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A REVIEW OF AMERICAN INVESTIGATIONS ON FATTENING LAMBS

WITH SPECIAL REFERENCE TO

THE PROTEIN AND ENERGY REQUIREMENTS

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Summary of Bulletin No. 166.

1. Object.—In connection with investigations carried on by the Animal Husbandry Department of this station upon the protein requirements of farm animals, it was necessary to review the literature with reference to fattening lambs. In addition, it was deemed of importance to the problem to include the energy requirements. Page 3

2. Nature of the Review.—The experiments studied were limited to those that have been carried on in the United States. Those in which the feeds were carefully weighed and analyzed chemically have been regarded as the most important. In nearly every case it was necessary to calculate the digestible protein, using coefficients of digestibility from the most recent and reliable sources. The net energy values of the rations also were calculated. Pages 3 to 5

3. Scope of the Review.—The review included the following investigations, the objects of which were to compare rations without special reference to any particular nutrients:

Cornell	Station,	3	experiments	with	303	lambs.	Pages 5 to 7
Michigan	"	4	"	"	430	"	" 7 to 10
Wyoming	"	7	"	"	940	"	" 10 to 14
Iowa	"	6	"	"	334	"	" 14 to 17
Nebraska	"	2	"	"	178	"	" 17 to 18
Colorado	"	2	"	"	911	"	" 18 to 20
South Dakota	"	3	"	"	125	"	" 20 to 21
Oklahoma	"	1	"	"	40	"	" 22
Wisconsin	"	3	"	"	58	"	" 22 to 23
New Hampshire	"	1	"	"	20	"	" 23 to 24
Ohio	"	4	"	"	490	"	" 24 to 26
Connecticut (Storrs)	"	1	"	"	220	"	" 26
Minnesota	"	1	"	"	10	"	" 26
Montana	"	2	"	"	230	"	" 27
Utah	"	4	"	"	300	"	" 27 to 29
Illinois	"	6	"	"	538	"	" 29 to 32

4. Compilation and Discussion of Results.—The results have been compiled and discussed in an effort to ascertain the minimum amount of protein and energy conducive to good fattening gains. They have been divided into four classes according to the average live weights of the lambs during the experiments: Class I, lambs weighing 50 to 70 pounds; Class II, lambs weighing 70 to 90 pounds; Class III, lambs weighing 90 to 110 pounds; and Class IV, lambs weighing 110 to 150 pounds. The results have been subdivided further into groups according to the amounts of digestible protein consumed. The number of animals in each lot, the average live weights of the lambs during the experiment, the net energy consumed per day, and the average daily gains have been given for each group. Pages 32 to 34

5. Conclusions.—From the results obtained in this review, which embrace 265 lots containing in all 5127 lambs, the following average values for protein and energy are suggested as being, in general, the most economical for fattening lambs: Page 35

a. Lambs weighing 50 to 70 pounds, 3.1 to 3.3 pounds of digestible protein and 17 to 19 therms of net energy.

b. Lambs weighing 70 to 90 pounds, 2.5 to 2.8 pounds of digestible protein and 18 to 20 therms of net energy. In certain instances 1.8 to 2.0 pounds of digestible protein and 18 to 20 therms of net energy are sufficient.

c. Lambs weighing 90 to 110 pounds, 2.2 to 2.4 pounds of digestible protein and 17 to 20 therms of net energy.

d. Lambs weighing 110 to 150 pounds, 2.6 to 3.0 pounds of digestible protein and 16 to 19 therms of net energy. It seems probable, however, that 1.4 to 1.9 pounds of protein would be sufficient for lambs of this weight.

A REVIEW OF AMERICAN INVESTIGATIONS ON FATTENING LAMBS

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By SLEETER BULL, Associate in Animal Nutrition, and
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INTRODUCTION

In connection with investigations carried on by the Animal Husbandry Department of this station upon the protein requirements of farm animals, it was necessary to make a comprehensive review of the literature upon the protein requirements of fattening lambs. While this study was being made, it became evident that the addition of the data dealing with the net energy requirements would aid decidedly in interpreting the results.

Inasmuch as Armsby[a] has quite thoroly reviewed the German investigations upon the protein requirements of sheep, it was thought best to confine this study to the American experiments. Table 1 presents a compilation of data obtained by Armsby from the results of experiments by Wolff and Weiske to determine the protein requirements of growing sheep. The gains represent a normal rate of growth.

Table 1.— Protein Requirements of Growing Sheep: from Data Compiled by Armsby[a]

Age	Digestible protein per 1000 pounds	Experimenter
mos.	*lbs.*	
4–5	3.76	Weiske
5–6	3.26	Weiske
5–6	3.16	Wolff
6–7	2.78	Weiske
6–8	2.96	Wolff
7–9	2.76	Weiske
8–9	1.87	Wolff
9–10	2.38	Weiske
10–11	2.30	Weiske
9–12	1.38	Wolff
11–12	2.16	Weiske
12–14	1.96	Weiske
12–14	1.61	Wolff
14–15	1.92	Weiske
24	1.22	Weiske

[a]Manual of Cattle Feeding, 5th ed. (1902), pp. 448–458; U. S. Dept. Agr., Bur. An. Ind., Bul. 108, p. 72; Bul. 143, p. 94.

From the results of a number of German feeding experiments, Armsby[a] calculated the standard for growing sheep shown in Table 2.

TABLE 2.— PROTEIN AND ENERGY REQUIREMENTS OF GROWING SHEEP: FROM DATA COMPILED BY ARMSBY

Age	Weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds
mos.	*lbs.*	*lbs.*	*therms*
6	70	4.4	18.6
9	90	2.8	15.6
12	110	2.1	12.7
15	130	1.8	11.5
18	145	1.5	11.0

Kellner[b] has presented a feeding standard for fattening sheep based upon the results obtained by the German experiment stations. His standard is given in Table 3.

TABLE 3.— PROTEIN AND ENERGY REQUIREMENTS OF FATTENING SHEEP: FROM DATA COMPILED BY KELLNER

Age	Weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds
mos.	*lbs.*	*lbs.*	*therms*
5–6	66	4.5	18.4
6–8	84	3.5	16.5
8–11	101	2.5	14.7
11–15	119	2.0	12.2
15–20	154	1.5	10.9

In making a study of the data given in the following pages, an effort has been made to embrace all the experiments that seemed of value. Since but few experiments have been carried on in this country with the protein requirement primarily in mind, it has been necessary to recalculate the results of many experiments that had for their object simply the comparison of rations without special reference to any particular nutrient[c].

More importance should be attached to those experiments in which the feeds were analyzed than to those in which they were not. Where the feeds were not analyzed, their composition has been taken from Henry's "Feeds and Feeding," unless some other source seemed more representative. Owing to the varying chemical composition of feeding stuffs, these calculated results must necessarily have a questionable value.

[a] U. S. Dept. Agr., Farmers' Bul. 346, p. 18.

[b] Die Ernährung der landwirtschaftlichen Nutztiere, Dritte Auflage (1906), p. 593.

[c] In the discussion of those experiments in which the investigators calculated the digestible nutrients, mention is made of the fact.

The coefficients of digestibility also have been taken from Henry's "Feeds and Feeding," unless some other source seemed better adapted to the particular experiment under consideration, in which case the reference is given. Only a few experiments have been reviewed in which the rations were not carefully weighed, as they obviously would be of little value.

The custom of speaking of digestible carbohydrates and digestible fats has been discarded, and the "net energy" values, as introduced by Armsby, have been substituted. When the digestible nutrients of a feed are considered, only the losses in the feces are deducted. In considering the net energy, one takes into account only that part which is available for maintenance, growth, fattening, wool production, etc.; the losses in the feces, intestinal gas, urine, labor of mastication, digestion, and assimilation being deducted. In calculating the energy of the rations, the net energy values of the feeds as compiled by Armsby and Kellner have been used.

The digestible protein and the net energy per 1000 pounds live weight have been calculated from the total amounts of digestible protein and net energy consumed, taking the average of the initial and the final live weights as the average weight of the lambs during the experiment. Thruout the study, 0.3 pound has been assumed to be a good daily gain for lambs.

AMERICAN INVESTIGATIONS

In 1888, Roberts and Wing,[1] at Cornell, carried on one of the first experiments in this country relating to the influence of the amount of protein consumed upon the nutrition of lambs. They fed 2 lots of 3

TABLE 4.— EXPERIMENT BY ROBERTS AND WING AT THE CORNELL STATION[1]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*		*therms*	*lbs.*
I	Bran, oil meal, cottonseed meal, mangels, mixed hay	46	76	4.9	1:3.3	18.1	0.18
II	Corn meal, mangels, mixed hay	46	63	2.2	1:8.4	17.8	0.10

lambs each, from November 11 to April 25, 166 days. The lambs at the beginning of the experiment were about six months old. The feeds were analyzed and the digestible nutrients calculated. The data are summarized in Table 4.

[1]This and other reference numbers refer to the bibliography on page 48.

In both lots the gains were quite low. Lot II, receiving the smaller amount of protein, made the lower gain. Altho it is not so stated in the report of the experiment, lambs weighing only 46 pounds at six months of age would hardly be considered representative animals; the fact that they were undersized would influence the gains more or less and detract from the value of the experiment.

Roberts and Wing,[2] in a continuation of the preceding experiment, fed 4 lots of 2 lambs each, from November 25 to April 25, 150 days. Whether the digestible nutrients were calculated from direct analyses of the feeds or from averages, is not stated. The data are summarized in Table 5.

TABLE 5.—EXPERIMENT BY ROBERTS AND WING AT THE CORNELL STATION[2]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*		*therms*	*lbs.*
I	Corn, turnips, mangels, timothy hay	47	72	1.6	1:10.9	16.7	0.16
II	Bran, cottonseed meal, turnips, mangels, clover hay	48	87	3.8	1: 4.2	15.9	0.26
III	Corn, bran, cottonseed meal, turnips, mangels, timothy hay	51	89	2.6	1: 6.5	17.1	0.25
IV	Corn, bran, cottonseed meal, timothy hay.	55	84	2.5	1: 6.3	16.7	0.19

A comparison of Lots I and IV would seem to indicate that the slightly greater gain of Lot IV was due to the considerable increase in the amount of protein consumed by that lot, since both lots received equal amounts of energy. The similarity of the gains made by Lots II and III would seem to indicate that there was no special advantage in increasing the protein above 2.6 pounds. In every lot the amount of energy in the ration was apparently too low for maximum gains, as in no case was the average daily gain 0.3 pound per head.

Wing[3] later fed 4 lots of lambs from December 15 to April 3, a period of 110 days. The feeds were not analyzed. A summary of the data is given in Table 6.

Only a slight difference in gains is shown between Lot III, on the high-protein plane with no succulent feed, and Lot II, on the low-protein plane with no succulent feed. Likewise, Lot I (low-protein)

TABLE 6.— EXPERIMENT BY WING AT THE CORNELL STATION[3]

Lot	Ration	No. in lot	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
			lbs.	*lbs.*	*lbs.*		*therms*	*lbs.*
I	Mixed hay, pea and oat hay, silage, grain.	58	56	79	2.6	1:8.4	21.9	0.21
II	Mixed hay, pea and oat hay, grain	58	56	71	2.8	1:8.3	22.0	0.14
III	Mixed hay, pea and oat hay, grain	86	56	75	4.1	1:5.2	19.9	0.17
IV	Mixed hay, pea and oat hay, silage, grain.	87	57	82	3.8	1:5.3	19.1	0.23

and Lot IV (high-protein), both of which received succulent feeds, show but little difference in gains. All gains were low and seemed to vary more with the succulent feeds than with the protein or the energy. Possibly the rations of Lots I and II were deficient in protein.

TABLE 7.— EXPERIMENT BY F. B. MUMFORD AT THE MICHIGAN STATION[4]

Lot	Ration	No. in lot	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
			lbs.	*lbs.*	*lbs.*		*therms*	*lbs.*
I	Corn, roots, clover hay...	10	83	127	2.2	1:7.8	17.7	0.37
II	Oats, roots, clover hay...	10	83	121	2.4	1:6.4	16.1	0.31
III	Bran, roots, clover hay...	10	82	106	2.9	1:5.1	13.7	0.20
IV	Corn, oats, roots, clover hay...	10	84	128	2.4	1:7.0	17.2	0.37
V	Corn, bran, roots, clover hay...	10	86	122	2.6	1:6.5	16.2	0.30
VI	Oats, bran, roots, clover hay...	15	84	120	2.6	1:5.6	14.8	0.30
VII	Oats, corn, bran, roots, clover hay	15	83	122	2.6	1:6.0	16.3	0.33
VIII	Oats, bran, roots, clover hay...	20	73	102	2.4	1:6.2	15.5	0.24
IX	Oats, bran, silage, clover hay	20	74	103	2.2	1:7.6	15.8	0.24
X	Corn, oats, bran, roots, clover hay	5	84	110	3.0	1:6.8	14.8	0.31

F. B. Mumford,[4] at the Michigan Station, fed 10 lots of Shropshire lambs from November 30 to March 29, a period of 120 days. The feeds were not analyzed, but the digestible nutrients were calculated. The data are summarized in Table 7.

