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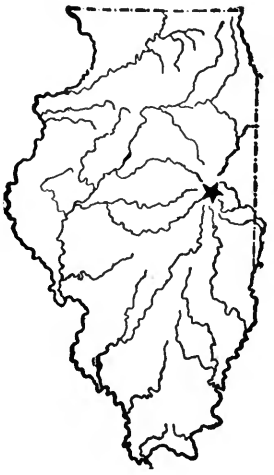
BULLETIN No. 168

A STUDY OF THE DEVELOPMENT OF GROWING PIGS

WITH SPECIAL REFERENCE TO THE INFLUENCE OF THE QUANTITY OF PROTEIN CONSUMED

By A. D. EMMETT and H. S. GRINDLEY

WITH THE COOPERATION OF
W. E. JOSEPH and R. H. WILLIAMS



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INTRODUCTION

The ultimate object of the investigation of which this publication is a partial report was to determine the influence of different quantities of protein upon the nutrition of *young growing* pigs. In this particular bulletin are given the experimental data relating to the live weights and the physical condition of the animals, the comparative weights of the various parts and organs of their bodies, and the relative sizes and breaking strengths of their leg bones.

The results of a large number of feeding experiments carried on in this country show clearly that the development of the bodies of growing pigs can be directly influenced by the feeds consumed. It has been found that feeds rich in protein are more favorable to the normal development of young swine than those that are poor in protein, and that animals fed a narrow ration have more blood, larger vital organs, and larger, stronger bones of a higher ash content than those fed a ration the nutritive ratio of which is wide.

From these earlier experiments, however, it was impossible to tell whether the beneficial effects of the high-protein rations were due to the amounts of protein or to the amounts of mineral matter consumed, for the rations containing the greater quantities of the one contained also the greater quantities of the other. That the mineral matter played an important part is evident from the results of later experiments which showed that some of the abnormal bodily conditions occasioned by a ration poor in protein can be corrected by feeding ground bone, calcium phosphate, or wood ashes. This has been further proven by the investigations of Hart, McCollum, and Fuller[1], which demonstrated that if the ration of growing pigs is rich in protein and *low in calcium phosphate,* the animals make small gains, are in poor physical condition, and have light bones of low mineral content and breaking strength. On the other hand, if in addition to a liberal supply of protein the ration contains *large quantities of calcium phosphate,* the pigs make good gains, are in normal condition, and have bones of normal composition and breaking strength.

[1]Wis. Agr. Exp. Sta., Res. Bul. 1, 1909.

In the light of the investigations cited above, it was thought that if growing pigs were given a liberal amount of calcium phosphate in connection with small, medium, and large quantities of protein, valuable data would be obtained as to the quantities of protein that are necessary for their normal development.

PLAN OF EXPERIMENT

At the time of weaning, October 30, 1909, fourteen thrifty Berkshire pigs were selected from the Station herd, under the direction of Professor Dietrich, formerly of this department. On December 25, twelve of these animals were divided into three lots of four pigs each in such a way that the lots were as similar as possible in regard to age, ancestry, weight, and condition. On the same date the two remaining pigs were slaughtered and analyzed for controls.

TABLE 1.— DESCRIPTION OF PIGS

Ancestry		Date farrowed 1909	Lot I Low protein		Lot II Medium protein		Lot III High protein		Lot IV Control		Age at close of experiment
Sire	Dam		Pig	Sex	Pig	Sex	Pig	Sex	Pig	Sex	
											days
Abron	90	Aug. 22	1	barrow	5	barrow	..	.....	..	.....	300
Abron	79	Aug. 22	4[1]	sow	..	.....	14[2]	barrow	..	.....	...
Abron	19	Aug. 21	..	.....	..	.....	16	barrow	..	.....	299
Beckon	47	Aug. 27	2[1]	barrow	6[2]	barrow	..	.....	..	.....	...
Beckon	77	Aug. 21	..	.....	8	barrow	..	.....	..	.....	299
Beckon	26	Aug. 20	..	.....	..	.....	..	.....	26	barrow	...
Beckon	44	Aug. 19	..	.....	..	.....	..	.....	44	barrow	...
Baron Duke 131st	13	Sept. 13	3[1]	barrow	7	barrow	13	barrow	..	.....	280
	32	Aug. 25	..	.....	..	.....	15	barrow	..	.....	297

[1]Died before close of experiment.
[2]Removed from lot after Pig 2 died.

During the experimental feeding period, which began December 25 and continued twenty-five weeks, Lot I was kept on a low-protein ration; Lot II, on a medium-protein ration; and Lot III, on a high-protein ration. The feeds used were ground corn, blood meal, and calcium phosphate. The animals were fed individually twice daily, at 7 a. m. and 4 p. m. All of them received, per 100 pounds live weight, approximately the same amounts of the ground corn. The calcium phosphate was so fed that the rations of Lots I, II, and III contained respectively, 11.03, 9.65, and 8.73 grams of phosphorus[2] per 100 pounds live weight. Of the blood meal, those of Lot II received more

[2]According to the results of Hart, McCollum, and Fuller, calcium phosphates are as efficient in supplementing rations low in phosphorus as are organic phosphorus compounds. These investigators state that young growing pigs should receive per day at least 6 to 10 grams of phosphorus per 100 pounds live weight.

than those of Lot I, and those of Lot III, more than those of Lot II. Thus, per 100 pounds live weight, the pigs of the three lots received *the same amounts of corn protein, but different amounts of blood-meal protein,* the percentages of corn protein and blood-meal protein in the total protein received by each lot being as follows: Lot I, corn protein, 50 percent, blood-meal protein, 50 percent; Lot II, corn protein, 20 percent, blood-meal protein, 80 percent; and Lot III, corn protein, 14 percent, blood-meal protein, 86 percent. Five grams of salt and 35 grams of charcoal were offered to each pig once a week, but in most instances no special desire for them was shown. The animals had free access to water at all times, and the weight of the water drunk was recorded for each lot, but not for each animal. Enough water was added to the feeds to make a thick slop.

The three lots of pigs were kept separate, but the animals belonging to the same lot were allowed to run together. Each lot was housed in a pen approximately 15 x 10 feet in size, which was paved with brick and provided with a movable wooden floor 5 feet square, upon which the pigs could lie. Pine shavings were used for bedding. During the first half of the experiment the animals were weighed once a week, but later, three times a week, on successive days. During the last half of the experiment, additional exercise was given them by driving them once daily up and down a 270-foot paved alley.

WEIGHTS, COMPOSITION, AND DIGESTIBLE NUTRIENTS OF FEEDS

The quantities of digestible nutrients in the feeds of the three lots of pigs were calculated from the coefficients of digestibility given by Henry and Kellner for ground corn, i. e., dry substance, 91.0; protein, 85.0; carbohydrates, 92.4; and fat, 74.6; and by Lindsey[1] for dried blood, i. e., dry substance, 84.0; protein, 84.0; and fat, 98.0.

