGE

Table XXXVII shows the amount of roughage fed and the amount and percentage consumed.

TABLE XXXVI, Experiment IV. Feed given; gains produced; cost of gains.

Feeds and prices	Lot 1 Corn and clover hay		Lot 2 Corn and alfalfa hay		Lot 3 Corn and oat straw		Lot 4 Corn and corn stover		Lot 5 Corn, 5; oilmeal, 1 and clover hay		Lot 6 Corn, 5; oilmeal, 1 and alfalfa hay		Lot 7 Corn, 5; oilmeal, 1 and oat straw		Lot 8 Corn, 5; oilmeal, 1 and corn stover	
	Amt.	Value	Amt.	Value	Amt.	Value	Amt.	Value	Amt.	Value	Amt.	Value	Amt.	Value	Amt.	Value
Corn, 56c per bushel...	Lbs. 1,542.5	\$15.43	Lbs. 1,524.	\$15.24	Lbs. 1,537.	\$13.37	Lbs. 1,451.5	\$14.52	Lbs. 1,285.4	\$12.85	Lbs. 1,224.	\$12.24	Lbs. 1,284.6	\$12.85	Lbs. 1,286.3	\$12.86
Oilmeal, \$36 per ton ...	.....	.....	.....	.....	.....	.....	.....	.....	257.1	4.63	244.8	4.41	256.9	4.62	257.2	4.63
Clover hay, \$12.50 per t.	1,966.	12.29	.....	.....	.....	.....	.....	.....	1,986.	12.41	.....	.....	.....	.....	.....	.....
Alfalfa hay, \$15 per ton	.....	.....	1,966.	14.74	.....	.....	.....	.....	.....	.....	1,986.	14.89	.....	.....	.....	.....
Oat straw, \$5 per ton..	.....	.....	.....	.....	2,608.	6.52	.....	.....	.....	.....	.....	.....	2,608.	6.52	.....	.....
Corn stover, \$5 per ton.	.....	.....	.....	.....	.....	.....	3,802.	9.50	.....	.....	.....	.....	.....	.....	3,802.	9.50
Total cost of feed.....	.....	\$27.72	.....	\$29.98	.....	\$19.89	.....	\$24.02	.....	\$29.89	461.	\$31.54	307.	\$23.99	.....	\$26.99
Total gain.....	413.	.....	463.	.....	260.	.....	321.	.....	422.	.....	461.	.....	307.	.....	384.	.....
Cost of feed per 100 lbs. gain on basis of above prices.....	.....	6.71	.....	6.48	.....	7.65	.....	7.48	.....	7.08	.....	6.84	.....	7.82	.....	7.03

TABLE XXXVII, Experiment IV. Roughage fed and consumed.

Lot	Kind of roughage	Amount fed	Amount consumed	Percentage consumed	Amount consumed daily per lamb
		Lbs.	Lbs.	Percent	Lbs.
1	Clover hay.....	1,966	1,576.	80.16	1.27
2	Alfalfa hay.....	1,966	1,675.	85.20	1.35
3	Oat straw*.....	2,608	1,261.8	48.38	1.07
4	Corn stover.....	3,802	1,435.5	38.07	1.19
5	Clover hay.....	1,966	1,724.5	88.83	1.39
6	Alfalfa hay.....	1,966	1,732.8	88.76	1.48
7	Oat straw*.....	2,608	1,300.8	49.88	1.04
8	Corn stover.....	3,802	1,695.	44.58	1.36

\*The amount and percentage of oat straw consumed is not quite as large as is here shown, on account of a small amount being pulled from the racks by the lambs.