Good gains were made in nearly all instances. Lots III, VIII, and IX made the poorest gains. The energy was lower and the protein higher for Lots V, VI, and X than for Lots I, II, and IV, due to the partial substitution of bran for grain. It seems probable that the protein in this experiment was sufficient for good fattening gains.

Smith and F. B. Mumford,[5] in a continuation of the experiment just cited, fed 9 lots of Shropshire lambs from November 27 to March 12, 106 days. No analyses were made of the feeds, but the digestible nutrients were calculated. In Table 8 is given a summary of the data of this experiment.

TABLE 8.— EXPERIMENT BY SMITH AND F. B. MUMFORD AT THE MICHIGAN STATION[5]

Lot	Ration	No. in lot	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
			lbs.	*lbs.*	*lbs.*		*therms*	*lbs.*
I	Corn, clover hay	10	82	115	2.0	1:8.0	17.0	0.31
II	Corn, clover hay, roots....	10	81	121	2.1	1:8.0	18.4	0.38
III	Corn, clover hay, roots, oil meal	10	84	123	2.7	1:6.0	18.4	0.37
IV	Corn, clover hay, oil meal.....	10	83	118	2.8	1:5.6	17.7	0.34
V	Corn, clover hay, bran	15	80	106	2.5	1:6.0	15.8	0.25
VI	Corn, clover hay, wheat	15	81	111	2.1	1:7.5	16.3	0.28
VII	Corn, clover hay, wheat, oil meal	15	80	109	2.7	1:5.5	16.4	0.28
VIII	Corn, clover hay[a]	20	82	107	2.0	1:7.9	16.6	0.24
IX	Corn, clover hay, bran[a]	20	80	104	2.6	1:6.2	16.3	0.23

[a]Self-feeder used.

Again the protein appears to have been sufficient for good fattening gains. The lower gains of Lots VIII and IX, and also of Lots V, VI, and VII, may have been due to a slight deficiency in the amount of energy consumed by each of these lots. A comparison of Lots I and II with Lots III and IV reveals no apparent advantage in increasing the protein over 2.1 pounds.

In a continuation of the above investigation, F. B. Mumford[6] fed 8 lots of 10 half-blood Hampshire lambs from November 25 to February 24, 92 days. The feeds were not analyzed. The data are summarized in Table 9.

TABLE 9.— EXPERIMENT BY F. B. MUMFORD AT THE MICHIGAN STATION[6]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Corn, wheat, clover hay.....	85	106	1.9	15.9	0.22
II	Corn, wheat, clover hay.....	85	108	1.9	15.8	0.25
III	Corn, clover hay.....	85	108	1.8	16.5	0.26
IV	Wheat, clover hay.....	84	106	2.1	16.1	0.24
V	Corn, wheat, clover hay.....	84	100	2.3	18.3	0.18
VI	Sugar beets, clover hay.....	84	95	1.7	11.9	0.13
VII	Corn, wheat, oats, bran, clover hay	85	106	2.3	15.5	0.23
VIII	Corn, wheat, clover hay.....	80	105	2.1	17.4	0.26

The gains in this experiment were only fair. In view of the preceding experiments by Mumford, it would seem that this may have been due in part at least to a deficiency in the energy supply and possibly also in the protein.

H. W. Mumford,[7] also at the Michigan Station, fed 10 lots of 10 Shropshire lambs from November 11 to February 17, 99 days. The feeds were not analyzed, but the digestible nutrients were calculated. The data are summarized in Table 10.

TABLE 10.— EXPERIMENT BY H. W. MUMFORD AT THE MICHIGAN STATION[7]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*		*therms*	*lbs.*
I	Corn, roots, clover hay	75	108	2.0	1: 8.4	19.0	0.33
II	Corn, roots, alfalfa hay	74	108	2.2	1: 7.9	19.3	0.35
III	Corn, roots, millet hay, clover hay....	75	108	1.9	1: 9.3	19.5	0.34
IV	Corn, roots, millet hay	73	99	1.8	1:10.4	20.2	0.26
V	Corn, roots, clover hay, oat straw.....	73	105	1.8	1: 9.9	18.7	0.32
VI	Corn, roots, oat straw	74	102	1.5	1:12.6	18.3	0.29
VII	Corn, roots, clover hay, corn stover....	73	106	1.8	1: 9.7	19.1	0.34
VIII	Corn, roots, corn stover	75	106	1.5	1:11.4	18.7	0.31
IX	Corn, roots, clover hay, bean straw....	74	107	....	....	....	0.33
X	Corn, roots, bean straw	74	104	....	....	....	0.30

The results show that the protein was ample for good fattening gains, even when only 1.5 pounds was fed, as was done in the cases of Lots VI and VIII. It may be interesting to note the difference be-

tween this and the preceding experiment as to gains. The greater gains made in this experiment were probably due to the considerably larger amounts of energy consumed, for the protein was about the same in both experiments.

Foster,[a] at the Wyoming Station, fed 2 lots of 50 lambs each, from December 31 to April 2, 98 days. The feeds were not analyzed. The values for digestible protein in native and in alfalfa hay were taken from results obtained at that station.[a] The data are summarized in Table 11.

TABLE 11.— EXPERIMENT BY FOSTER AT THE WYOMING STATION[a]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Corn, oil cake, native hay.....	48	72	1.9	17.2	0.25
II	Corn, oil cake, alfalfa hay....	47	78	3.9	18.9	0.32

Lot II, the high-protein lot, made the better gain. This may have been due in part, however, to the larger amount of energy consumed by Lot II, as the difference in gains was not proportional to the difference in protein.

Morton,[a] also at the Wyoming Station, fed 3 lots of 20 lambs each and 2 lots of 3 lambs each, from October 16 to February 21, a period of 112 days, using Shropshire-Merino crossbreds. The feeds were analyzed, and the digestible nutrients calculated, the coefficients of digestibility of the protein of alfalfa and native hay being taken from previous digestion experiments made at the Wyoming Station.[b] The data are summarized in Table 12.

TABLE 12.— EXPERIMENT BY MORTON AT THE WYOMING STATION[a]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*		*therms*	*lbs.*
I	Corn, turnips, alfalfa hay	63	94	3.7	1: 4.8	17.0	0.31
II	Barley, turnips, alfalfa hay	62	95	3.6	1: 4.8	16.9	0.33
III	Corn, turnips, native hay	63	83	1.7	1:10.5	15.6	0.21
IV	Corn, turnips, flaxseed, alfalfa hay...	65	94	3.5	1: 5.1	17.0	0.32
V	Turnips, flaxseed, alfalfa hay	65	91	3.7	1: 4.2	12.6	0.26

[a]Wyo. Agr. Exp. Sta., Buls. 69 (1905) and 78 (1908).

[b]Wyo. Agr. Exp. Sta., Bul. 69 (1905).

It is evident that all lots received enough protein for good fattening gains, with the exception of Lot III. The fact that Lot III made only a fair gain indicates that a larger amount of either protein or energy, or both, would have been preferable. There is nothing to show, however, that the other lots would not have done as well upon somewhat less protein than they received. The comparatively low gain made by Lot V was probably due to a deficiency in the energy supply.

Morton,[10] in a continuation of the preceding experiment, fed 7 lots of 5 lambs each and one lot of 100 lambs, for 98 days. These also were Shropshire-Merino crosses. Analyses were made of all the feeds except the alfalfa hay, the composition of which was taken from the report of a previous experiment at the Wyoming Station.[a] The digestible nutrients were calculated, the coefficients of digestibility of the protein of alfalfa and native hay being taken from the same source as in the previous experiment.[a] The data are given in Table 13.

TABLE 13.— EXPERIMENT BY MORTON AT THE WYOMING STATION[10]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*		*therms*	*lbs.*
I	Oats, native hay.....	64	79	1.8	1: 9.4	15.1	0.15
II	Corn, native hay.....	64	77	1.5	1:11.2	15.7	0.13
III	Corn, oil meal, native hay	64	80	2.2	1: 8.3	17.3	0.17
IV	Oats, oil meal, native hay	64	81	2.4	1: 7.4	16.1	0.18
V	Barley, oil meal, native hay	64	80	2.4	1: 7.3	16.8	0.18
VI	Barley, native hay...	63	79	1.8	1: 9.3	15.6	0.16
VII	Corn, alfalfa hay....	63	92	3.8	1: 5.4	20.4	0.29
VIII	Corn, alfalfa hay....	59	90	4.5	1: 5.4	21.1	0.31

Lots VII and VIII, fed corn and alfalfa hay, were the only lots that made good gains. The poorer gains made by the other lots were probably due in part to the smaller amounts of protein and energy consumed. The source of the nutrients may also have had some influence upon these gains.

Morton,[11] in another experiment, fed 9 lots of lambs for 98 days. All the feeds were analyzed with the exception of the alfalfa and the pea hay. The coefficients of digestibility of the protein of the alfalfa, the native, the pea, and the sweet-clover hay were taken from the results of digestion experiments made at the Wyoming Station,[b] and of the speltz, from results obtained at the South Dakota Station.[c] The data are summarized in Table 14.

[a] Wyo. Agr. Exp. Sta., Bul. 69 (1905).

[b] Wyo. Agr. Exp. Sta., Buls. 69 (1905) and 78 (1908).

[c] So. Dak. Agr. Exp. Sta., Bul. 114 (1909).

TABLE 14.— EXPERIMENT BY MORTON AT THE WYOMING STATION[11]

Lot	Ration	No. in lot	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
			lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Corn, alfalfa hay.....	40	54	88	4.3	21.9	0.35
II	Oats, oil meal, native hay	40	53	74	2.0	17.2	0.21
III	Corn, alfalfa hay.....	40	53	87	4.3	21.2	0.35
IV	Corn, oil meal, sweet-clover hay	10	55	86	4.5	22.0	0.31
V	Pea hay	10	53	70	4.6	17.5	0.17
VI	Barley, oil meal, native hay	10	54	77	1.8	18.8	0.23
VII	Barley, oil meal, native hay	10	54	77	1.8	18.4	0.23
VIII	Speltz, oil meal, native hay	10	54	68	2.0	19.0	0.14
IX	Pea hay	40	77	83	2.8	10.8	0.06

In this experiment, of the lots receiving the most protein, Nos. 1, III, and IV made the highest gains; these lots also received the most energy. The low gains made by Lots V and IX were probably due to a deficiency in energy, while the low gains of Lots II, VI, VII, and VIII may have been due to a deficiency both in protein and in energy, or to the source of these nutrients.

Faville,[12] also at the Wyoming Station, fed 3 lots of 35 lambs each, for 91 days beginning November 23. The feeds were not analyzed. In recalculating the results, the analyses of speltz and alfalfa hay as determined at the Wyoming Station the following year, were used.[a] The coefficients of digestibility of the protein of alfalfa hay and of speltz were taken from the same sources as in the preceding experiment by Morton. A summary of the data of this experiment is given in Table 15.

TABLE 15.— EXPERIMENT BY FAVILLE AT THE WYOMING STATION[12]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Corn, alfalfa hay.....	59	87	4.0	22.1	0.30
II	Speltz, alfalfa hay.....	61	81	4.1	21.8	0.23
III	Barley, alfalfa hay.....	60	90	4.1	21.4	0.33

The protein and the energy both appear to have been sufficient for good gains in Lots I and III. In the case of Lot II, their source seems to have been responsible for the lower gain.

[a] Wyo. Agr. Exp. Sta., Bul. 85 (1910).

Faville,[13] in the following year, fed 4 lots of 41 lambs each, for 91 days. The feeds were all analyzed. The coefficients of digestibility of the protein of alfalfa and native hay were again taken from the same sources as in the experiment by Morton.[11] The data of this experiment are given in Table 16.

TABLE 16.— EXPERIMENT BY FAVILLE AT THE WYOMING STATION[13]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Corn, alfalfa hay.....	64	96	2.9	18.2	0.35
II	Barley, alfalfa hay.....	64	90	3.2	18.8	0.28
III	Speltz, alfalfa hay.....	63	89	3.7	20.7	0.29
IV	Corn, native hay.....	64	87	1.8	18.0	0.25

In this experiment the gains did not vary either with the protein or with the energy consumption. Lot IV made nearly as high a gain as did either Lot II or Lot III, each of which received nearly twice as much protein and slightly more energy than did Lot IV. This experiment, like the preceding one, seems to indicate that the source of the protein or the energy, or both, had some influence upon the gains. The fact that the gains in this experiment were as high as those in the experiment preceding, suggests that the protein in the latter experiment may have been unnecessarily high.

Faville,[14] in another experiment, fed 5 lots of 32 lambs each, for a period of 98 days. The feeds were all analyzed. In calculating the digestible protein, the coefficient of digestibility of native hay was taken from determinations made at the Wyoming Station.[a] A summary of the data of this experiment is given in Table 17.

TABLE 17.— EXPERIMENT BY FAVILLE AT THE WYOMING STATION[14]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Corn, native hay.....	77	102	1.4	15.6	0.25
II	Barley, native hay.....	77	94	1.5	15.5	0.17
III	Barley, native hay.....	76	95	1.5	15.6	0.19
IV	Corn, oil meal, native hay.....	76	102	2.1	16.0	0.27
V	Corn, alfalfa hay, native hay..	77	99	1.6	14.6	0.23

The amounts both of protein and of energy were lower than those in the two preceding experiments, and they were apparently too low

[a] Wyo. Agr. Exp. Sta., Buls. 69 (1905) and 78 (1908).

to give good gains. Since the energy supply was no greater than that required by growing lambs, as determined by Armsby,[a] it is improbable that the small amount of protein was the only factor producing the low gains; a comparison of Lot I with Lots II and III would seem to show that the source of the protein was also a factor.