Pigs 8 and 15 were not good feeders. They went off feed several times, and as it was, therefore, necessary to reduce their portions of corn meal and blood meal considerably, the amounts of feeds consumed by these animals were somewhat lower than those consumed by the two other pigs in their respective lots.

[1]These values were for sheep. The only experiment bearing upon the digestibility of blood meal for swine that we were able to find was one quoted in Henry's "Feeds and Feeding." In that experiment the coefficient of digestibility of the protein was given as 72, but the blood meal used was hard and had been overheated. Wildt, in experiments with sheep, found that such meal is less digestible than meal that has been properly prepared.

From the standpoint of feed consumption, the most representative animals were Nos. 1 of Lot I, 5 and 7 of Lot II, and 16 and 13 of Lot III. The average amounts of nutrients consumed daily per 100 pounds live weight by these pigs were as follows: digestible protein, 0.32 pound by Lot I, 0.70 pound by Lot II, and 0.94 pound by Lot III; carbohydrates, 1.55 pounds by Lot I, 1.44 pounds by Lot II, and 1.32 pounds by Lot III; and fat, 0.061 pound by Lot 1, 0.059 pound by Lot II, and 0.056 pound by Lot III. The average energy values of the digestible nutrients per 100 pounds live weight were: for Pig 1, 3.79 therms; for Pigs 5 and 7, 4.28 therms; and for Pigs 16 and 13, 4.49 therms. Pig 1 consumed daily per 100 pounds live weight 71.24 grams of ash, including the added calcium phosphate; Pigs 5 and 7, 64.34 grams; and Pigs 16 and 13, 59.06 grams. The total phosphorus values for the same animals on the same basis were 11.03 grams for Lot I, 9.65 grams for Lot II, and 8.73 grams for Lot III.

The average nutritive ratios for the whole experiment were narrow, being 1:5.3 for Lot I, 1:2.2 for Lot II, and 1:1.5 for Lot III. The corresponding values at the beginning of the experiment were 1:8.2, 1:3.3, and 1:2.3, and those at the end of the experiment, 1:3.1, 1:1.4, and 1:0.8. The narrowing of the nutritive ratio as the experiment progressed was due to the fact that the quantities of corn meal fed per 100 pounds live weight were continuously decreased while the amounts of blood meal either remained constant or were slightly increased.

TABLE 2.—CHEMICAL COMPOSITION OF COMPOSITE FEEDS

(Results expressed in percent of fresh substance)

Feed	Time used	Dry substance	Protein (Nx6.25)	Fat	Carbohydrates	Ash	Phosphorus
Ground corn	Dec. 20–Jan. 28	86.58	7.90	3.91	73.54	1.23	0.251
" "	Jan. 29–Mar. 11	86.30	7.95	3.89	73.16	1.30	0.256
" "	Mar. 12–May 13	86.52	8.17	3.95	73.17	1.23	0.254
" "	May 14–June 20	86.26	8.16	2.33	74.52	1.25	0.248
Average....	Dec. 20–June 20	86.41	8.04	3.52	73.60	1.25	0.252
Blood meal..	Dec. 20–Jan. 28	88.57	83.79	0.38	1.73	2.66	0.186
" "	Jan. 29–May 17	89.43	85.97	0.37	0.90	2.19	0.153
" "	May 19–June 20	90.51	87.39	0.46	0.36	2.30	0.148
Average....	Dec. 20–June 20	89.50	85.72	0.40	1.00	2.38	0.162
Tankage[1]...	May 17–May 19	89.15	56.50	10.55	....	15.15	1.221

[1]Used in place of blood meal for two days, equivalent quantities of protein being weighed out.

TABLE 3.—FEEDS, NUTRIENTS, AND ENERGY CONSUMED PER DAY PER 100 POUNDS LIVE WEIGHT[1]

Lot	Animal	Feeds			Digestible nutrients						Ash	Phosphorus	Calcium[3]	Metabolizable energy[4]	Nutritive ratio
		Ground corn	Blood meal	Total	Dry substance	Protein (N x 6.25)			Carbohydrates	Fat					
						Ground corn	Blood meal	Total							
		lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*grams*	*grams*	*grams*	*therms*	
I	1	2.29	0.22	2.51	1.97	0.16	0.16	0.32	1.55	0.061	71.24	11.03	4.07	3.79	1:5.3
	3[2]	2.40	0.13	2.54	1.99	0.13	0.13	0.26	1.62	0.064	....	....	....	3.90	1:6.8
	4[2]	1.58	0.18	1.76	1.38	0.12	0.12	0.24	1.07	0.042	....	....	....	2.65	1:4.9
II	5	2.14	0.78	2.92	2.27	0.14	0.57	0.71	1.45	0.059	65.26	9.65	3.56	4.32	1:2.2
	7	2.11	0.76	2.87	2.23	0.14	0.55	0.69	1.43	0.059	63.42	9.65	3.56	4.24	1:2.3
	8	1.91	0.72	2.64	2.05	0.13	0.52	0.65	1.29	0.053	53.98	7.71	2.72	3.88	1:2.2
Average.	.....	2.05	0.75	2.81	2.18	0.14	0.54	0.68	1.39	0.057	60.88	9.00	3.28	4.14	1:2.2
III	16	1.92	1.10	3.02	2.34	0.13	0.80	0.93	1.29	0.055	57.45	8.73	3.22	4.41	1:1.5
	13	2.00	1.14	3.14	2.43	0.13	0.83	0.96	1.35	0.057	60.67	8.73	3.22	4.58	1:1.5
	15	1.82	0.92	2.75	2.13	0.11	0.68	0.79	1.23	0.052	55.34	8.16	3.22	4.02	1:1.7
Average.	.....	1.91	1.05	2.97	2.30	0.12	0.77	0.89	1.29	0.055	57.82	8.54	3.22	4.33	1:1.6

[1]The detailed data for each pig are given in the Appendix, pages 122 to 127.

[2]Died before close of experiment.

[3]Calculated from average composition of feeds.

[4]The metabolizable energy of a ration is the energy that can be liberated and utilized in the animal body, or the gross energy less the energy contained in the feces, urine, and intestinal gases. The metabolizable energy of the rations has been calculated by multiplying the weights of the digestible nutrients by the following factors: digestible protein, 1860; digestible carbohydrates, 1905; and ether extract, 2992. One therm equals 1000 calories.

LIVE WEIGHTS AND AVERAGE DAILY GAINS

Attention should again be called to the fact that the pigs used in this investigation were young, growing animals weighing on an average only 51 pounds at the beginning of the experiment, and that they were housed in small pens paved with brick. The reader is cautioned against assuming that similar results would have been obtained if the pigs had been more mature.