As in Experiments II and III, the lambs were fed enough roughage to insure their having all they cared to eat, which accounts for the rather low percentage of roughage consumed. A comparison of Tables XXVI and XXXVII shows that there was but little difference in the percentage of roughage consumed by the lambs in Experiments III and IV, with the exception of corn stover. The fact that apparently a larger percentage of the stover was consumed in Experiment III than in Experiment IV is perhaps due to the fact that the stover fed in Experiment III was cut, while that fed in Experiment IV was fed whole. The lambs pulled a part of the cut stover fed in Experiment III from the racks and mixed it with the bedding so that it could not be weighed with the refused stover remaining in the racks. Very little of the uncut stover fed in Experiment IV was pulled from the racks, and the small amount that was pulled out was in large enough pieces to be gathered up and weighed. While it is possible that a larger percentage of stover was consumed in Experiment III on account of its being cut, such a case does not seem very probable. In Experiment IV all the leaves and practically all the husks were eaten so that almost nothing was left but the stalks.

In Experiment III there was practically no difference in either amount or percentage of roughage consumed by the lots fed oilmeal and those not fed oilmeal. (See page 707). In Experiment IV, however, with the exception of Lots 3 and 7, fed oat straw, the lots fed oilmeal consumed not only a larger amount of roughage per head, but also a larger percentage of the roughage fed than did the lots fed corn alone. Lot 3 consumed more straw per head than did Lot 7, probably because Lot 3 would not take a full feed of grain (see page 711).

#### CONSUMPTION OF CONCENTRATES

Table XXXI shows that in Experiment IV the lots fed oilmeal in connection with oat straw and corn stover consumed a larger amount of concentrates daily per head than did the lots not fed oilmeal. This difference was not observed in the lots fed clover and

alfalfa hay. It will be observed from Table XXXI that all lots, except 3 and 4, fed oat straw and corn stover, respectively, reached a full grain feed, 1.5 pounds per head daily, during the ninth week of the experiment. Lot 4 was unable to consume this amount of grain until the last week of the experiment and the largest amount of grain consumed by Lot 3 during any week was 1.36 pounds per head per day, in the last week of the experiment. It may be assumed from this that the greater gains made by Lots 7 and 8 than than by Lots 3 and 4 were partly due to the larger consumption of grain as well as to the more nitrogenous ration. However, the more nitrogenous rations fed Lots 7 and 8 may have been the cause of these lots consuming more concentrates than did Lots 3 and 4, and thus, indirectly, may have been the cause of the greater gains.

During the progress of Experiments III and IV it was observed that the lots fed oilmeal had better appetites and showed less tendency to go off feed than did those not fed oilmeal. This was especially true as the lambs approached full feed, and while it was not so striking in the lots fed clover and alfalfa hay as in those fed oat straw and corn stover, it was plainly noticeable in all lots.

#### FINISH AND MARKET PRICE

Upon arrival at Pittsburgh the lambs were divided into lots as fed in the experiment and were inspected by a sheep buyer who placed a valuation upon each lot on a basis of current market prices. Lots 1, 2, 5 and 6 were valued alike at \$7 per hundredweight. These lots showed the same degree of finish, and with respect to finish they were beyond criticism from a market standpoint. Lot 8 was valued at \$6.85 and Lot 7 at \$6.80. Lot 8 possessed a slightly higher degree of finish than did Lot 7, although neither lot was quite as good in this respect as were Lots 1, 2, 5 and 6. Lot 4 was valued at \$6.75 and Lot 3 at \$6.65. Lot 4 showed a lower degree of finish than did Lot 7 or Lot 8, and Lot 3 showed lower finish than did Lot 4.

It was observed in Experiments III and IV that there was a much greater lack of uniformity of finish shown by the lambs in the lots fed oat straw or corn stover than was shown by the lots fed clover or alfalfa hay. This was much more noticeable in the lots fed oat straw or corn stover and shelled corn without oilmeal than in the lots fed oilmeal in connection with the feeds named.

#### MANURE PRODUCTION

Within recent years there has been an increasing amount of attention paid to the value of the manure resulting from stock feeding, and it is safe to assume that in the future this important by-product will be even more highly valued than it is at present.