Wilson and Curtiss,[15] at the Iowa Station, fed 11 lots of lambs of different breeds. There were 10 lambs in each lot, with the exception of Lot VI, in which there were but 9. The lambs were all pure-bred, with the exception of those of Lots X and XI, which were crossbred and range lambs. The experiment ran from January 1 to March 31, 90 days. Each lot was fed the same ration, consisting of shelled corn, oats, bran, oil meal, roots, and clover, pea, and timothy hay. Timothy hay was fed only during the first month, and in but a small amount then; pea hay was fed during the first two months; and the other feeds were fed during the entire experiment. None of the feeds was analyzed. A summary of the data of this experiment is given in Table 18.

TABLE 18.— EXPERIMENT BY WILSON AND CURTISS AT THE IOWA STATION[15]

Lot	Breed	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Southdown	91	132	3.1	19.3	0.45
II	Shropshire	101	144	2.9	18.5	0.48
III	Oxford	119	166	2.9	18.5	0.52
IV	Suffolk	117	166	3.0	19.0	0.55
V	Lincoln	121	171	2.9	18.1	0.55
VI	Leicester	132	179	2.6	16.4	0.52
VII	Cotswold	118	174	2.9	18.1	0.62
VIII	Dorset	101	145	3.2	20.1	0.48
IX	Merino	82	108	3.0	19.1	0.29
X	Crossbred	81	118	3.1	19.5	0.41
XI	Range	71	104	3.0	18.8	0.37

The gains certainly indicate that the protein and the energy were sufficient for very good results. It must be remembered, however, in comparing this experiment with others of a similar character, that the pure-bred lambs used in this experiment and in the one following, were selected with the idea of obtaining the best representatives of each breed; hence better gains than the average would be expected.

Curtiss and Wilson,[16] in a continuation of the preceding experiment, fed 9 lots of pure-bred lambs from September 16 to January 1, a period of 106 days. There were 9 lambs in each lot, with the exception of Lots I and IX, which contained 10 and 8 lambs respectively. The animals received the same feeds as in the previous ex-

[a] This bulletin, page 4.

periment, with the exception that at the beginning of the experiment cabbage and a little green clover were added to the ration. The feeds were not analyzed. A summary of the data is given in Table 19.

TABLE 19.— EXPERIMENT BY CURTISS AND WILSON AT THE IOWA STATION[16]

Lot	Breed	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Southdown	65	102	4.2	26.0	0.35
II	Shropshire	88	126	3.6	22.3	0.36
III	Oxford	95	138	3.7	22.6	0.40
IV	Suffolk	92	134	3.7	23.0	0.40
V	Lincoln	94	144	3.6	22.3	0.46
VI	Leicester	86	133	3.8	23.7	0.44
VII	Cotswold	85	138	3.8	23.7	0.50
VIII	Dorset	82	128	4.0	25.1	0.43
IX	Merino	74	113	4.1	25.1	0.37

It is noticeable that with an increased amount of protein and energy the gains in this experiment, altho very good, were considerably lower than in the experiment of the previous year. Curtiss and Wilson attributed this difference to the fact that the lambs of the latter experiment were three months younger than those of the earlier experiment, and that the weather conditions were less favorable.

Kennedy and Marshall,[17] also at the Iowa Station, fed 4 lots of 10 lambs each, from October 1 to November 25, 56 days. The feeds were not analyzed. In calculating the digestible protein, the value for speltz was taken from Bulletin No. 114 of the South Dakota Station. A summary of the data is given in Table 20.

TABLE 20.— EXPERIMENT BY KENNEDY AND MARSHALL AT THE IOWA STATION[17]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Bran, speltz, clover hay	111	137	3.8	28.0	0.46
II	Bran, soy beans, clover hay	110	133	8.1	25.2	0.41
III	Corn, gluten feed, bran, clover hay	110	135	4.6	27.7	0.45
IV	Corn, bran, clover hay	109	134	3.8	28.6	0.45

Altho the gains were very good in all instances, the lots receiving the smallest amounts of protein made gains as high as or slightly higher than the lots receiving the largest amounts of protein. As the energy was amply sufficient, there seems to have been no advantage in feed-

ing more than 3.8 pounds of protein. Perhaps a smaller amount of protein would have sufficed. The large gains are accounted for possibly in part by the short duration of the experiment.

Kennedy, Robbins, and Kildee,[18] in experiments extending over three years, fed different combinations of hay, grain, and succulents. The feeds were analyzed and careful records were kept. A summary of the data of the three experiments is given in Table 21.

TABLE 21.— EXPERIMENTS BY KENNEDY, ROBBINS, AND KILDEE AT THE IOWA STATION[18]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
First year: 7 lambs to a lot, 112 days							
		lbs.	*lbs.*	*lbs.*		*therms*	*lbs.*
I	Corn, oats, bran, mangels, alfalfa hay...	79	128	4.6	1:4.2	21.6	0.44
II	Corn, oats, bran, mangels, sugar beets, alfalfa hay	78	128	4.6	1:4.2	22.9	0.45
III	Corn, oats, bran, silage, alfalfa hay..	78	125	4.3	1:4.2	22.0	0.42
IV	Corn, oats, bran, alfalfa hay	80	121	4.4	1:3.7	20.0	0.37
Second year: 10 lambs to a lot, 84 days							
I	Corn, mixed hay, cowpea hay, alfalfa hay	69	97	3.1	1:6.1	23.3	0.33
II	Corn, turnips, mixed hay, cowpea hay, alfalfa hay	67	93	3.3	1:5.9	24.7	0.30
III	Corn, sugar beets, mixed hay, cowpea hay, alfalfa hay...	68	102	3.3	1:5.9	25.9	0.41
IV	Corn, cabbage, mixed hay, cowpea hay, alfalfa hay	69	94	3.5	1:5.8	26.0	0.30
Third year: 9 lambs to a lot, 168 days							
I	Corn, cottonseed meal, mixed hay	76	126	2.1	1:4.1	19.8	0.30
II	Corn, cottonseed meal, silage, mixed hay.	78	126	2.1	1:4.1	20.3	0.29
III	Corn, cottonseed meal, sugar beets, mixed hay	74	139	2.2	1:3.1	21.2	0.39
IV	Corn, cottonseed meal, mangels, mixed hay	71	133	2.3	1:3.3	20.1	0.37

In the experiment of the first year, 4 lots of 7 lambs each were fed from December 28 to April 19, 112 days. The gains show that there was ample protein and energy in the ration for fattening.

In the experiment of the second year, 4 lots of 10 lambs each were fed from November 15 to February 7, a period of 84 days. Again the gains were good, indicating that the protein and energy were sufficient. It will also be noted that while the energy was somewhat greater, the protein considerably lower, and the feeding period shorter than in the experiment of the first year, the gains were somewhat less.

In the experiment of the third year, 4 lots of 9 lambs each were fed from September 11 to February 26, a period of 168 days. Altho this was considerably longer than the feeding period of the second year, and altho considerably less protein was consumed, yet the gains were as large. Compared with the first year, however, the average daily gains were smaller. This may be explained by the fact that the experiment of the first year was run during cold weather (December 28 to April 19, 112 days), which is generally considered to be more conducive to good gains, while the experiment of the third year, altho extending into cold weather, was begun in warmer weather (September 11 to February 26, 168 days). If the gains of only the last 112 days of the third-year experiment are taken into consideration, the average daily gain of all the lots was 0.44 pound. This is practically the same gain as was made in the first-year experiment, and it was made on slightly less energy and about two-thirds the amount of protein.

Burnett,[19] of the Nebraska Station, fed 8 lots of lambs for 98 days. The feeds were not analyzed. A summary of the data is given in Table 22.

The results seem to indicate that lambs of this weight should be fed from 2.3 to 3.1 pounds of protein. In no instance was a smaller

TABLE 22.— EXPERIMENT BY BURNETT AT THE NEBRASKA STATION[19]

Lot	Ration	No. in lot	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
			lbs.	*lbs.*	*lbs.*		*therms*	*lbs.*
I	Corn, alfalfa hay	16	53	85	3.1	1: 5.9	19.4	0.33
II	Corn, oats, alfalfa hay....	16	54	85	3.2	1: 5.6	18.5	0.32
III	Corn, bran, alfalfa hay....	16	52	82	3.3	1: 5.5	18.1	0.30
IV	Corn, prairie hay	8	52	72	1.7	1:10.5	17.0	0.20
V	Corn, oil meal, prairie hay..	8	52	77	2.3	1: 8.0	17.8	0.24
VI	Corn, oats, prairie hay..	8	52	71	1.8	1:10.0	16.7	0.19
VII	Corn, bran, prairie hay..	8	51	70	1.9	1: 9.0	16.3	0.19
VIII	Corn, bran, alfalfa hay..	20	53	83	3.3	1: 5.2	17.5	0.34

amount conducive to good gains. It is to be noted, however, that the energy also was lower in the low-protein lots, which fact undoubtedly influenced the gains to a certain extent.

In the following year, Burnett,[20] fed 10 lots of lambs for 98 days, beginning December 8. The feeds were not analyzed. Inasmuch as four lots received sorghum hay, for which no coefficients of digestibility and no energy values could be found, the results for these four lots have not been recalculated. A summary of the data for the six other lots is given in Table 23.

TABLE 23.— EXPERIMENT BY BURNETT AT THE NEBRASKA STATION[20]

Lot	Ration	No. in lot	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
			lbs.	*lbs.*	*lbs.*		*therms*	*lbs.*
I	Corn, alfalfa hay	14	56	92	3.8	1:5.9	23.6	0.37
II	Corn, oats, alfalfa hay....	14	57	89	3.9	1:5.6	22.9	0.33
III	Corn, bran, alfalfa hay....	14	56	90	4.0	1:5.4	22.5	0.35
IV	Corn, alfalfa hay	12	62	93	3.6	1:6.0	23.0	0.32
V	Corn, oats, alfalfa hay....	12	60	94	3.7	1:5.5	22.0	0.35
VI	Corn, bran, alfalfa hay....	12	62	96	3.7	1:5.4	21.1	0.35

The lots in this second experiment all made better gains than those of the high-protein lots of the preceding experiment. Whether this increase was due to the additional amount of protein fed, cannot be determined, since there was also a considerable increase in the amount of energy consumed.

Buffum and Griffith,[21] at the Colorado Station, fed 13 lots of Mexican range lambs. Four lots were fed from March 5 to May 28, 84 days; five lots, from March 5 to June 6, 93 days; and four lots, from January 23 to May 2, 99 days. The feeds were not analyzed. In recalculating the data of this experiment, the coefficients of digestibility of the protein of alfalfa and native hay were taken from the results of digestion trials at the Colorado Station;* the coefficient of beet pulp, from Farmers' Bulletin 346 of the U. S. Department of Agriculture, and the coefficient of speltz from Bulletin 114 of the South Dakota station. A summary of the data is given in Table 24.

In this experiment, Lots X, XI, XII, and XIII, on the lower protein plane, made the highest gains. The lower gains made by the other lots cannot be accounted for by any deficiency in the energy supply,

*Colo. Agr. Exp. Sta., Bul. 93 (1904).

TABLE 24.— EXPERIMENT BY BUFFUM AND GRIFFITH AT THE COLORADO STATION[21]

Lot	Ration	No. in lot	Initial weight	Final weight	Length of experiment	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
			lbs.	*lbs.*	*days*	*lbs.*	*therms*	*lbs.*
I	Wheat, barley, beet pulp, alfalfa hay....	5	57	72	84	3.7	16.4	0.19
II	Wheat, barley, beet pulp, alfalfa hay....	5	58	77	84	4.4	21.6	0.23
III	Wheat, barley, sugar beets, alfalfa hay..	5	52	73	84	4.0	18.4	0.25
IV	Wheat, barley, sugar beets, alfalfa hay..	5	58	82	84	2.8	15.0	0.28
V	Corn, alfalfa hay	5	54	78	93	3.9	21.3	0.29
VI	Speltz, alfalfa hay	5	54	78	93	4.3	22.0	0.31
VII	Barley, alfalfa hay	5	57	77	93	4.2	20.9	0.26
VIII	Barley, wheat, alfalfa hay..	5	47	71	93	4.6	23.4	0.29
IX	Speltz, wheat, alfalfa hay..	5	57	75	93	4.0	20.4	0.20
X	Oats, barley, wheat, alfalfa hay	4	75	104	99	3.5	18.7	0.36
XI	Oats, barley, wheat, alfalfa hay.....	4	85	108	99	2.9	16.2	0.32
XII	Corn, alfalfa hay	4	84	115	99	3.2	18.7	0.39
XIII	Corn, alfalfa hay	4	84	112	99	2.8	17.5	0.36

as the latter appears to have been sufficient for all except Lots I and IV. These results indicate that the source of the protein or the energy, or both, has considerable influence upon the gains.