The live weights of the pigs during the different periods of the experiment are given in Table 4. All of the animals of Lot I remained small and underdeveloped, and three of them died before the close of the experiment. Pig 1, which was the only animal on the low-protein ration that did live to the end of the experiment, increased less in live weight than those of the other lots except No. 8. The average daily gain of Pig 1 for the entire experiment was 0.64 pound, while that of the pigs of Lot II was 0.85 pound, and that of the animals of Lot III, 0.90 pound.

There was no significant difference between the average live weights and the average daily gains of the pigs of Lots II and III.

TABLE 4.—LIVE WEIGHTS AND GAINS

(Results expressed in pounds)

Animal	Lot	Weight at weaning	Weight at beginning of experiment	Weight at close of experiment	Total gain from beginning to close, 174 days	Average daily gain
1	I	31.0	67.9	180.1	112.2	0.64
3	I	30.0	51.8	74.0[1]	(22.2)[1]	....[1]
2	I	25.0	35.9	35.3[2]	(−0.6)[2]	....[2]
4	I	27.0	42.4	44.0[3]	(1.6)[3]	....[3]
Total....	I	113.0	198.0	....	....	....
5	II	31.0	62.9	249.4	186.5	1.07
7	II	27.0	49.8	199.6	149.8	0.86
6	II	31.0	34.9	47.8[4]	(12.9)[4]	....[4]
8	II	28.0	49.4	157.0	107.6	0.62
Total....	II	117.0	197.0	606.0	443.9	0.85
16	III	34.0	62.8	248.4	185.6	1.06
13	III	26.0	44.9	189.3	144.4	0.82
14	III	22.0	42.4	66.4[4]	(24.0)[4]	....[4]
15	III	35.0	62.9	203.7	140.8	0.80
Total....	III	117.0	213.0	641.4	470.8	0.90

[1]Pig 3 removed on 125th day of experiment; died a week later.

[2]Pig 2 removed on 41st day of experiment.

[3]Pig 4 died the night before experiment closed.

[4]In order to keep all lots comparable, Pigs 6 and 14 were removed soon after Pig 2 died, and their gains have not been included in the total for their respective lots.

PHYSICAL CONDITION

As formerly stated, the three lots of pigs were kept under conditions as much alike as possible in every respect except as to the quantity and quality of the protein consumed. The pens, the amount of room for exercising, the ventilation, and the sanitary conditions were alike for all.

Notes as to the condition and appearance of the pigs were taken at the beginning of, and at frequent intervals thruout, the experiment. The rating of the twelve pigs of Lots I, II, and III at the beginning of the experiment, from the feeder's standpoint in regard to conformation, condition, thrift, etc., was as follows:

Pig No.	1	5	16	15	8	3	7	4	14	13	2	6
Lot No.	I	II	III	III	II	I	II	I	III	III	I	II

Pig 1 was a rather exceptional individual with respect to vigor and thrift, while Pigs 2 and 6 were the poorest animals in the experiment. Pigs 16 and 15 were not very widely different, and both were inferior to Pig 5. Pig 3 was nearly equal to Pig 8 and distinctly superior to Pig 7. Pigs 4 and 14 were inferior to Pig 7 and only slightly better than Pig 13.

The physical condition of the pigs as the experiment progressed was as follows:

Pig 2 of Lot I was removed on the forty-first day of the experiment, as it had become sluggish and lacked appetite, walked with difficulty, and appeared to be starving. It died on the forty-sixth day of the experiment.

Pig 3 of Lot I made fairly good gains up to February 5. It then began to lose its appetite, appeared drowsy, and became stiff in the hind quarters. On April 30 this animal was in such a bad condition that it was removed and given a different treatment to see if it would recover. It died on May 5.

Unlike Pigs 2 and 3, Pig 4 of Lot I was very active and never showed signs of being stiff. Like them, however, this animal also was in poor condition during the latter part of the experiment. About February 5 it began to lose its appetite, its hair came off, and it stopped growing entirely. During the last two weeks of the experiment it was practically fasting and it was plainly seen that it could not live long. It died June 19.

The remaining pig of this lot (No. I), during the latter half of the experiment showed distinct symptoms of stiffness in all parts. It walked and stood with difficulty, and occasionally showed signs of drowsiness.

When Pig 2 died, Pigs 6 and 14 were removed from Lots II and III, respectively, in order to make the three lots directly comparable from the standpoint of merit of the animals, number of animals, and

area per head in each pen. On the whole, the remaining pigs of Lots II and III continued thrifty and in good condition for animals kept in small pens for an extended period of time.

Pig 6 of the medium-protein lot made the smallest gain in weight and was the most unthrifty individual of the lot. Altho at the beginning of the experiment this animal was rated below Pig 2, its litter mate, it gradually surpassed Pig 2 in every way. Up to the time that Pig 2 was removed, Pig 6 gained about 0.3 pound per day. The other pigs of the medium-protein lot were not sluggish like those of Lot I, but they were somewhat stiff in the hind quarters at times during very cold weather.

The pigs of the high-protein lot were particularly active, tho occasionally during very cold weather, like the pigs of the medium-protein lot, they became stiff in the hind quarters. Pigs 13 and 14 were not as thrifty as Pigs 15 and 16. Up to the time that Pig 2 was removed, Pigs 13 and 14 gained 0.6 pound per day, and Pigs 15 and 16, 1.0 pound. The main reason for removing Pig 14 instead of Pig 13 at the time that Pig 2 was removed, was the fact that Pig 13 was a litter mate of Pig 7 of Lot II.

The general appearance of Pigs 1 and 4 of Lot I, 5 and 7 of Lot II, and 16 and 13 of Lot III, is shown by Figures 1, 2, and 3 in the Appendix, pages 128 to 130.

BLOOD EXAMINATION

Towards the end of the experiment, examinations were made of the blood of all of the pigs in order that the data so obtained might be used as an aid in determining the comparative physical conditions of the animals. Three of these tests were made on Pigs 1 and 16, and two on each of Nos. 4, 5, 7, 13, and 15.

Only the count of the total number of white blood cells, or leucocytes, showed any definite distinction between the lots. In the differential count of the white blood cells and the count of the red blood cells, the differences within the lots were as great as, or greater than, the lot differences. The average of the white blood cells for Lot I was 26,222; that for Lot II, 19,339; and that for Lot III, 20,405. The number of leucocytes in the blood of Pigs 1 and 4 of the low-protein lot was unusually large and may have indicated an abnormal condition.