TABLE XXXVIII, Experiment III. Manure produced in 77 days.

Lot	No. in lot	Ration	Weight of manure	Composition (Percent of fresh substance)					
				Water	Organic matter	Ash	Nitrogen	Phosphorus	Potassium
			Lbs.	Percent	Percent	Percent	Percent	Percent	Percent
1	14	Corn and clover hay.....	2,130	60.89	34.79	4.32	1.482	.2061	1.2292
2	14	Corn and alfalfa hay.....	2,240	65.68	30.17	4.15	1.374	.1970	.9675
3	13	Corn and oat straw.....	2,560	66.86	29.53	3.61	.853	.1805	.7364
4	13**	Corn and corn stover.....	2,110	62.96	32.51	4.53	1.141	.2000	.6956
5	14	Corn, 5; oilmeal, 1, clover hay....	2,580	62.48	33.22	4.30	1.769	.2260	1.1811
6	14	Corn, 5; oilmeal, 1, alfalfa hay....	2,450	65.04	30.90	4.06	1.655	.2532	1.1442
7	14	Corn, 5; oilmeal, 1, oat straw....	2,280	65.33	30.45	4.22	1.177	.2448	.9028
8	14	Corn, 5; oilmeal, 1, corn stover...	2,620	62.22	32.98	4.80	1.421	.2466	.7809

\*The manure produced the first 16 days was removed January 18. This table shows only the manure produced the last 77 days of the experiment.

\*\*One lamb died March 9.

Experiment IV: Manure produced in 83 days.

1	15	Corn and clover hay . . . . .	3,550	62.76	32.80	4.44	1.294	.2010	.7718
2	15	Corn and alfalfa hay.....	3,850	65.09	30.03	4.88	1.477	.2050	.8362
3	15*	Corn and oat straw.....	3,400	65.58	30.49	3.93	1.909	.1890	.8638
4	15	Corn and corn stover.....	3,700	67.18	28.30	4.52	1.049	.1920	.6053
5	15	Corn, 5; oilmeal, 1, clover hay....	3,510	66.42	29.33	4.25	1.425	.1920	.7533
6	15**	Corn, 5; oilmeal, 1, alfalfa hay..	3,940	67.62	27.48	4.20	1.534	.2130	.8693
7	15	Corn, 5; oilmeal, 1, oat straw..	3,400	65.69	29.72	4.59	1.131	.2270	.9215
8	15	Corn, 5; oilmeal, 1, corn stover..	3,904	67.61	27.52	4.87	1.130	.1890	.7032

\*One lamb died December 10.

\*\*One lamb taken out December 16.

The preceding data concerning the amount and composition of the manure produced in Experiments III and IV reported in this bulletin are presented with the hope that they may show something of the value of the manure resulting from lamb feeding.

The manure was allowed to collect in the pens until the close of the experiment, when samples from each pen were taken for analysis. Table XXXVIII shows the analysis of the manure produced by each lot, as reported by the Department of Chemistry of this Station. In Experiment III each lot was bedded with the manure refuse from the roughage fed the respective lot, and when such roughage was insufficient, oat straw was used as bedding. The same is true of Experiment IV except that Lots 4 and 8, fed corn stover, were bedded with oat straw instead of with the refuse stover.

Table XXXIX shows the amount of nitrogen, phosphorus and potassium in the manure produced by the various lots, based on the chemical analyses reported in Table XXXVIII, and the value of these fertilizing constituents, based on retail prices in 1912 for the most common carriers of these constituents in a commercial form. This table shows a higher value both per ton and per head for manure from the lots fed clover and alfalfa hay than from those lots fed oat straw and corn stover, due mainly to a larger percentage and amount of nitrogen in the manure from the lots fed the leguminous roughages. A higher value per ton and per head is also shown for the

manure from the lots fed oilmeal than for that from the lots not fed oilmeal. This is also principally due to a larger percentage and amount of nitrogen in the manure from the lots fed oilmeal. While the more nitrogenous rations resulted in a notably larger percentage of nitrogen in the manure, the nature of the ration seems to have produced no striking differences in the percentage of phosphorus and potassium. The data presented in this table show very plainly that manure resulting from lamb feeding is a very important source of revenue which should not be overlooked.