Carlyle and Morton,[22] also at the Colorado Station, fed 5 lots of grade Shropshire lambs; the first two lots, consisting of 125 lambs each, from December 1 to January 12, 42 days, and the last three lots, consisting of 200 lambs each, from November 23 to February 29, 98 days. The feeds were not analyzed. The value for the digestible protein in the alfalfa hay was taken from the same source as in the previous experiment.[a] A summary of the data is given in Table 25.

A comparison of Lots I and II reveals no apparent advantage in feeding an increased amount of protein by increasing the oil meal, as was done in the case of Lot I, especially when the much larger amount

[a] Colo. Agr. Exp. Sta., Bul. 93 (1904).

TABLE 25.— EXPERIMENT BY CARLYLE AND MORTON AT THE COLORADO STATION[22]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Corn, oil meal, alfalfa hay....	101	114	5.7	27.4	0.31
II	Corn, oil meal, alfalfa hay....	100	112	3.2	19.6	0.29
III	Corn, alfalfa hay.....	58	97	4.3	22.4	0.39
IV	Corn, alfalfa hay.....	61	96	3.9	21.2	0.35
V	Corn, alfalfa hay.....	59	93	4.6	23.7	0.34

of energy received by Lot I is taken into consideration. Neither does there appear to have been any advantage in increasing the amount of protein by increasing the alfalfa hay. (Note Lots III, IV, and V.)

Chilcott,[23] at the South Dakota Station, fed 2 lots of 12 grade Shropshire and Hampshire lambs each, from December 11 to March 26, a period of 105 days. The grain was analyzed but the hay was not. In recalculating the data of this experiment, the coefficients of digestibility of the protein in barley and speltz, and the digestible protein in brome hay as determined at that station[a] were used. The data are summarized in Table 26.

TABLE 26.— EXPERIMENT BY CHILCOTT AT THE SOUTH DAKOTA STATION[23]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Speltz, brome hay.....	84	109	2.0	18.2	0.24
II	Barley, brome hay.....	84	122	2.0	17.5	0.36

The protein appears to have been sufficient in Lot II to make good gains; yet an additional amount might have produced still better gains. The source of the protein seems to have influenced the increase to a considerable extent, barley giving better results than speltz.

Wilson and Skinner,[24] also at the South Dakota Station, fed 9 lots of 9 lambs each (grade Shropshire and Hampshire), from January 5 to April 24, 109 days. The speltz, the macaroni wheat, and the bread wheat were analyzed. The digestible protein in native hay and the coefficients of digestibility of the protein in macaroni wheat, speltz, and oats were taken from results obtained at that station. A summary of the data is given in Table 27.

[a] So. Dak. Agr. Exp. Sta., Bul. 114 (1909).

TABLE 27.— EXPERIMENT BY WILSON AND SKINNER AT THE SOUTH DAKOTA STATION[24]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Corn, prairie hay	81	120	1.5	20.0	0.35
II	Wheat, prairie hay	78	118	2.0	20.5	0.37
III	Macaroni wheat, prairie hay	81	119	1.8	19.6	0.35
IV	Speltz, prairie hay	79	118	2.2	22.9	0.35
V	Speltz, prairie hay	81	115	2.1	22.1	0.31
VI	Corn, bran, prairie hay	81	121	2.0	19.4	0.37
VII	Macaroni wheat, bran, prairie hay	81	118	2.3	20.0	0.34
VIII	Macaroni wheat, bran, prairie hay	82	116	2.1	18.6	0.31
IX	Speltz, bran, prairie hay	82	119	2.6	21.3	0.34

Good gains were made on these rations, which contained a relatively small amount of protein but a large amount of energy. The gains seemed to depend, not upon the amount either of protein or of energy fed but possibly upon the source of the nutrients. It is to be noted that these gains were made on rations containing only one-half to two-thirds the quantity of protein required by Kellner's standard for lambs of this weight.

Wilson,[25] in another experiment at the South Dakota Station, fed 2 lots of 10 grade lambs each, from January 24 to March 25, a period of 60 days. The feeds were not analyzed. In calculating the digestible protein, the composition and coefficients of digestibility of the crude protein in alfalfa and native hay were taken from the results of digestion trials at that station.[a] A summary of the data is given in Table 28.

TABLE 28.— EXPERIMENT BY WILSON AT THE SOUTH DAKOTA STATION[25]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Corn, oats, oil meal, alfalfa hay	88	119	3.9	19.0	0.51
II	Corn, oats, oil meal, prairie hay	87	111	2.0	17.9	0.38

Altho the high-protein lot made the highest gain, the low-protein lot also made a very good gain, especially when the somewhat smaller amount of energy consumed by the low-protein lot is taken into consideration. The short duration of the experiment possibly detracts from its value when compared with other experiments of longer duration.

[a] So. Dak. Agr. Exp. Sta., Bul. 114 (1909).

McDonald and Malone,[26] at the Oklahoma Station, fed 4 lots of 10 lambs each, from October 1 to February 18, a period of 140 days. None of the feeds was analyzed. A summary of the data is given in Table 29.

TABLE 29.— EXPERIMENT BY MCDONALD AND MALONE AT THE OKLAHOMA STATION[26]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Corn meal, alfalfa hay.....	77	128	2.5	19.2	0.36
II	Corn meal, cowpea hay.....	73	125	2.3	20.6	0.37
III	Corn meal, cottonseed meal, corn stover, alfalfa hay.....	77	125	3.1	18.5	0.34
IV	Corn meal, cottonseed meal, prairie hay	78	117	2.8	18.2	0.28

The gains made by Lots III and IV were not so large as those made by Lots I and II, altho Lots III and IV received more protein and less energy than Lots I and II. The gains seemed to depend more upon the energy in the ration than upon the protein. The results indicate that the lower amounts of protein were sufficient for lambs of this weight.

Richards and Kleinheinz,[27] at the Wisconsin Station, fed 2 lots of 10 ewe lambs each, for a period of 84 days beginning January 20. The feeds were analyzed and the digestible nutrients calculated. A summary of the data is given in Table 30.

TABLE 30.— EXPERIMENT BY RICHARDS AND KLEINHEINZ AT THE WISCONSIN STATION[27]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*		*therms*	*lbs.*
I	Corn, soy beans, clover hay, June grass hay, corn stover	103	119	2.7	1:4.9	12.7	0.20
II	Corn, oats, clover hay, June grass hay, corn stover	102	116	1.5	1:9.0	12.6	0.16

The very poor gains made by both lots were probably due to the fact that the rations contained too small an amount of energy, especially since Lot I, which received a considerably larger amount of protein than Lot II, did not make a corresponding gain.

Humphrey and Kleinheinz,[28] also at the Wisconsin Station, fed 2 lots of 9 lambs each, for a period of 84 days beginning January 23. The feeds were analyzed. A summary of the data is given in Table 31.

TABLE 31.— EXPERIMENT BY HUMPHREY AND KLEINHEINZ AT THE WISCONSIN STATION[28]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Shelled corn, soy beans, mixed hay, corn stover.....	113	126	2.0	11.0	0.16
II	Shelled corn, oats, mixed hay, corn stover	113	120	1.1	10.8	0.09

In this experiment, too, the gains were very poor, but this is not strange, as the amount of energy consumed in each instance was about the same as Armsby's standard for maintenance[a]. Lot I, consuming the more protein, made the better gain.

In the following year, Humphrey and Kleinheinz,[29] fed 2 lots of 10 lambs each for a period of 91 days beginning January 13. The feeds were analyzed and the digestible nutrients calculated. A summary of the data is given in Table 32.

TABLE 32.— EXPERIMENT BY HUMPHREY AND KLEINHEINZ AT THE WISCONSIN STATION[29]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Oats, dried beet pulp, clover hay	93	115	2.1	12.6	0.24
II	Oats, corn, clover hay.....	93	115	2.1	14.0	0.24

The gains were probably lessened by the fact that the energy was insufficient and the protein somewhat low.

Arkell,[30] at the New Hampshire Station, fed 4 lots of 5 lambs each, from December 6 to March 14, a period of 90 days. The feeds were analyzed and the digestible nutrients calculated. A summary of Arkell's data is shown in Table 33.

The gains produced are certainly surprising when one considers the amounts of protein and energy consumed. The digestible protein down to 0.9 pound was ample for fair gains, but the energy seems to have been very low.

[a] U. S. Dept. Agr., Farmers' Bul. 346, p. 17.

TABLE 33.— EXPERIMENT BY ARKELL AT THE NEW HAMPSHIRE STATION[30]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*		*therms*	*lbs.*
I	Corn, bran, oats, turnips, clover hay....	102	137	1.4	1: 6.2	8.1	0.35
II	Corn, bran, oats, turnips, timothy hay..	100	123	0.9	1:10.5	8.6	0.23
III	Corn, bran, oats, clover hay	105	134	1.9	1: 5.9	11.4	0.29
IV	Corn, bran, oats, turnips, clover hay.	106	143	1.7	1: 6.6	9.9	0.38

Carmichael,[31] at the Ohio Station, fed 4 lots of 40 range lambs each, from November 30 to March 12, 102 days. None of the feeds was analyzed, and the total amount of hay fed was estimated from the quantities determined at different times during the experiment. The data are summarized in Table 34.

TABLE 34.— EXPERIMENT BY CARMICHAEL AT THE OHIO STATION[31]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Corn, alfalfa hay.....	67	98	2.5	19.3	0.30
II	Corn, cottonseed meal, alfalfa hay	67	98	3.2	19.3	0.31
III	Corn, oil meal, alfalfa hay....	65	98	3.1	19.4	0.30
IV	Corn, alfalfa hay.....	67	97	2.5	19.5	0.31

The energy was about the same for all lots, but the protein varied considerably. It is of interest to note, however, that the increase in protein, as provided by the cottonseed meal and oil meal in Lots II and III respectively, did not increase the gains.

Carmichael and Hammond,[32] at the Ohio Station, conducted feeding experiments extending over three years. In each experiment the feeds were weighed carefully and analyzed. A summary of the data obtained is given in Table 35.

In the experiment of the first year, 4 lots of 25 choice western lambs each, were fed from December 22 to March 1, a period of 70 days. A comparison of Lots I and II with Lot III indicates again that the source of the nutrients had considerable influence upon the gains. It is of interest to note that Lot IV, receiving considerably more protein than Lot III and the same amount of energy, did not make as good an average gain. The investigators state that the clover hay was of excellent quality while the alfalfa hay was not so good.

TABLE 35.— EXPERIMENTS BY CARMICHAEL AND HAMMOND AT THE OHIO STATION[32]

Lot	Ration	No. in lot	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
	First year: 70 days						
			lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Corn, oil meal, corn stover	25	73	91	2.1	18.6	0.26
II	Corn, oil meal, soy bean straw	25	73	93	2.3	19.9	0.28
III	Corn, clover hay	25	73	98	1.9	19.5	0.36
IV	Corn, alfalfa hay	25	73	97	2.5	19.4	0.33
	Second year: 93 days						
I	Corn, clover hay	14	64	94	1.8	19.9	0.32
II	Corn, alfalfa hay	14	63	95	2.6	20.2	0.34
III	Corn, oat straw	13	63	80	1.3	19.2	0.18
IV	Corn, corn stover	13	65	79	1.5	20.5	0.23
V	Corn, oil meal, clover hay	14	64	91	2.6	20.0	0.29
VI	Corn, oil meal, alfalfa hay	14	64	95	3.3	19.8	0.34
VII	Corn, oil meal, oat straw	14	63	85	2.1	18.5	0.24
VIII	Corn, oil meal, corn stover	14	62	86	2.3	20.1	0.26
	Third year: 83 days						
I	Corn, clover hay	15	61	89	2.0	20.5	0.33
II	Corn, alfalfa hay	15	62	92	2.6	20.1	0.37
III	Corn, oat straw	15	59	77	1.4	17.9	0.22
IV	Corn, corn stover	15	58	79	1.5	19.8	0.26
V	Corn, oil meal, clover hay	15	63	91	2.8	20.4	0.34
VI	Corn, oil meal, alfalfa hay	15	61	94	3.5	20.3	0.39
VII	Corn, oil meal, oat straw	15	62	82	2.2	18.1	0.25
VIII	Corn, oil meal, corn stover	15	60	86	2.3	19.8	0.31

In the experiment of the second year, 8 lots of range lambs were fed from January 3 to April 5, a period of 93 days. Again the data show that the source of the nutrients had considerable influence upon the gains. If Lot I is compared with Lot V, it is found that there was no advantage in increasing the protein of the ration from 1.8 to 2.6 pounds per day by adding oil meal, the energy remaining the same. Likewise, it is seen that there was no additional gain obtained by increasing the protein from 2.6 pounds in Lot II to 3.3 pounds in Lot VI. In the cases of lots receiving the non-nitrogenous roughages, however, an increase in protein by the use of oil meal caused additional gains.

The experiment was repeated in practically the same manner the following year. Eight lots of 15 lambs each were fed from November 18 to February 8, a period of 83 days. All gains were slightly better

than those of the previous year. The source of the nutrients apparently had some influence upon the gains, the use of oil meal resulting in all cases in slightly better gains.

The results of all four Ohio experiments indicate that for lambs of these weights, 19 or 20 therms of energy are sufficient for good gains, provided the source and the amount of the protein of the ration are favorable. They indicate also that there is no marked advantage in feeding over 2.5 pounds of protein to lambs of these weights.