TABLE 5.— BLOOD EXAMINATION[1]

Animal	Lot	Date	Percentage of hemoglobin by von Fleischl-Miescher	Blood cells per cubic millimeter		Differential count in percent of total count							
				Red	White	Polymorphonuclear	Small lymphocytes	Large lymphocytes	Mononuclear	Transitional	Eosinophile	Basophile	Normoblasts
1	I	6–7	12.3	7 903 000	23 568	43.0	44.0	3.0	4.4	1.4	3.8	0.0	0.0
		6–10	11.7	6 240 000	27 712	31.8	52.8	1.4	1.0	2.2	4.6	0.2	1.0
		6–14	11.3	6 024 000	29 728	35.8	53.4	3.0	1.0	2.2	4.6	0.0	0.0
Aver.	.....	.....	11.8	6 722 000	27 003	36.9	50.1	2.5	2.5	2.6	5.3	0.1	0.3
4	I	6–9	11.5	6 568 000	20 160	58.6	31.6	4.2	2.8	1.2	1.0	0.6	0.0
		6–13	11.7	5 848 000	30 720	62.8	34.0	1.0	0.0	1.6	0.4	0.2	0.0
Aver.	.....	.....	11.6	6 208 000	25 440	60.7	32.8	2.6	1.4	1.4	0.7	0.4	0.0
Average I.....			11.7	6 465 000	26 222	48.8	41.4	2.6	2.0	2.0	3.0	0.2	0.2
5	II	6–9	11.9	6 808 000	15 616	18.6	69.8	3.6	2.2	2.8	1.6	1.4	6.0
		6–13	10.5	4 800 000	18 560	17.0	74.6	1.6	1.8	2.4	2.2	0.4	5.0
Aver.	.....	.....	11.2	5 804 000	17 088	17.8	72.2	2.6	2.0	2.6	1.9	0.9	5.5
7	II	6–9	12.2	7 520 000	13 540	30.6	56.6	1.4	3.2	4.0	4.0	0.2	1.0
		6–13	10.4	4 360 000	19 520	31.8	60.3	0.5	0.2	1.8	5.4	0.0	3.0
Aver.	.....	.....	11.3	5 940 000	16 530	31.2	58.5	0.9	1.7	2.9	4.7	0.1	2.0
8	II	6–10	12.0	7 200 000	30 080	37.0	53.0	1.8	1.8	2.4	3.8	0.2	0.0
		6–14	12.2	7 104 000	18 720	34.0	59.4	1.2	0.8	1.0	3.4	0.2	0.0
Aver.	.....	.....	12.1	7 152 000	24 400	35.5	56.2	1.5	1.3	1.7	3.6	0.2	0.0
Average II.....			11.5	6 299 000	19 339	28.2	62.3	1.7	1.6	2.4	3.4	0.4	2.5
16	III	6–7	12.5	4 852 000	13 776	23.2	68.2	1.0	2.6	1.8	2.6	0.6	2.0
		6–10	12.0	5 840 000	16 064	21.8	69.0	1.8	0.8	2.0	4.4	0.2	2.0
		6–14	10.5	5 968 000	22 720	22.4	71.2	0.6	1.0	0.6	4.0	0.2	1.0
Aver.	.....	.....	11.7	5 553 000	17 520	22.5	69.4	1.1	1.5	1.5	3.7	0.3	1.6
13	III	6–9	11.5	5 280 000	18 112	31.6	53.8	2.8	3.0	5.6	2.6	0.6	3.0
		6–13	11.3	3 880 000	22 976	27.3	65.5	0.8	0.2	2.0	3.2	1.0	1.0
Aver.	.....	.....	11.4	4 580 000	20 554	29.5	59.6	1.8	1.6	3.8	2.9	0.8	2.0
15	III	6–10	13.0	7 400 000	28 480	31.8	58.6	2.0	0.8	1.8	4.6	0.4	0.0
		6–14	11.8	6 120 000	20 704	37.0	55.0	1.0	0.8	1.0	5.2	0.0	0.0
Aver.	.....	.....	12.4	6 760 000	24 592	34.4	56.8	1.5	0.8	1.4	4.9	0.2	0.0
Average III.....			11.8	5 631 000	20 405	28.8	61.9	1.5	2.2	3.9	3.8	0.4	1.2

[1]The authors wish hereby to acknowledge their indebtedness to Dr. W. J. MacNeal, formerly of this department, for the data relating to the blood examinations.

SLAUGHTER TESTS

For the purpose of making a detailed study of the various parts of the animals, careful slaughter tests were carried out on the following pigs: No. 1 of Lot I, Nos. 5 and 7 of Lot II, Nos. 16 and 13 of Lot III, and Nos. 26 and 44 of Lot IV.

The selection of the animals in the case of the low-, medium-, and high-protein lots was based upon the general behavior and condition of the pigs thruout the experiment, and also upon their blood relationship. Pig 1 was the only available animal in Lot I at the close of the experiment, the other three having died. Since this animal was the best pig in the three lots at the beginning of the experiment, and the best pig in Lot I thruout the experiment, it put the low-protein lot in a more favorable light than should have been the case. The animals in Lots II and III, respectively, that were most nearly comparable with No. 1 were Pigs 5 and 16. These three animals were of very similar type and ancestry. They were very similar also in thift and condition during the preliminary part of the experiment, and thruout the experiment they ate their feed about equally well. The second individuals that were selected for the slaughter test from Lots II and III, Nos. 7 and 13, were chosen because they were from the same litter, of similar type, and of about equal merit from the standpoint of thrift and condition at the beginning of the experiment.

Judged on foot as market hogs on the days they were slaughtered, the pigs ranked as follows, the best being placed first:

Pig No.	5	16	7	13	1
Lot No.	II	III	II	III	I

Pig 5 had the best finish and was very good in quality and conformation. Pig 16 was somewhat inferior to Nos. 5 and 7 in finish and possibly in quality, but he was smoothly and thickly fleshed and evenly developed, being very uniform from front to back. Pigs 7 and 13 were lighter in weight than Nos. 5 and 16. Pig 7 possessed a higher degree of finish and somewhat better conformation than No. 13. No. 1 was inferior in condition, medium in quality, and fair in conformation.

The killing was carried out under careful supervision, and special effort was made to do the work as accurately and yet as rapidly as possible. The dressed carcasses, the halves, the wholesale cuts, i. e., the hams, shoulders, and sides, the fats, and the various organs and parts were carefully examined and weighed. The following outline shows the parts that were weighed and how they were grouped for sampling for the subsequent chemical analysis.

GROUPING OF WEIGHED PARTS OF BODIES FOR SAMPLING

I. Composite offal
   (a) Respiratory organs
      Lungs, larynx, trachea, etc.
   (b) Digestive organs
      Pharynx, esophagus, stomach, small intestine, large intestine
   (c) Heart
   (d) Liver
   (e) Gall bladder
   (f) Spleen
   (g) Pancreas
   (h) Tongue
   (i) Urinary organs
      Kidneys, bladder, penis, ureters, etc.
   (j) Organs of the central nervous system
      Brain, spinal cord
   (k) Miscellaneous parts
      Head, feet, tail, trimmings, skin, hair, toes
II. Blood
III. Bone and marrow
IV. Composite fat
   (a) leaf, (b) intestinal, (c) head
V. Boneless meat of shoulder (right half)
VI. Boneless meat of ham (right half)
VII. Boneless meat of side (right half)

POST-MORTEM EXAMINATION

The liver, kidneys, lungs, heart, spleen, stomach, and intestines were studied in particular for the purpose of determining any abnormalities. The results are tabulated in Table 6.