TABLE XXXIX, Experiment III. 77 days.\* Fertilizing constituents and commercial value of manure.†

Lot No.	Nitrogen			Phosphorus			Potassium			Value of fertilizing elements in manure		
	Nitrogen	Ammonia equivalent	Value of ammonia	Phosphorus	Phosphoric acid equivalent	Value of phosphoric acid	Potassium	Potash equivalent	Value of potash	Total	Per head	Per ton of manure
	Lbs.	Lbs.	\$	Lbs.	Lbs.	\$	Lbs.	Lbs.	\$	\$	\$	\$
1	31.57	38.37	5.60	4.39	10.05	.37	26.18	31.54	1.45	7.42	.53	\$6.97
2	30.78	37.41	5.46	4.41	10.10	.37	21.67	26.10	1.20	7.03	.50	6.28
3	21.85	26.56	3.88	4.62	10.58	.39	18.85	22.71	1.04	5.31	.41	4.15
4	24.08	29.27	4.27	4.22	9.67	.36	14.68	17.68	.81	5.44	.43	5.16
5	45.64	55.48	8.10	5.83	13.35	.49	30.47	36.70	1.69	10.28	.73	7.97
6	40.55	49.29	7.19	6.20	14.20	.53	28.03	33.76	1.55	9.27	.66	7.57
7	26.84	32.62	4.76	5.58	12.78	.47	20.68	24.79	1.14	6.37	.46	5.89
8	37.23	45.25	6.60	6.46	14.80	.55	20.46	24.65	1.13	8.28	.59	6.32

\*The manure produced the first 16 days was removed January 18. This table shows only the manure produced the last 77 days of the experiment.

Experiment IV. 83 days.

1	45.94	55.84	8.15	7.14	16.35	.60	27.40	33.01	1.52	10.27	.68	5.79
2	56.86	69.11	10.09	7.89	18.07	.67	32.19	38.78	1.78	12.54	.84	6.51
3	30.91	37.57	5.48	6.43	14.73	.55	29.97	35.88	1.63	7.66	.54	4.50
4	38.81	47.17	6.88	7.10	16.26	.60	22.40	26.88	1.24	6.72	.58	4.71
5	59.02	60.80	8.87	6.74	15.44	.57	26.63	32.08	1.48	10.92	.73	6.22
6	60.44	73.46	19.72	8.39	19.22	.71	34.25	41.26	1.90	13.33	.95	6.77
7	38.45	46.74	6.82	7.72	17.68	.65	31.33	37.74	1.74	9.21	.61	5.42
8	44.12	53.63	7.83	7.38	16.90	.63	27.45	33.07	1.52	9.98	.67	5.11

†Value of ammonia and potash is computed from prices of nitrate of soda and muriate of potash, f. o. b. Wooster in 1912, viz.: \$55 per ton for nitrate of soda containing 15.5 percent nitrogen and \$46 per ton for muriate of potash containing 50 percent potash (K<sub>2</sub>O). Phosphoric acid was valued at 8.7c per pound, the price quoted for phosphoric acid in fine bone in the 1911 Official Report of the Secretary of the Ohio State Board of Agriculture.

### SUMMARY

#### EXPERIMENT I

In this experiment corn, oilmeal and timothy hay produced 16.5 percent greater gain than did corn and timothy hay and required less feed per 100 pounds gain (page 688). With prices indicated in Table V, the gain produced by the former ration cost 29c less per 100 pounds than did that produced by the latter ration.