Lyman and Phelps,[33] at the Connecticut (Storrs) Station, fed 2 lots of 10 grade Shropshire lambs each, for a period of 62 days. A third lot of 200 range lambs was fed for 48 days. The feeds were not analyzed but the digestible nutrients were calculated. The data are summarized in Table 36.

TABLE 36.— EXPERIMENT BY LYMAN AND PHELPS AT THE CONNECTICUT (STORRS) STATION[33]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*		*therms*	*lbs.*
I	Corn, bran, pea meal, silage, clover rowen	87	111	3.3	1:4.8	18.6	0.39
II	Corn, pea meal, silage, clover rowen	87	115	2.7	1:7.0	22.7	0.45
III	Corn, pea meal, bran, silage, clover rowen	73	88	3.3	1:5.8	22.3	0.32

From a comparison of Lots I and II, made up of the same kind of lambs, it is seen that the gains may have depended upon the amount of energy consumed rather than upon the amount of protein. In Lot III, also, it is evident that there was no advantage in increasing the protein. The use of bran seems to have been detrimental.

Shaw,[34] at the Minnesota Station, fed 10 grade Dorset lambs for 112 days, beginning November 23. The feeds were not analyzed. From a summary of the data given in Table 37, it is apparent that the protein and the energy were both sufficient; but too much importance should not be attached to an experiment where a check is not run.

TABLE 37.— EXPERIMENT BY SHAW AT THE MINNESOTA STATION[34]

Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
	lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
Oats, bran, barley, oil cake, roots, native hay.....	93	134	2.7	17.1	0.37

Linfield,[35] at the Montana Station, fed 5 lots of 22 grade Down lambs each, for a period of 95 days beginning November 22 and ending February 25. None of the feeds was analyzed. The data are summarized in Table 38.

TABLE 38.— EXPERIMENT BY LINFIELD AT THE MONTANA STATION[35]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Wheat screenings, clover hay..	67	94	2.8	17.6	0.29
II	Wheat, clover hay.....	71	96	2.6	16.6	0.27
III	Oats, clover hay.....	71	92	2.8	15.8	0.22
IV	Barley, clover hay.....	73	97	2.6	16.3	0.26
V	Wheat, oats, barley, clover hay	54	76	2.6	15.9	0.29

Probably better gains would have resulted if the energy had been increased somewhat, as it appears to have been below the standard even for growing lambs.

In a continuation of the foregoing experiment, Linfield[36] fed 5 lots of 24 range lambs each, for a period of 97 days beginning November 20 and ending February 26. The feeds were not analyzed. The data are summarized in Table 39.

TABLE 39.— EXPERIMENT BY LINFIELD AT THE MONTANA STATION[36]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Wheat screenings, clover hay..	57	82	2.7	16.3	0.26
II	Wheat, clover hay.....	57	79	2.7	16.7	0.22
III	Oats, clover hay.....	58	81	2.7	15.1	0.25
IV	Barley, clover hay.....	57	80	2.7	16.9	0.23
V	Barley, oats, wheat, clover hay.	58	80	2.6	16.0	0.23

The protein and the energy consumed were about the same as in the previous experiment. While the lambs of this experiment were considerably smaller than those of the former experiment, nevertheless the gains were almost as large. The energy was probably insufficient for the best gains.

Linfield,[37] at the Utah Station, carried on feeding experiments extending over three years. The feeds were analyzed and the rations carefully weighed. The data are summarized in Table 40.

TABLE 40.— EXPERIMENT BY LINFIELD AT THE UTAH STATION[37]

Lot	Ration	No. in lot	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
	First year: 90 days						
			lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Wheat, alfalfa hay.....	24	47	64	3.6	20.6	0.19
II	Frosted wheat, alfalfa hay.....	24	47	66	3.4	21.3	0.21
III	Wheat screenings, alfalfa hay	24	47	66	4.0	23.6	0.20
IV	Wheat screenings, alfalfa hay	23	47	68	3.8	22.3	0.24
	Second year: 84 days						
I	Wheat screenings, alfalfa hay	25	38	47	4.0	19.8	0.12
II	Wheat, alfalfa hay.....	25	37	45	3.6	19.3	0.11
III	Screenings, bran, alfalfa hay	25	39	49	3.5	18.7	0.12
IV	Screenings, bran, straw, alfalfa hay.....	24	38	47	3.8	16.8	0.10
	Third year: 78 days						
I	Screenings, alfalfa hay.	16	55	72	3.2	15.0	0.22
II	Beet pulp, alfalfa hay..	17	61	77	2.3	12.4	0.21
III	Beet pulp, alfalfa hay..	17	57	68	2.6	11.8	0.13
IV	Bran, screenings, beet pulp, alfalfa hay.....	17	54	80	2.8	15.9	0.33
V	Bran, screenings, beet pulp, alfalfa hay.....	17	54	71	3.1	15.5	0.21

Very poor gains were made in the experiment of the first year, altho the protein and energy appear sufficient. The same is true of the second year but to a more marked extent. The somewhat better gains made in the experiment of the third year seem to have been due more to the source of the protein and energy than to the quantity.

Clark,[38] also at the Utah Station, fed 2 lots of 11 lambs each, for a period of 85 days. The feeds were not analyzed. A summary of the data is given in Table 41.

TABLE 41.— EXPERIMENT BY CLARK AT THE UTAH STATION[38]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	Bran, middlings, sugar beets, alfalfa hay	86	116	3.2	14.8	0.35
II	Bran, middlings, alfalfa hay..	83	101	4.3	15.0	0.22

The energy supply for these lambs was quite low. Altho Lot I received considerably less protein than Lot II and the same amount of energy, it made much the higher gain. This doubtless was due to the addition of sugar beets to the ration of Lot I.

Coffey,[39] at the Illinois Station, fed 3 lots of 10 Shropshire lambs each, for 98 days, beginning November 26, on a ration of corn, oats, bran, oil meal, and clover hay. The feeds were not analyzed. From a summary of the data given in Table 42 it is evident that the amounts of protein and energy consumed were sufficient for fair fattening gains for lambs of these ages.

TABLE 42.— EXPERIMENT BY COFFEY AT THE ILLINOIS STATION[39]

Lot	Initial age	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
	mos.	*lbs.*	*lbs.*	*lbs.*		*therms*	*lbs.*
I	9	95	123	2.8	1:6.7	20.1	0.28
II	7	78	106	3.1	1:6.8	21.9	0.28
III	6	63	92	3.1	1:6.8	22.2	0.30

Craig and Melvin,[40] under the direction of Coffey, fed 6 lots of 10 Cotswold-Merino lambs each, from February 3 to May 5, a period of 92 days. All lots were fed a ration of corn, oats, oil meal, and clover hay. The feeds were not analyzed. The data are summarized in Table 43.

TABLE 43.— EXPERIMENT BY CRAIG AND MELVIN AT THE ILLINOIS STATION[40]

Lot	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
	lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	64	97	3.2	23.7	0.36
II	65	104	3.3	24.9	0.42
III	63	107	3.4	25.4	0.47
IV	64	101	3.3	24.9	0.40
V	63	99	3.2	22.8	0.39
VI	63	98	3.2	22.5	0.37

Both the protein and the energy were sufficient for very good gains, but the experiment does not show whether or not less protein in the ration would have decreased the gains.

Hammond,[41] under the direction of Coffey, fed corn, prepared in various ways, and clover hay to 6 lots of 16 lambs each, for 98 days, beginning November 18. Another lot received oil meal in addition

to shelled corn and clover hay. The lambs were about 5½ months old at the beginning of the experiment. The silage and corn stover were analyzed; the analyses of the other feeds were taken from Bulletin 71 of the Pennsylvania Agricultural Experiment Station. The digestible nutrients were calculated by the experimenter, the coefficients of digestibility of all the feeds, with the exception of the corn stover and the shock corn, being taken from Henry's "Feeds and Feeding." The coefficient of digestibility of corn stover was taken from Bulletin 58 of the Illinois Agricultural Experiment Station, and that of shock corn from the above-mentioned bulletin of the Pennsylvania Station. The data are summarized in Table 44.

TABLE 44.— EXPERIMENT BY HAMMOND AT THE ILLINOIS STATION[41]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*		*therms*	*lbs.*
I	Shelled corn, clover hay	65	94	1.9	1:10.0	19.8	0.30
II	Corn meal, clover hay	65	91	2.0	1:10.0	20.4	0.26
III	Corn and cob meal, clover hay	66	92	1.7	1:11.2	19.5	0.27
IV	Ear corn, clover hay	66	94	1.9	1:10.1	22.7	0.29
V	Shelled corn, silage, clover hay	66	94	1.9	1:10.4	19.7	0.29
VI	Shelled corn, oil meal, clover hay	66	93	2.3	1: 8.4	20.2	0.28
VII	Shock corn, clover hay	65	90	1.8	1:10.5	15.9	0.25

Here again the amount of protein seems to have been sufficient to produce good fattening gains. The gains made by Lots II and III were not so high as would be expected, due possibly to the fact that the corn was ground. The energy of the shock-corn and clover-hay ration of Lot VII was insufficient for maximum gains. It is noticeable also that the increased amount of protein received by Lot VI produced no increase in gain.

In another experiment, Coffey[42] fed 6 lots of 16 range lambs each, from January 12 to April 26, 105 days. The feeds were not analyzed but the digestible nutrients were calculated from the values given in Bulletin 84 of the Pennsylvania Agricultural Experiment Station. The data are summarized in Table 45.

The gains seem to indicate that the protein and energy were sufficient for good results.

TABLE 45.— EXPERIMENT BY COFFEY AT THE ILLINOIS STATION[42]

Lot	Ration	Initial weight	Final weight	Digestible protein per 1000 pounds	Nutritive ratio	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*		*therms*	*lbs.*
I	Corn, clover hay.....	68	101	1.9	1:10.0	19.6	0.31
II	Corn, silage (small amount), clover hay	68	104	1.8	1:10.3	19.2	0.35
III	Corn, silage (medium amount), clover hay	67	102	1.8	1:10.3	19.7	0.33
IV	Corn, silage (medium amount), clover hay	68	105	1.8	1:10.5	19.4	0.36
V	Corn, silage (large amount), clover hay	68	106	1.8	1:10.4	19.3	0.36
VI	Corn, silage (large amount), clover hay	68	106	1.7	1:10.8	19.1	0.37

Coffey,[43] also fed 6 lots of 20 range lambs each on a ration of shelled corn and alfalfa hay in varying proportions. The feeding periods lasted from October 23 to January 20, 91 days. Toward the end of the experiment, soy beans were also fed. None of the feeds was analyzed. In Table 46 is given a summary of the data.

TABLE 46.— EXPERIMENT BY COFFEY AT THE ILLINOIS STATION[43]

Lot	Proportion of grain to hay	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	1:0.99	69	96	2.8	18.2	0.30
II	1:1.01	68	95	2.8	18.4	0.30
III	1:1.36	69	90	3.0	17.8	0.27
IV	1:1.36	68	90	2.8	17.6	0.24
V	1:2.43	69	88	3.0	15.4	0.21
VI	1:3.48	69	87	3.0	14.3	0.20

In this experiment the protein was probably sufficient for all the lots. The same cannot be said of the energy, which appears to have been somewhat deficient in all but Lots I and II.

Immediately following the foregoing experiment, Coffey[44] again fed 6 lots of 20 lambs each on a ration of corn and alfalfa hay in varying proportions. The feeding period lasted from February 19 to May 27, 98 days. The feeds were not analyzed. The data are summarized in Table 47.

Again it seems that the protein was probably sufficient for all lots, but the energy appears to have been somewhat deficient for Lots V and VI.

TABLE 47.— EXPERIMENT BY COFFEY AT THE ILLINOIS STATION[44]

Lot	Proportion of grain to hay	Initial weight	Final weight	Digestible protein per 1000 pounds	Net energy per 1000 pounds	Average daily gain
		lbs.	*lbs.*	*lbs.*	*therms*	*lbs.*
I	1:0.86	65	97	2.8	19.8	0.33
II	1:0.85	65	97	2.9	20.3	0.33
III	1:1.31	65	96	3.1	18.9	0.32
IV	1:1.31	65	96	3.1	19.2	0.31
V	1:2.03	64	93	3.2	17.7	0.29
VI	1:2.03	65	89	3.2	17.7	0.25

DISCUSSION OF RESULTS

In an effort to ascertain the minimum amounts of protein and energy conducive to good fattening gains (0.3 pound or more per day), the data given in the preceding pages have been tabulated and divided into four classes according to the average live weights of the lambs during the experiments. Class I includes those lambs that weighed 50 to 70 pounds; Class II, those that weighed 70 to 80 pounds; Class III, those that weighed 90 to 110 pounds; and Class IV, those that weighed 110 to 150 pounds[a]. (See Tables 48 to 51, pages 36 to 43). In this compilation no effort has been made to distinguish between the breeds of the lambs, the systems of feeding, the climatic conditions, etc.