TABLE 6.—POST-MORTEM EXAMINATION[1]

Pig	Lot	Liver	Kidneys	Lungs	Heart	Spleen	Stomach	Intestines
1	I	Normal but small	Parenchymatous nephritis	Normal	Normal	Normal	Normal	Normal
3[2]	I	Normal but small	Parenchymatous nephritis	Normal	Normal	Normal	Congested	Congested
4[2]	I	Normal but small	Parenchymatous nephritis	Apparently tubercular	Normal	Normal	Inflammation	Congested
5	II	Normal	Normal	Normal	Normal	Normal	Normal	Rectal ulcers
7	II	Normal	Normal	Normal	Normal	Normal	Normal	.....[3]
16	III	Normal	Normal	Normal	Normal	Normal	Slight inflammation	Rectal ulcers
13	III	Normal	Normal	Normal	Normal	Normal	.....[3]	.....[3]

[1]The authors wish hereby to acknowledge their indebtedness to Dr. W. J. MacNeal, formerly of this department, for the data relating to the post-mortem examination.

[2]Pigs 3 and 4 died before close of experiment.

[3]Not examined.

The most striking condition found by the post-mortem examination was that of the kidneys of the animals in Lot I. They all showed distinct lesions of chronic parenchymatous nephritis, which apparently was the cause of the death of Nos. 3 and 4, and possibly of No. 2. Abnormally small livers were also characteristic of the animals on the low-protein ration. Pig 4 had apparently tubercular fossæ at the end of the bronchus leading to the right lower lobe of the lungs. The linings of the stomachs of Pigs 3 and 4 seemed to be somewhat inflamed, and the intestines were congested. Between Lots II and III, the post-mortem examination showed no differences.

MEASUREMENTS AND WEIGHTS OF KIDNEYS

The data for the weights and measurements of the right and left kidneys of Pigs 1, 5, 7, 16, and 13, are given in Table 7.

TABLE 7.—MEASUREMENTS AND WEIGHTS OF KIDNEYS

Pig	Lot	Right kidney				Left kidney			
		Length	Width	Thickness	Weight	Length	Width	Thickness	Weight
		cm.	*cm.*	*cm.*	*grams*	*cm.*	*cm.*	*cm.*	*grams*
1	I	10.0	4.0	2.7	68	11.8	5.0	2.6	90
5	II	13.5	6.8	3.3	166	13.0	6.0	2.7	131
7	II	12.0	5.0	2.2	139	11.5	5.8	2.7	118
Average	II	12.7	5.9	2.7	153	12.2	5.9	2.7	124
16	III	12.5	6.5	3.0	151	14.5	6.5	2.9	177
13	III	14.5	4.5	2.5	129	14.0	5.3	2.3	124
Average	III	13.5	5.5	2.7	140	14.2	5.9	2.6	150

When the average data for the pigs of the medium- and high-protein lots are compared, no significant differences are apparent in either the right or left kidneys. On the other hand, the differences between the values within the lots are marked. On comparing all three lots, it will be noted that No. 1 of the low-protein lot had lower values for length and width than either No. 5 from the same litter or No. 16 from the same sire, tho it had practically the same value for thickness. Pigs 7 and 13 possibly are not so directly comparable with Pig 1, as they were of different ancestry, type, and age. However, the average values for the length and width of the kidneys of Pig 1 were lower than the corresponding average values for Lots II and III.

The kidneys weighing the least were those of the animal on the low-protein ration, the weight of the right kidney of Pig 1 being 68 grams as compared with 166, 139, 151, and 129 grams for Pigs 5, 7, 16, and 13, respectively, and the weight of the left kidney only

90 grams as compared with 131, 118, 177, and 124 grams, respectively, for Pigs 5, 7, 16, and 13. The kidneys of the pig on the low-protein ration, therefore, weighed only from one-half to three-fourths as much as those of the pigs on the medium- and the high-protein rations. On the other hand, the weights of the kidneys of the pigs on the high-protein ration were not much different from those of the animals on the medium-protein ration.

JUDGING OF DRESSED CARCASSES

As soon as the various organs were removed, the dressed carcasses were judged. Figures 4 and 5,[1] show the comparative sizes of the five pigs. The head and feet were not taken off until the carcasses were brought back from cold storage. The hair also was left on because it would have been necessary to use hot water to remove it and this would have introduced errors in the subsequent chemical analyses. The judging was carried out under the direction of Professor Hall of this department. As soon as it was completed the entire carcass was cut in half, and each side wrapped in cheese cloth and put into cold storage.

The following notes were taken in judging the dressed carcasses. They are given in the order in which the pigs were slaughtered.

Comments by L. D. Hall.—"Pigs 7 and 13.—Grade, 'light loin' or 'shipper' hogs. No marked difference in quality or finish. No. 7 slightly fatter on belly and brisket than No. 13. Color of bones (breast bone, hench bone, and ribs) and color of flesh alike. No. 7 is slightly more compact in shape and fuller in the hams.

"Pig 1.—Same grade as Nos. 7 and 13. Less fat on sides, brisket, and flanks than either No. 7 or 13. Color of flesh and fat same as that of the other two. Carcass is especially suitable for use as 'shipper.' Kidneys completely covered with fat.

"Pig 5.—'Light butcher' hog. Very compact. Choice in quality and well finished. Hams large and plump. Sides thickly covered. Jowls full and fat. Color of flesh and fat good. Hench bones and breast bone cartilaginous. Kidneys well covered with leaf fat.

"Pig 16.—'Medium butcher grade. Medium finish; form somewhat rangy. Hams good, but not as fat as those of No. 5. Larger proportion of lean to fat thruout the carcass than in No. 5. Fineness of bone about the same. Flesh normal in color. Less fat on brisket and flanks than in No. 5. Kidneys visible thru fat. Leaf fat thinner than in Nos. 1 and 5.

"Comparison of Pigs 1, 5, and 16.—*Grade.*—The three are 'light loin' hogs. No. 16 is suitable also for packing purposes; No. 1 especially adapted to dress 'head-on' and sell as 'shipper.'" *Form.*—"No. 1 moderately compact. No. 5 very compact and well propor-

[1]See Appendix, pages 131 and 132.

tioned for a lard hog. No. 16 long bodied, with length particularly in the sides; a good light hog." *Quality.*—"No material difference in relative size of bone, color of flesh or fat, firmness, or general appearance. No. 5 has the best, and No. 16 the largest, proportion of lean to fat. All three are choice hogs." *Finish.*—"No. 1 medium in finish; has not enough covering over back, loin, and sides. No. 5 choice in finish; scarcely fat enough for choice, but the fattest of the three hogs. No. 16 decidedly lower in degree of finish than No. 5 and about the same as No. 1."