Corn, oilmeal, timothy and alfalfa hay produced 10.3 percent greater gain and at a smaller requirement of feed for a given gain than did corn, oilmeal and timothy hay (page 688). With feeds at the prices indicated, the former ration made a gain that cost 69c less per 100 pounds than did that produced by the latter (page 689).

In this experiment a full grain ration made 22 percent greater gain than did a three-fourths grain ration, and at prices indicated, the gain produced by the full grain ration cost 55c less per 100 pounds than did that produced by the light grain ration (page 688).

The addition of oilmeal to a ration of corn and timothy hay resulted in an increased consumption of both concentrates and roughage (page 690).

Lots fed one feed of alfalfa and one of timothy hay each day consumed a larger percentage of the timothy than did the lots fed roughage consisting solely of timothy hay (page 690).

There was practically no difference in the percentage of shrinkage for the lots fed the different rations in this experiment.

#### EXPERIMENT II

Soybean straw produced 6.6 percent greater gain on a smaller amount of feed per 100 pounds gain than did corn stover, when both roughages were fed in connection with corn and oilmeal. Both clover and alfalfa hay, when fed with corn, produced greater gains on a smaller amount of feed per 100 pounds gain than did either corn stover or soybean straw when fed with corn and oilmeal, (page 695).

In this experiment corn and clover hay produced 9.4 percent greater gain on a smaller amount of feed per 100 pounds gain (page 695) than did corn and alfalfa hay.

No discrimination was made at time of sale, but this experiment showed very plainly that the lots fed corn stover and soybean straw, in connection with corn and oilmeal, required a longer time to reach a desirable market finish than did the lots fed clover or alfalfa hay, with corn alone.

#### EXPERIMENTS III AND IV

In both experiments alfalfa hay, when fed with or without oilmeal, produced slightly greater gain than did clover hay and at a smaller consumption of feed per 100 pounds gain (pages 703, 714 and 715). At the prices that prevailed for feeds used in these experiments the cost of gains produced by these two roughages was nearly the same, the slight difference which did exist being in favor of alfalfa hay (pages 703 and 715). Alfalfa and clover hay produced practically the same degree of finish (pages 707 and 718).

In both experiments corn stover produced greater gain than did oat straw, whether fed with or without oilmeal and with a smaller consumption of feed per 100 pounds gain (pages 703, 714 and 715). In all cases corn stover produced a higher degree of finish than did oat straw (pages 707 and 718).

The addition of oilmeal to a ration of corn and clover or of corn and alfalfa hay resulted in slightly larger gain in Experiment IV, while in Experiment III it resulted in slightly smaller gain (pages 703 and 714). In all cases the addition of oilmeal to such a ration resulted in more expensive gain, and there was no noticeable effect upon the degree of finish secured. This indicates that the addition of oilmeal to a ration of corn and clover or corn and alfalfa hay is not economical.

In both experiments the addition of oilmeal to a ration of corn and oat straw or of corn and corn stover resulted in larger gain and in a smaller consumption of feed per 100 pounds gain (pages 703, 714 and 715) and with the prices of feeds which prevailed during the experiment, it resulted in cheaper gain (pages 703 and 715). The addition of oilmeal to such rations produced a higher degree of finish.

These experiments show that when oat straw or corn stover constitute the entire roughage, the cost of gain is too high to be profitable with usual prices for feeds and lambs.

In Experiment IV the addition of oilmeal to any of the four rations resulted in an increased consumption of roughage, while both experiments showed that such an addition resulted in the lambs consuming more concentrates and showing less tendency to go off feed.

Manure from the lots fed clover and alfalfa hay contained a higher percentage of nitrogen and had a higher value both per ton and per head than did that from the lots fed oat straw and corn stover (pages 719 and 720).

Manure from the lots fed oilmeal contained a higher percentage of nitrogen and had a higher value both per ton and per head than did that from the lots not fed oilmeal (pages 719 and 720).

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