The results have been further subdivided into groups according to the amount of digestible protein consumed per 1000 pounds live weight. The number of animals in each lot, the average live weight of the lot during the experiment, the net energy of the ration expressed in therms per 1000 pounds live weight, and the average daily gain are given for each lot. In each case the average live weight was obtained by taking the mean of the average initial weight and the average final weight. This average has been used in calculating the protein and the energy consumption per 1000 pounds live weight.

Further, where there were two or more experiments within a group the results have been arranged according to relative energy consumption, the group that shows the highest consumption being placed first. With this arrangement it is comparatively easy to ascertain for any group what influence, if any, the change in energy had upon the gain in live weight. The average daily energy consumption and the average daily gain of each group are also given. These averages are arithmetic means. It was found that "weighting" the results did not materially affect the averages.

[a]In live-stock markets animals of this weight, Class IV, would be called sheep, but here most of the animals referred to were probably of lamb age, i. e., under twelve months.

These tabulated results[a] have been plotted with respect to the protein consumed and the average daily gains in weight, and also in a sense with respect to the energy consumed. See Figs. 1 to 4 (pages 44, 45, 46, and 47). In each figure the abscissæ represent the average daily consumption of digestible protein per 1000 pounds live weight; the ordinates, the average daily gain; and each dot, the protein consumption and the average daily gain of a lot. The number at the side of each dot represents the energy consumption of the lot expressed in therms. In case two lots coincide in protein consumption and in gain, the energy consumption of each lot is given. Each point on the curve represents the average daily gain of all the lots on the same protein plane, and the number at each point, the average daily energy consumption. The heavy horizontal line represents the average daily gain of all the lambs of the class.

The Lambs of Class I.—It appears from Table 48 and Fig. 1 that the lambs in Class I made in most cases only fair gains until the protein consumption reached 3.1 pounds. This seems to have been true even tho the energy consumption reached as high as 22.0 therms. When fed more than 3.3 pounds of digestible protein, the lambs did not seem to make correspondingly better gains even when the energy was increased considerably. With 3.8 to 4.3 pounds of protein, they made just as good gains as when they consumed from 3.1 to 3.3 pounds, but no better. However, on these higher protein planes they consumed somewhat more energy. There seems to have been no definite relation between the energy consumption and the gain in weight on any particular protein plane. In some cases a high gain was associated with a high energy value, and in others with a low energy value, and *vice versa.*

In general, the results indicate that 3.1 to 3.3 pounds of protein and 17 to 19 therms of energy are sufficient for lambs of this weight.

The Lambs of Class II.—The lambs of Class II (Table 49, Fig. 2) made an average daily gain of 0.31 pound on as little as 1.8 to 2.0 pounds of digestible protein, with not less than 18 to 20 therms of energy. Additional amounts of protein up to 2.5 pounds produced no better gains even when accompanied by amounts of energy as high as were fed the lambs on the lower protein plane. In fact, most of the gains were lower. With the consumption of 2.5 to 2.8 pounds of digestible protein and 18 to 20 therms, or more, of energy, there was a considerable increase in the gains. Beyond 3.1 pounds of protein, there was a noticeable increase. This, however, was associated with an increase in energy. Nearly all cases of poor gains by individual lots were associated with a low energy consumption.

[a]The data for the second year of Linfield's experiment, page 28, have been omitted, as the initial weight was only 38 pounds. Also, Lots IX and X of Mumford's experiment, page 9, have been omitted because of lack of data with respect to the protein and energy.

In general the results seem to indicate that 2.5 to 2.8 pounds of digestible protein and 18 to 20 therms of energy are sufficient for fattening lambs of this weight. It should be noted, however, that under proper conditions 1.8 to 2.0 pounds of protein and 18 to 20 therms of energy may be sufficient to produce good gains.

In connection with these data, it is of interest to note that usually the higher energy values on any one protein plane were associated with gains that were above the average.

The Lambs of Class III.—According to Table 50 and Fig. 3, the lots of Class III that received rations containing from 2.2 to 2.4 pounds, or more, of digestible protein, and from 17 to 23 therms, or more, of energy made, as a rule, satisfactory gains. Those receiving between 2.4 and 3.6 pounds of protein generally made no greater gains than were made on the lower protein plane even when the energy ran as high as 22 therms. When the lambs consumed from 3.8 to 4.0 pounds of protein and from 19 to 25 therms of energy, they made distinct additional gains. It should be noted, however, that only three lots received this amount of protein, and two of these three lots were made up of carefully selected pure-bred lambs.

The results seem to indicate that from 2.2 to 2.4 pounds of digestible protein, and from 17 to 20 therms of energy are sufficient for fattening lambs of this weight. In this class the tendency of the low energy values to be associated with the low gains (Fig. 3) was more decided than that shown by any of the other classes. The high energy values also tend more decidedly to follow the higher gains, altho, as in the other two classes, the majority of the highest gains are not associated with the largest number of therms.

The Lambs of Class IV.—Altho the data for Class IV are quite few, yet it is of interest to note (Table 51, Fig. 4) that when the digestible protein consumption ranged from 2.6 to 3.0 pounds, and the energy consumption from 16 to 19 therms, the lambs made exceptionally good gains. Also beyond 3.0 pounds of protein, they made good gains, but here the energy consumption was considerably higher, averaging 24 therms.

There are three lots which made good gains on 1.4 to 1.9 pounds of protein and 8 to 11 therms of energy. While these results are too few from which to draw a definite conclusion, yet they are quite suggestive in view of the fact that the Armsby standard[a] for growing lambs calls for practically the same amount of digestible protein. The Kellner standard[b] for fattening lambs calls for practically the same amount of digestible protein and 11 to 12 therms of energy. Under ordinary conditions probably 16 to 19 therms of energy would be better.

[a]This bulletin, page 3.
[b]This bulletin, page 4.

CONCLUSIONS

From the results obtained in reviewing these American experiments, which embrace 265 lots of lambs, aggregating 5127 animals, the following values are suggested as the minimum protein and energy requirements per 1000 pounds live weight per day for fattening lambs.

1. Lambs weighing 50 to 70 pounds (Class I) require from 3.1 to 3.3 pounds of digestible protein and from 17 to 19 therms of net energy to make satisfactory daily gains.

2. Lambs weighing 70 to 90 pounds (Class II) require from 2.5 to 2.8 pounds of digestible protein, and from 18 to 20 therms of net energy. Under proper conditions, 1.8 to 2.0 pounds of protein and 18 to 20 therms of energy are sufficient for good gains.

3. Lambs weighing 90 to 110 pounds (Class III) require 2.2 to 2.4 pounds of digestible protein and 17 to 20 therms of net energy to make good daily gains.

4. In the case of lambs weighing 110 to 150 pounds (Class IV), no definite conclusion can be drawn from the limited data here reported. Lambs of this class made exceptional gains when the digestible protein ranged from 2.6 to 3.0 pounds, and the net energy from 16 to 19 therms. Taking into consideration the results obtained with 1.4 to 1.9 pounds of protein, however, and the results reported by Kellner and Armsby, it seems reasonable to state that probably from 1.4 to 1.9 pounds of digestible protein with from 16 to 19 therms of net energy would be sufficient for animals of this weight.

The authors wish to acknowledge their indebtedness to Dr. H. S. Grindley, Chief in Animal Nutrition, for the generous and helpful suggestions given in connection with this study, and to W. C. Coffey, Chief in Sheep Husbandry, for the use of unpublished data.

TABLE 48.— PROTEIN AND ENERGY CONSUMED AND GAINS IN WEIGHT PER DAY LAMBS OF CLASS I, WEIGHING 50 TO 70 POUNDS

Group	Reference No.[a]	No. of animals in lot	Average weight of lambs	Digestible protein consumed per 1000 pounds	Net energy consumed per 1000 pounds	Average daily gain
			lbs.	*lbs.*	*therms*	*lbs.*
1	1	3	61	4.9	18.1	0.18
2	21	5	59	4.6	23.4	0.29
	11	10	61	4.6	17.5	0.17
Average of Group 2.....				4.6	20.4	0.23
3	21	5	67	4.4	21.6	0.23
4	21	5	66	4.3	22.0	0.31
5	21	5	67	4.2	20.9	0.26
6	3	86	65	4.1	19.9	0.17
7	37	24	56	4.0	23.6	0.20
	21	5	66	4.0	20.4	0.20
	21	5	62	4.0	18.4	0.25
Average of Group 7.....				4.0	20.8	0.22
8	21	5	66	3.9	21.3	0.29
	3	50	62	3.9	18.9	0.32
Average of Group 8.....				3.9	20.1	0.30
9	37	23	57	3.8	22.3	0.24
	3	87	69	3.8	19.1	0.23
	2	2	67	3.8	15.9	0.26
Average of Group 9.....				3.8	19.1	0.24
10	21	5	64	3.7	16.4	0.19
11	37	24	55	3.6	20.6	0.19
12	37	24	56	3.4	21.3	0.21
13	19	16	67	3.3	18.1	0.30
	19	20	68	3.3	17.5	0.34
Average of Group 13.....				3.3	17.8	0.32
14	19	16	69	3.2	18.5	0.32
	37	16	63	3.2	15.0	0.22
Average of Group 14.....				3.2	16.7	0.27
15	19	16	69	3.1	19.4	0.33
	37	17	62	3.1	15.5	0.21
Average of Group 15.....				3.1	17.4	0.27
16	3	58	63	2.8	22.0	0.14
	37	17	67	2.8	15.9	0.33
	11	40	61	2.8	10.8	0.06
Average of Group 16.....				2.8	16.2	0.18
17	36	24	68	2.7	16.9	0.23
	36	24	69	2.7	16.7	0.22
	36	24	69	2.7	16.3	0.26
Average of Group 17.....				2.7	16.6	0.24
18	3	58	67	2.6	21.0	0.21
	36	24	69	2.6	16.0	0.23
	35	22	65	2.6	15.9	0.29
	37	17	62	2.6	11.8	0.13
Average of Group 18.....				2.6	16.2	0.21

[a] See bibliography on page 48.

TABLE 48.— *Concluded*

Group	Reference No.[a]	No. of animals in lot	Average weight of lambs	Digestible protein consumed per 1000 pounds	Net energy consumed per 1000 pounds	Average daily gain
			lbs.	*lbs.*	*therms*	*lbs.*
19	2	2	69	2.5	16.7	0.19
20	19	8	64	2.3	17.8	0.24
	37	17	69	2.3	12.4	0.21
Average of Group 20.....				2.3	15.1	0.22
21	1	3	54	2.2	17.8	0.10
22	11	10	61	2.0	19.0	0.14
	11	40	63	2.0	17.2	0.21
Average of Group 22.....				2.0	18.1	0.17
23	8	50	60	1.9	17.2	0.25
	19	8	60	1.9	16.3	0.19
Average of Group 23.....				1.9	16.7	0.22
24	11	10	65	1.8	18.8	0.23
	11	10	65	1.8	18.4	0.23
	19	8	61	1.8	16.7	0.19
Average of Group 24.....				1.8	18.0	0.22
25	19	8	62	1.7	17.0	0.20
26	2	2	59	1.6	16.7	0.16
27	32	15	68	1.5	19.8	0.26
28	32	15	68	1.4	17.9	0.22
Average of All (49) Lots.....				**3.0**	**18.1**	0.23

[a]See bibliography on page 48.

TABLE 49.— PROTEIN AND ENERGY CONSUMED AND GAINS IN WEIGHT PER DAY LAMBS OF CLASS II, WEIGHING 70 TO 90 POUNDS

Group	Reference No.[a]	No. of animals in lot	Average weight of lambs	Digestible protein consumed per 1000 pounds	Net energy consumed per 1000 pounds	Average daily gain
			lbs.	*lbs.*	*therms*	*lbs.*
1	22	200	76	4.6	23.7	0.34
2	11	10	70	4.5	22.0	0.31
	10	100	74	4.5	21.1	0.31
	Average of Group 2.....			4.5	21.5	0.31
3	22	200	77	4.3	22.4	0.39
	11	40	71	4.3	21.9	0.35
	11	40	70	4.3	21.2	0.35
	Average of Group 3.....			4.3	21.8	0.36
4	16	10	83	4.2	26.0	0.35
5	12	35	71	4.1	21.8	0.23
	12	35	75	4.1	21.4	0.33
	Average of Group 5.....			4.1	21.6	0.28
6	20	14	73	4.0	22.5	0.35
	12	35	73	4.0	22.1	0.30
	Average of Group 6.....			4.0	22.3	0.32
7	20	14	73	3.9	22.9	0.33
	22	200	78	3.9	21.2	0.35
	Average of Group 7.....			3.9	22.0	0.34
8	20	14	74	3.8	23.6	0.37
	10	5	77	3.8	20.4	0.29
	Average of Group 8.....			3.8	22.0	0.33
9	20	12	77	3.7	22.0	0.35
	20	12	79	3.7	21.1	0.35
	13	41	76	3.7	20.7	0.29
	9	20	78	3.7	17.0	0.31
	9	3	78	3.7	12.6	0.26
	Average of Group 9.....			3.7	18.7	0.31
10	20	12	77	3.6	23.0	0.32
	9	20	78	3.6	16.9	0.33
	Average of Group 10.....			3.6	19.9	0.32
11	18	10	81	3.5	26.0	0.30
	32	15	78	3.5	20.3	0.39
	21	4	89	3.5	18.7	0.36
	9	3	79	3.5	17.0	0.32
	Average of Group 11.....			3.5	20.5	0.34
12	40	10	85	3.4	25.4	0.47
13	18	10	85	3.3	25.9	0.41
	40	10	84	3.3	24.9	0.42
	40	10	82	3.3	24.9	0.40
	18	10	80	3.3	24.7	0.30
	33	200	80	3.3	22.3	0.32
	32	14	80	3.3	19.8	0.34
	Average of Group 13.....			3.3	23.7	0.36

[a]See bibliography on page 48.