Comments by W. E. Joseph.—"No. 5 has the thickest external fat. Very little difference between Nos. 1 and 16. The fat of No. 1 is perhaps a trifle thicker than that of No. 16. The differences in lean meat are not very striking. Tenderloin muscles of No. 1 seem to be the smallest, while those of Nos. 5 and 16 are very full and large."

Comments by R. H. Williams.—"No. 1 is the shortest pig of the three. The fat of No. 1 seems to be a little dry. Pig No. 5, tho not as long as No. 16, is fatter, particularly over the loin and back, and carries less lean meat in proportion to fat. Pig 16 is the longest of the lot and has less fat and more lean meat than Pig 5."

Summary.—The dressed carcass of Pig 1 had less fat on the sides, brisket, and flanks, than the dressed carcasses of the pigs of Lots II and III. The chief physical difference between the related pigs of Lots I, II, and III seems to have been in the length of the body, which varied directly as the amount of protein fed. The kidneys of all the pigs were well covered with fat. Nos. 1, 7, and 13 were classed as "light loin" or "shipper," No. 5 as "light butcher," and No. 16 as "medium butcher."

JUDGING OF CROSS-SECTIONS OF HALF-CARCASSES

When the halves were taken out of cold storage, cross-sections[1] were made at the fifth rib. The cross-sections were judged under the direction of Professor Hall, and the notes recorded were as follows:

Comments by L. D. Hall.—"No. 1 is very soft in both fat and lean. The fat is of a darker color than that of the others. No. 5 is considerably softer in fat and lean than No. 7. The meat of No. 7 is probably the firmest of the meats of the five pigs. On the whole, No. 16 is firmer than No. 5, and No. 13 firmer than No. 16. No. 13 is superior to No. 16 in color. The bones of the different half-carcasses are very much alike except that those of No. 1 are lighter in color and apparently harder than the others. The marrow of the bones, except that of No. 1, is reddish."

[1]See Fig. 6 in Appendix, page 133.

Comments by W. E. Joseph.—"The arrangement of the pigs in order of decreasing thickness of the layer of fat is as follows: Nos. 5, 16, 7, 13, and 1. No. 1 is quite thin. Nos. 5 and 16 appear to have a trifle the most lean. Not much difference between Nos. 5 and 16. No. 1 shows nearly as much lean as Nos. 7 and 13, and, since it has less fat, its lean shows up better. No. 13 has a trifle more lean than No. 7. In order of decreasing intensity of the color of their flesh, the pigs may be arranged as follows: Nos. 7, 5, 13, 16, and 1. The fat of No. 1 is darker than that of any of the others. No decided difference in color of fat of the others."

Comments by R. H. Williams.—"No. 7 is fatter than No. 13. From the fat covering the ribs, along the back, and especially in the belly, this animal seems to have been in the higher condition. No. 7 has as much lean as No. 13. General grading:—in order of decreasing length, 16, 5, 13, 7, and 1; in order of decreasing condition, 5, 16, 7, 13, and 1; in order of decreasing firmness, 7, 13, 16, 5, and 1. Of Pigs 16, 5, and 1, No. 16 has the smoothest and the best carcass and seems to be much firmer than either of the others. The color of the fat and lean meat does not vary much in any of them. If anything, the lean meat of Nos. 13 and 16 is somewhat the brightest in color. No. 1 is darker in both lean and fat."

Summary.—From the above comments upon the cross-sections of the carcasses, it seems probable that the carcass of Pig 1 of Lot I differed somewhat from the carcasses of the animals of the two other groups, as follows: first, both its fat and its lean were darker in color; second, its fat was softer; and third, the marrow of its bones was not as deep a red. As regards Lots II and III, no definite lot differences between the cross-sections of their respective animals was apparent.

MEASUREMENTS OF CROSS-SECTIONS OF HALF-CARCASSES

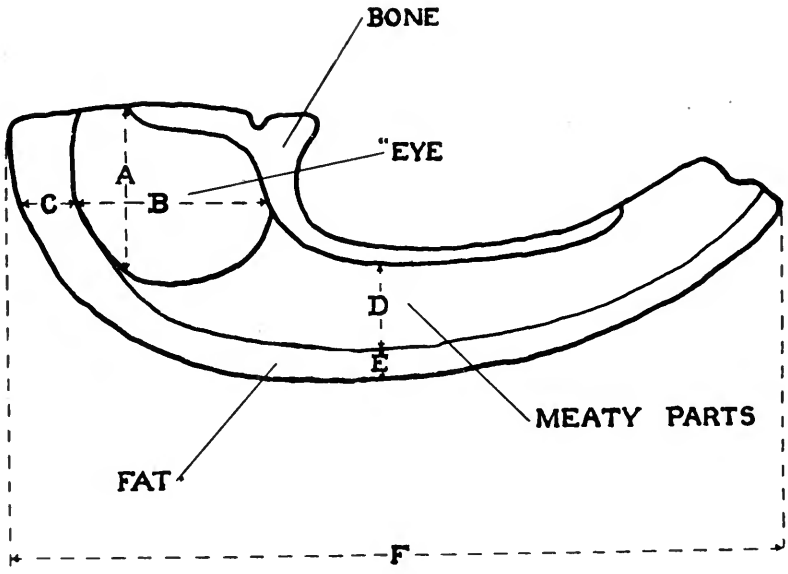
The cross-sections made at the fifth rib were measured in the manner indicated on page 100. Altho the measurements were taken carefully, they were, at the same time, more or less arbitrary.

From the values given in Table 8, it is evident that, as a rule, the differences between the animals within the lots were as great as, or greater than, those between the lots. There were three exceptions to this statement, i. e., measurements C, E, and F in the case of Pig 1 of Lot I, which were lower than any of those given for the pigs in Lots II and III. Thus, the distance C was 3.6 centimeters for Pig 1 as compared with 5.6 and 5.5 centimeters, the averages of Lots II and III, respectively; the distance E, 2.4 centimeters for Pig 1 as compared with 3.3 and 3.2 centimeters for Lots II and III; and the distance F, 36.0 centimeters for Pig 1 as

TABLE 8.—MEASUREMENTS OF CROSS-SECTIONS OF HALF-CARCASSES

(Results expressed in centimeters)

Pig	Lot	A	B	C	D	E	F
1	I	5.8	9.3	3.6	2.9	2.4	36.0
5	II	5.4	10.4	5.3	4.3	3.2	42.0
7	II	6.3	9.0	6.0	3.2	3.4	40.0
Average	II	5.8	9.7	5.6	3.7	3.3	41.0
16	III	6.1	9.0	5.5	4.0	3.6	40.3
13	III	5.5	8.7	5.5	3.0	2.9	39.0
Average	III	5.8	8.8	5.5	3.5	3.2	39.6



CROSS-SECTION OF SIDE CUT AT FIFTH RIB

A—height of "eye" below bone
B—width of "eye"
C—thickness of fat and skin
D—thickness of meaty parts
E—thickness of fat and skin
F—extreme length of cross-section

compared with 41.0 and 39.6 centimeters for Lots II and III. It is thus apparent that the cross-section of the side of Pig 1 showed less fat than the cross-sections of the four other pigs, tho practically the same amount of lean.

WEIGHTS OF PIGS, DRESSED CARCASSES, AND CUTS OF PORK

From the data presented in Tables 9 and 10, it is quite apparent that there were no significant differences between the fasted live weights, the net live weights, the weights of the dressed carcasses, or the cuts of pork from the right and left halves of the pigs of the different lots, other than those due to differences in the live weights of the animals when slaughtered. In other words, the weights of the dressed carcasses and the cuts of pork varied in general directly with the live weight.

On comparing the weights of corresponding cuts from the two sides of the same animal, it will be seen that they agreed fairly well. For example, with Pig 1 the corresponding left and right shoulder, side, and ham cuts weighed 17.74 and 17.22, 30.36 and 29.40, and 13.36 and 14.80 pounds, respectively. The data for the three cuts in the case of all five animals show that the weight of the ham cut was the smallest, the weight of the shoulder cut slightly greater, and the weight of the side cut about twice the weight of the ham.

The percentages for the net live weights given in Table 10 show that the contents of the digestive tract made up about 2.8 percent of the live weight. The carcass of Pig 16 dressed the highest, and that of Pig 13 of the same lot, the lowest, the values being 73.13 and 68.67 percent, respectively. In Lot II, Pig 7 dressed out higher than Pig 5, while in Lot III, Pig 16 dressed higher than Pig 13. The difference within Lot II was not so great as that in Lot III. The carcass of Pig 1 dressed 71.04 percent, a value about the average for the other two lots.

The data show that the percentages of the ham and shoulder cuts of Pig 1 were among the highest, while the values for the side cut were among the lowest. The average percentages of the right and left cuts for the three lots as a whole were, respectively: for the ham, 8.05 and 7.71; for the shoulder, 9.71 and 10.10; and for the side, 17.99 and 17.59.

TABLE 9.—WEIGHTS OF PIGS, DRESSED CARCASSES, AND CUTS OF PORK

(Results expressed in pounds)

Animal	Lot	Fasted live weight	Net[1] live weight	Dressed carcass	Cuts from right half			Cuts from left half		
					Ham	Shoulder	Side	Ham	Shoulder	Side
1	I	173.0	169.1	122.9	14.80	17.22	29.40	13.36	17.74	30.36
5	II	238.6	232.2	169.1	18.20	22.64	44.24	18.19	21.05	44.81
7	II	195.2	188.8	140.7	15.52	19.23	35.82	15.58	21.56	33.08
Average	II	216.9	210.5	154.9	16.86	20.93	40.03	16.88	21.25	38.94
16	III	240.8	235.2	176.1	20.30	23.54	45.46	18.62	25.26	42.92
13	III	181.6	175.6	124.7	14.00	17.24	31.20	13.66	17.96	30.60
Average	III	211.2	205.4	150.4	17.15	20.39	38.33	16.14	21.61	36.76
Average	All	205.8	200.2	146.7	16.56	19.97	37.22	15.88	20.71	36.35
26	IV	61.0	58.4	.....	.....	.....	.....	.....	.....	.....
44	IV	54.7	52.5	.....	.....	.....	.....	.....	.....	.....
Average	IV	57.8	55.4	.....	.....	.....	.....	.....	.....	.....

TABLE 10.—RELATION OF WEIGHTS OF PIGS, DRESSED CARCASSES, AND CUTS OF PORK TO FASTED LIVE WEIGHT

(Results expressed in percent)

Animal	Lot	Net[1] live weight	Dressed carcass	Cuts from right half			Cuts from left half		
				Ham	Shoulder	Side	Ham	Shoulder	Side
1	I	97.75	71.04	8.55	9.95	16.99	7.72	10.25	17.55
5	II	97.32	70.87	7.63	9.49	18.54	7.62	8.82	18.78
7	II	96.72	72.08	7.95	9.85	18.35	7.98	11.05	16.95
Average	II	97.02	71.47	7.79	9.67	18.44	7.80	9.95	17.86
16	III	96.67	73.13	8.43	9.78	18.88	7.73	10.49	17.82
13	III	96.70	68.67	7.71	9.49	17.18	7.52	9.89	16.85
Average	III	97.18	70.90	8.07	9.63	18.03	7.62	10.19	17.33
Average	All	97.23	71.16	8.05	9.71	17.99	7.71	10.10	17.59
26	IV	95.74	55.11	.....	.....	.....	.....	.....	.....
44	IV	95.97	55.08	.....	.....	.....	.....	.....	.....
Average	IV	95.85	55.09	.....	.....	.....	.....	.....	.....

[1]Fasted live weight less weight of contents of digestive tract.

WEIGHTS OF BONELESS MEAT, SKELETON, FATS, AND OFFAL

From the data given in Table 11, it is apparent that the weight of the boneless meat in the cuts varied directly with the net live weight. That is, the weights of the meat in the cuts from Pigs 5 and 16 were greater than those for the cuts of Pigs 7 and 13. The values for Pig 1 corresponded to those for Pig 13. The weights for

Pig 7 were a little higher than those for Pigs 1 and 13. The average values for all five pigs for the boneless meat were as follows: ham, 27.58 pounds; shoulder, 34.54 pounds; and side cut, 62.98 pounds.

The weights of the skeletons of the different animals varied decidedly. For example, in Lot III, the skeleton of Pig 13 weighed 16.96 pounds, and that of Pig 16, 20.88 pounds. The weight of the skeleton of Pig 1 was more nearly like the weights of the skeletons of Pigs 7 and 13, and much less than those of the skeletons of Pigs 5 and 16. The average weight for all five pigs was 18.68 pounds. The differences within Lots II and III were greater than those between them.

In the case of Pig 1, the leaf, intestinal, and composite fats weighed less than those from Pigs 5 and 16, but more than those from Pigs 7 and 13. Taking the average of the weights for the pigs in Lots II and III, the intestinal and composite fats were higher, and the leaf fat lower, than those for Pig 1.

The weights of the composite offal show that there was practically no difference between Lots II and III, and that the values for Pig 1 were lower than those of any other animal in the experiment. The average weight of the composite offal for all five pigs was 38.09 pounds.

With the weights of the parts of the five pigs in Table 11 are presented also those for the two pigs that were slaughtered for a control at the beginning of the experiment. The differences between the values for these two animals in some instances were marked.