TABLE 49.— *Continued*

Group	Reference No.[a]	No. of animals in lot	Average weight of lambs	Digestible protein consumed per 1000 pounds	Net energy consumed per 1000 pounds	Average daily gain
			lbs.	*lbs.*	*therms*	*lbs.*
14	40	10	80	3.2	23.7	0.36
	40	10	81	3.2	22.8	0.39
	40	10	80	3.2	22.5	0.37
	31	40	82	3.2	19.3	0.31
	13	41	77	3.2	18.8	0.28
	44	20	79	3.2	17.7	0.29
	44	20	77	3.2	17.7	0.25
Average of Group 14.....				3.2	20.4	0.32
15	18	10	83	3.1	23.3	0.33
	39	10	77	3.1	22.2	0.30
	31	40	81	3.1	19.4	0.30
	44	20	80	3.1	19.2	0.31
	44	20	80	3.1	18.9	0.32
Average of Group 15.....				3.1	20.6	0.31
16	15	10	87	3.0	18.8	0.37
	43	20	79	3.0	17.8	0.27
	43	20	78	3.0	15.4	0.21
	43	20	78	3.0	14.3	0.20
Average of Group 16.....				3.0	16.6	0.26
17	44	20	81	2.9	20.3	0.33
	13	41	80	2.9	18.2	0.35
Average of Group 17.....				2.9	19.2	0.34
18	32	15	77	2.8	20.4	0.34
	44	20	81	2.8	19.8	0.33
	43	20	81	2.8	18.4	0.30
	43	20	82	2.8	18.2	0.30
	35	22	80	2.8	17.6	0.29
	43	20	79	2.8	17.6	0.24
	35	22	81	2.8	15.8	0.22
	21	5	70	2.8	15.0	0.28
Average of Group 18.....				2.8	17.8	0.29
19	36	24	70	2.7	15.1	0.25
20	32	14	79	2.6	20.2	0.34
	32	15	77	2.6	20.1	0.37
	32	14	78	2.6	20.0	0.29
	2	2	70	2.6	17.1	0.25
	35	22	83	2.6	16.6	0.27
	35	22	85	2.6	16.3	0.26
Average of Group 20.....				2.6	18.4	0.30
21	31	40	82	2.5	19.5	0.31
	32	25	85	2.5	19.4	0.33
	31	40	82	2.5	19.3	0.30
Average of Group 21.....				2.5	19.4	0.31
22	10	5	72	2.4	16.8	0.18
	10	5	72	2.4	16.1	0.18
	4	20	87	2.4	15.5	0.24
Average of Group 22.....				2.4	16.1	0.20
23	41	16	79	2.3	20.2	0.28
	32	14	74	2.3	20.1	0.26

[a] See bibliography on page 48.

TABLE 49.— *Concluded*

Group	Reference No.[a]	No. of animals in lot	Average weight of lambs	Digestible protein consumed per 1000 pounds	Net energy consumed per 1000 pounds	Average daily gain
			lbs.	*lbs.*	*therms*	*lbs.*
23	32	25	83	2.3	19.9	0.28
cont'd	32	15	73	2.3	19.8	0.31
	Average of Group 23.....			2.3	20.0	0.28
24	32	15	72	2.2	18.1	0.25
	10	5	72	2.2	17.3	0.17
	4	20	88	2.2	15.8	0.24
	Average of Group 24.....			2.2	17.1	0.22
25	32	25	82	2.1	18.6	0.26
	32	14	74	2.1	18.5	0.24
	14	32	89	2.1	16.0	0.27
	Average of Group 25.....			2.1	17.7	0.26
26	32	15	75	2.0	20.5	0.33
	41	16	78	2.0	20.4	0.26
	Average of Group 26.....			2.0	20.4	0.29
27	41	16	80	1.9	22.7	0.29
	41	16	79	1.9	19.8	0.30
	41	16	80	1.9	19.7	0.29
	42	16	84	1.9	19.6	0.31
	32	25	86	1.9	19.5	0.36
	Average of Group 27.....			1.9	20.3	0.31
28	7	10	86	1.8	20.2	0.26
	32	14	79	1.8	19.9	0.32
	42	16	87	1.8	19.7	0.33
	42	16	86	1.8	19.4	0.36
	42	16	87	1.8	19.3	0.36
	42	16	86	1.8	19.2	0.35
	7	10	89	1.8	19.1	0.34
	7	10	89	1.8	18.7	0.32
	13	41	75	1.8	18.0	0.25
	41	16	77	1.8	15.9	0.25
	10	5	71	1.8	15.6	0.16
	10	5	71	1.8	15.1	0.15
	Average of Group 28.....			1.8	18.3	0.29
29	41	16	79	1.7	19.5	0.27
	42	16	87	1.7	19.1	0.37
	9	20	73	1.7	15.6	0.21
	6	10	89	1.7	11.9	0.13
	Average of Group 29.....			1.7	16.5	0.24
30	14	32	88	1.6	14.6	0.23
31	32	13	72	1.5	20.5	0.23
	7	10	88	1.5	18.3	0.29
	10	5	70	1.5	15.7	0.13
	14	32	85	1.5	15.6	0.19
	14	32	85	1.5	15.5	0.17
	Average of Group 31.....			1.5	17.1	0.20
32	14	32	89	1.4	15.6	0.25
33	32	13	72	1.3	19.2	0.18
Average of All (113) Lots.....				**2.7**	**19.4**	0.30

[a]See bibliography on page 48.

TABLE 50.— PROTEIN AND ENERGY CONSUMED AND GAINS IN WEIGHT PER DAY

LAMBS OF CLASS III, WEIGHING 90 TO 110 POUNDS

Group	Reference No.[a]	No. of animals in lot	Average weight of lambs	Digestible protein consumed per 1000 pounds	Net energy consumed per 1000 pounds	Average daily gain
			lbs.	*lbs.*	*therms*	*lbs.*
1	22	125	107	5.7	27.4	0.31
2	18	7	103	4.6	22.9	0.45
	18	7	103	4.6	21.6	0.44
	Average of Group 2.....			4.6	22.2	0.44
3	18	7	100	4.4	20.0	0.37
4	18	7	102	4.3	22.0	0.42
	38	11	92	4.3	15.0	0.22
	Average of Group 4.....			4.3	18.7	0.32
5	16	8	93	4.1	25.1	0.37
6	16	9	105	4.0	25.1	0.43
7	25	10	103	3.9	19.0	0.51
8	16	9	109	3.8	23.7	0.44
9	16	9	107	3.6	22.3	0.36
10	33	10	99	3.3	18.6	0.39
11	22	125	106	3.2	19.6	0.29
	21	4	99	3.2	18.7	0.39
	38	11	101	3.2	14.8	0.35
	Average of Group 11.....			3.2	17.7	0.34
12	39	10	92	3.1	21.9	0.28
	15	10	99	3.1	19.5	0.41
	26	10	101	3.1	18.5	0.34
	Average of Group 12.....			3.1	20.0	0.34
13	15	10	95	3.0	19.1	0.29
	4	5	97	3.0	14.8	0.31
	Average of Group 13.....			3.0	16.9	0.30
14	21	4	96	2.9	16.2	0.32
	4	10	94	2.9	13.7	0.20
	Average of Group 14.....			2.9	14.9	0.26
15	39	10	109	2.8	20.1	0.28
	26	10	97	2.8	18.2	0.28
	5	10	100	2.8	17.7	0.34
	21	4	98	2.8	17.5	0.36
	Average of Group 15.....			2.8	18.4	0.31
16	33	10	101	2.7	22.7	0.45
	5	10	103	2.7	18.4	0.37
	5	15	94	2.7	16.4	0.28
	Average of Group 16.....			2.7	19.2	0.37
17	24	9	96	2.6	21.3	0.34
	4	15	102	2.6	16.3	0.33
	5	20	92	2.6	16.3	0.23
	4	10	104	2.6	16.2	0.30
	4	15	102	2.6	14.8	0.30
	Average of Group 17.....			2.6	17.0	0.30

[a]See bibliography on page 48.

TABLE 50.— *Concluded*

Group	Reference No.[a]	No. of animals in lot	Average weight of lambs	Digestible protein consumed per 1000 pounds	Net energy consumed per 1000 pounds	Average daily gain
			lbs.	*lbs.*	*therms*	*lbs.*
18	26	10	102	2.5	19.2	0.36
	5	15	93	2.5	15.8	0.25
Average of Group 18.....				2.5	17.5	0.30
19	4	10	106	2.4	17.2	0.37
	4	10	102	2.4	16.1	0.31
Average of Group 19.....				2.4	16.6	0.34
20	26	10	99	2.3	20.6	0.37
	18	9	102	2.3	20.1	0.37
	24	9	96	2.3	20.0	0.34
	6	10	92	2.3	18.3	0.18
	6	10	95	2.3	15.5	0.23
Average of Group 20.....				2.3	18.9	0.30
21	24	9	94	2.2	22.9	0.35
	18	9	106	2.2	21.2	0.39
	7	10	91	2.2	19.3	0.35
	4	10	105	2.2	17.7	0.37
Average of Group 21.....				2.2	20.3	0.36
22	24	9	94	2.1	22.1	0.31
	18	9	102	2.1	20.3	0.29
	18	9	101	2.1	19.8	0.30
	24	9	96	2.1	18.6	0.31
	5	10	101	2.1	18.4	0.38
	6	10	92	2.1	17.4	0.26
	5	15	96	2.1	16.3	0.28
	6	10	95	2.1	16.1	0.24
	29	10	104	2.1	14.0	0.24
	29	10	104	2.1	12.6	0.24
Average of Group 22.....				2.1	17.6	0.28
23	24	9	94	2.0	20.5	0.37
	24	9	97	2.0	19.4	0.37
	7	10	91	2.0	19.0	0.33
	23	12	96	2.0	18.2	0.24
	25	10	99	2.0	17.9	0.38
	23	12	103	2.0	17.5	0.36
	5	10	98	2.0	17.0	0.31
	5	20	94	2.0	16.6	0.24
Average of Group 23.....				2.0	18.3	0.32
24	7	10	91	1.9	19.5	0.34
	6	10	95	1.9	15.9	0.22
	6	10	96	1.9	15.8	0.25
Average of Group 24.....				1.9	17.1	0.27
25	24	9	96	1.8	19.6	0.35
	6	10	96	1.8	16.5	0.26
Average of Group 25.....				1.8	18.0	0.30
26	24	9	97	1.5	20.0	0.35
	7	10	90	1.5	18.7	0.31
	27	10	109	1.5	12.6	0.16
Average of Group 26.....				1.5	17.1	0.27
Average of All (73) Lots.....				2.7	18.6	0.32

[a]See bibliography on page 48.

TABLE 51.— PROTEIN AND ENERGY CONSUMED AND GAIN IN WEIGHT PER DAY LAMBS OF CLASS IV, WEIGHING 110 TO 150 POUNDS

Group	Reference No.[a]	No. of animals in lot	Average weight of lambs	Digestible protein consumed per 1000 pounds	Net energy consumed per 1000 pounds	Average daily gain
			lbs.	*lbs.*	*therms*	*lbs.*
1	17	10	121	8.1	25.2	0.41
2	17	10	122	4.6	27.7	0.45
3	17	10	121	3.8	28.6	0.45
	17	10	124	3.8	28.0	0.46
	16	9	111	3.8	23.7	0.50
Average of Group 3				3.8	26.8	0.47
4	16	9	113	3.7	23.0	0.40
	16	9	116	3.7	22.6	0.40
Average of Group 4				3.7	22.8	0.40
5	16	9	119	3.6	22.3	0.46
6	15	10	123	3.2	20.1	0.48
7	15	10	111	3.1	19.3	0.45
8	15	10	141	3.0	19.0	0.55
9	15	10	122	2.9	18.5	0.48
	15	10	142	2.9	18.5	0.52
	15	10	146	2.9	18.1	0.55
	15	10	146	2.9	18.1	0.62
Average of Group 9				2.9	18.3	0.54
10	34	10	113	2.7	17.1	0.37
	27	10	111	2.7	12.7	0.22
Average of Group 10				2.7	14.9	0.29
11	15	9	155	2.6	16.4	0.52
12	28	9	119	2.0	11.0	0.16
13	30	5	119	1.9	11.4	0.29
14	30	5	124	1.7	9.9	0.38
15	30	5	119	1.4	8.1	0.35
16	28	9	116	1.1	10.8	0.09
17	30	5	111	0.9	8.6	0.23
Average of All (24) Lots				**3.0**	**18.3**	**0.41**

[a]See bibliography on page 48.

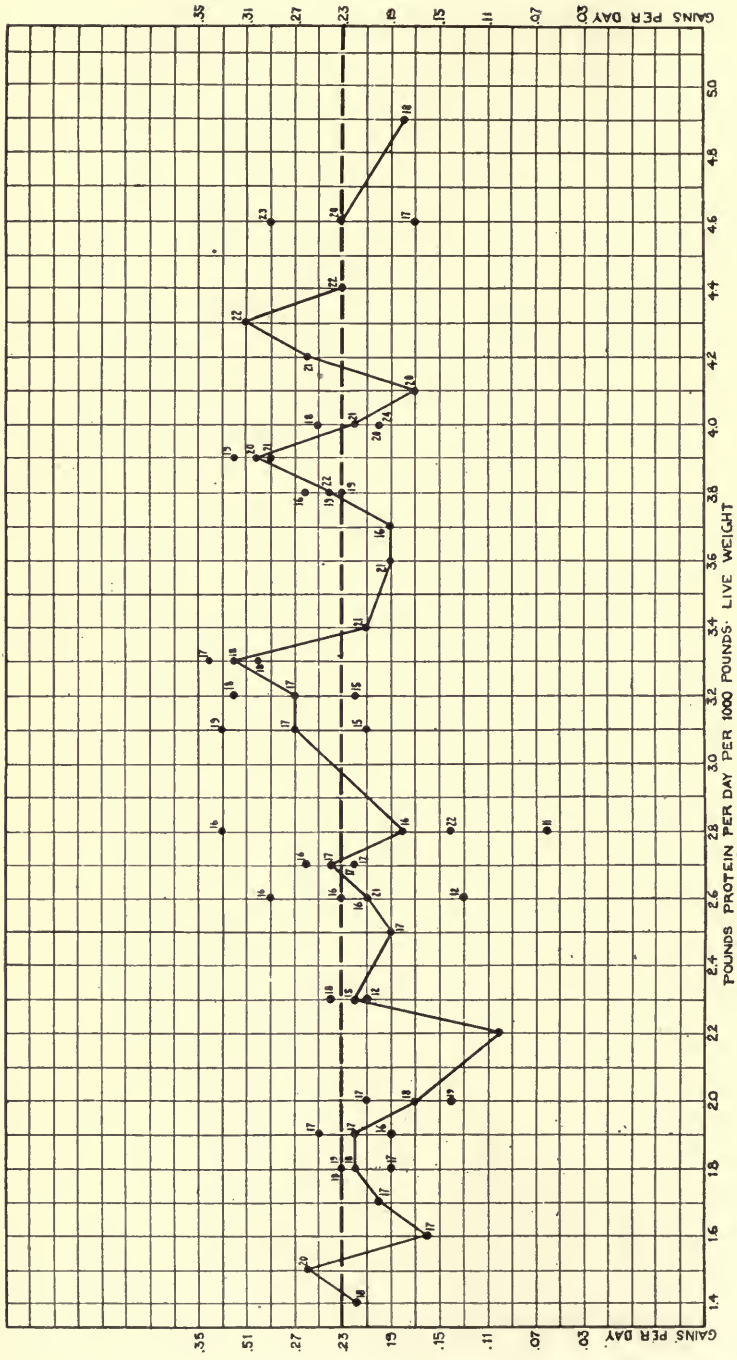

FIG. 1.—PROTEIN AND ENERGY CONSUMED AND GAINS IN WEIGHT PER DAY
LAMBS OF CLASS I, WEIGHING 50 TO 70 POUNDS

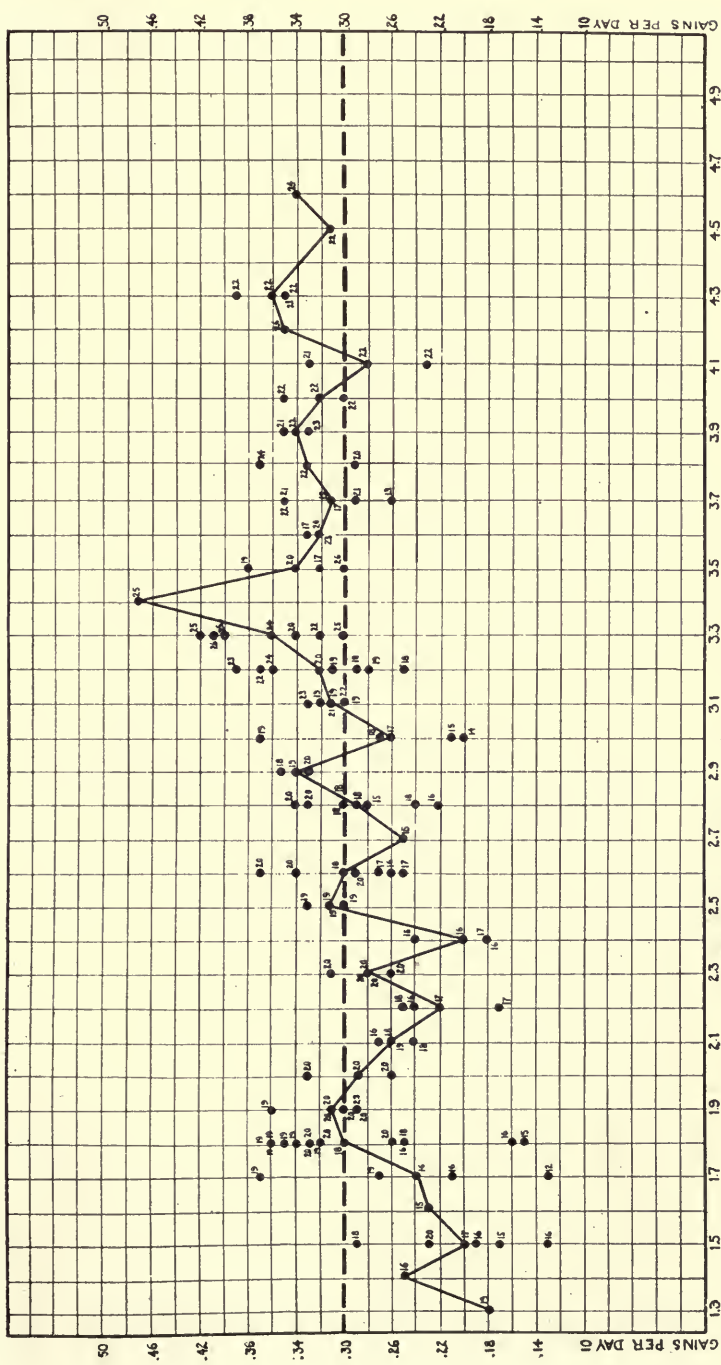

FIG. 2.—PROTEIN AND ENERGY CONSUMED AND GAINS IN WEIGHT PER DAY
LAMBS OF CLASS II, WEIGHING 70 TO 90 POUNDS

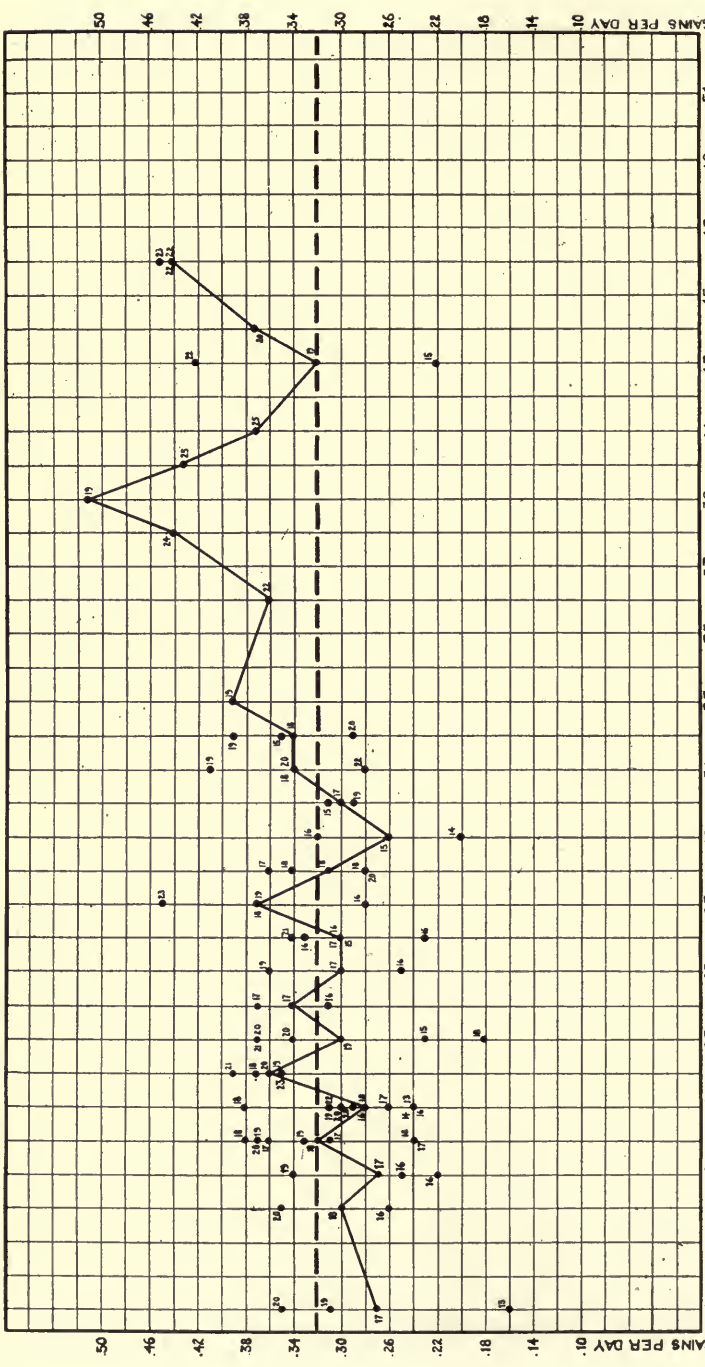

FIG. 3.—PROTEIN AND ENERGY CONSUMED AND GAINS IN WEIGHT PER DAY LAMBS OF CLASS III, WEIGHING 90 TO 110 POUNDS

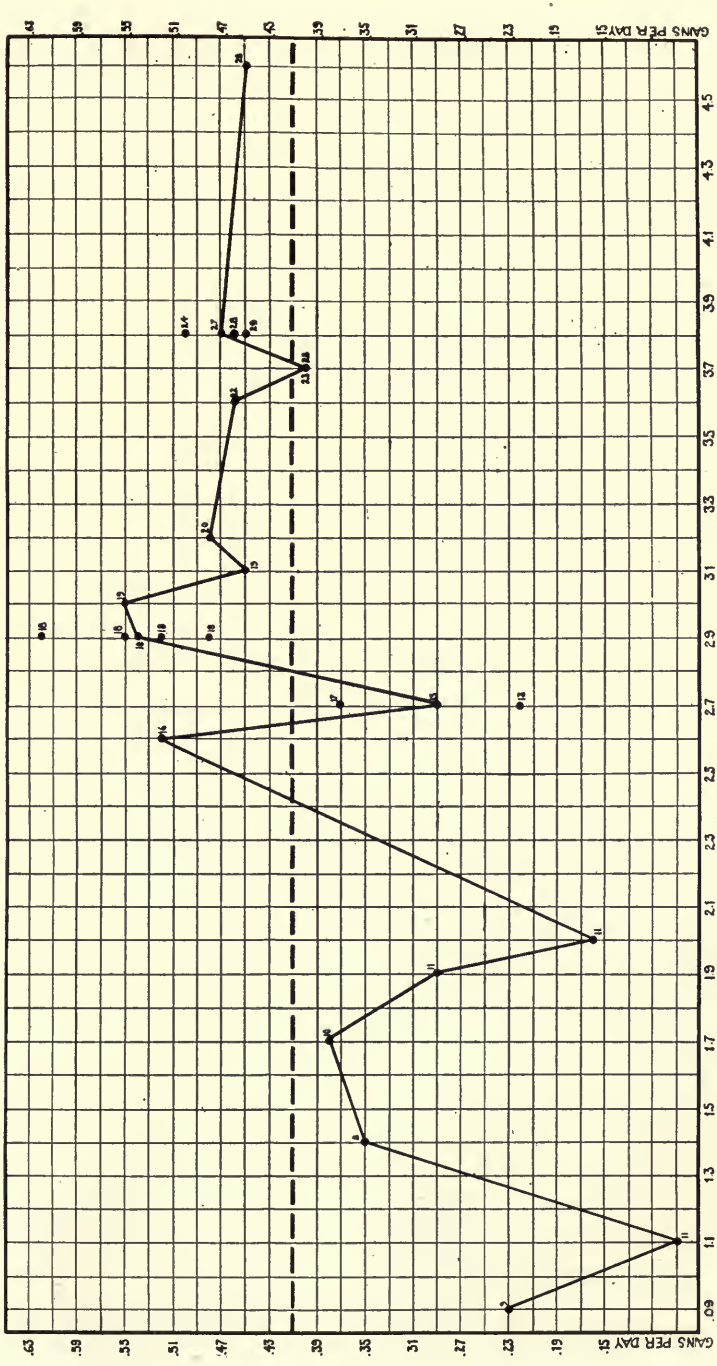

FIG. 4.—PROTEIN AND ENERGY CONSUMED AND GAINS IN WEIGHT PER DAY . . LAMBS OF CLASS IV, WEIGHING 110 TO 150 POUNDS

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