Table 12 gives the weights of the various parts of the carcasses in percent of the net live weight. It will be noted that the differences between Lots II and III were slight, while the differences between the individual pigs were in some instances great. In the case of Pig 1, the values for the boneless meat of the ham and shoulder cuts, for the intestinal and composite fats, and for the composite offal were intermediate between those for the pigs of one or both of the other lots, and the values for the ham, shoulder, and offal were very nearly the same as the average values for Lots II and III. The value of the side cut for Pig 1 agreed with the corresponding values for Pigs 7 and 13. The skeleton of Pig 1 was the heaviest in relation to the net live weight, and the skeletons of Nos. 5 and 16, the lightest. Pig 1 had the highest percentage of leaf fat, i. e., 4.36 percent. The averages for Lots II and III, respectively, were 3.08 and 3.13 percent.

Referring to the data for the pigs of Lot IV, it will be of interest to note that the values for the skeletons were almost the same as those for the older and more mature pigs; the percentages of leaf and composite fat, much lower; and the percentage of composite offal, higher.

TABLE 11.—WEIGHTS OF BONELESS MEAT, SKELETON, FATS, AND OFFAL

(Results expressed in pounds)

Animal	Lot	Boneless Meat				Skeleton	Fats			Composite offal	Loss and error in slaughtering
		Ham	Shoulder	Side	Dressed carcass		Leaf	Intestinal	Composite		
1	I	23.04	29.28	49.78	102.1	17.87	7.36	3.04	12.04	32.45	4.64
5	II	31.53	37.17	77.86	146.5	19.75	9.25	4.08	16.85	44.36	4.74
7	II	26.46	35.55	58.18	120.2	17.95	4.10	2.15	9.91	35.41	5.33
Average	II	28.99	36.36	68.02	133.4	18.85	6.68	3.11	13.38	39.88	5.03
16	III	33.52	41.16	76.22	150.9	20.88	7.96	4.40	16.31	42.67	4.44
13	III	23.34	29.56	52.88	105.8	16.96	5.07	2.86	11.70	35.56	5.58
Average	III	28.43	35.36	64.55	128.3	18.92	6.51	3.63	14.00	39.11	5.01
Average	All	27.58	34.54	62.98	125.1	18.68	6.75	3.31	13.36	38.09	4.95
26	IV	.....	.....	.....	28.7	5.60	0.39	.....	0.69	20.07	3.34
44	IV	.....	.....	.....	25.5	4.37	0.55	.....	0.82	18.28	3.53
Average	IV	.....	.....	.....	27.1	4.98	0.47	.....	0.75	19.17	3.43

TABLE 12.—RELATION OF WEIGHTS OF BONELESS MEAT, SKELETON, FATS, AND OFFAL TO NET LIVE WEIGHT

(Results expressed in percent)

Animal	Lot	Boneless meat				Skeleton	Fats			Composite offal	Loss and error in slaughtering
		Ham	Shoulder	Side	Dressed carcass		Leaf	Intestinal	Composite		
1	I	13.63	17.32	29.41	60.39	10.58	4.36	1.80	7.12	19.19	2.74
5	II	13.58	16.01	33.53	63.12	8.51	3.99	1.76	7.26	19.10	2.04
7	II	14.01	18.83	30.82	63.64	9.50	2.17	1.14	5.25	18.76	2.82
Average	II	13.79	17.42	32.17	63.38	9.00	3.08	1.45	6.25	18.93	2.43
16	III	14.25	17.50	32.41	64.16	8.88	3.38	1.87	6.94	18.14	1.89
13	III	13.29	16.83	30.11	60.24	9.65	2.89	1.63	6.66	20.25	3.18
Average	III	13.77	17.16	31.26	62.20	9.26	3.13	1.75	6.80	19.19	2.53
Average	All	13.75	17.30	31.26	62.31	9.42	3.36	1.64	6.65	19.09	2.53
26	IV	.....	.....	.....	51.35	9.59	0.66	.....	1.34	34.38	5.72
44	IV	.....	.....	.....	50.97	8.33	1.04	.....	1.84	34.82	6.72
Average	IV	.....	.....	.....	51.16	8.96	0.85	.....	1.60	34.60	6.22

WEIGHTS OF BLOOD AND RESPIRATORY AND DIGESTIVE ORGANS

From the data in Table 13, it will be seen that the weights of the blood for the pigs in Lots II and III varied considerably, those for Nos. 7 and 13 being lower than those for Nos. 5 and 16. The differences between the corresponding pigs of these two lots, however, were slight. The weight of the blood of Pig 1 was lower than that for any of the animals of Lots II and III. It corresponded more nearly to the values for Pigs 7 and 13, but was about 0.9 pound less. Calculated on the basis of the net live weight, the amount of blood for the five pigs was fairly constant, ranging from 2.89 percent for Pig 5 to 3.38 percent for Pig 13, with an average for all of 3.15 percent.

The weights of the respiratory organs seemed to be fairly uniform for the pigs in Lots II and III. The differences within the lots were greater than those between them. In the case of Lots I and II, the value for Pig 1 of Lot I was about the same as that for Pig 7 of Lot II. That the differences within Lots II and III were greater than those between the lots is shown also by the data expressed in percent of the net live weight.

In the case of the digestive organs, the weights of the stomach for the pigs of Lots II and III were uniform both within the lots and between them. The average weight for Lot II was 1.28 pounds, and that for Lot III, 1.31 pounds. The weights of the small and large intestines of the pigs on the medium- and high-protein rations showed considerable difference within the lots. On the other hand, the average data for these lots as a whole agreed quite closely, being 2.19 and 2.21 pounds for the small intestines, and 2.10 and 2.07 pounds, respectively, for the large intestines. The average total weights of the digestive organs for Lots II and III were almost exactly alike, being 5.58 and 5.59 pounds, respectively. The differences between the pigs, however, were noticeable, the value for Pig 7 being 0.83 pound less than that for Pig 5, and that for Pig 13, 0.87 pound more than that for Pig 16. The weight of the stomach of Pig 1 on the low-protein ration was distinctly less than the weights of the stomachs of the pigs on the medium- and high-protein rations. In the case of the intestines, the lot differences were insignificant.

The weights of the blood and the small and large intestines for the pigs of the control lot, No. IV, were very much lower than those for the pigs of Lots I, II, and III. The weights of the respiratory organs and the stomach were slightly less than those for Lot I, and considerably less than those for Lots II and III.

Calculated on the basis of the net live weight, the weights of the respiratory organs and the digestive organs show differences within the lots greater than those between them. This seems true especially in connection with Lot III. If the results for the individual pigs of

Lot III are compared with the corresponding data for Lot II, it will be noted that the values for the small and large intestines of Pig 16 were very low, while those for Pig 13 were correspondingly high. Apparently the values for the blood of Lot III were significantly higher than those of the other lots.

The values for the pigs of Lot IV were distinctly different from those of Lots I, II, and III. The percentage of blood was 4.98, or about 50 percent greater than the values for the other pigs, while the values for the respiratory organs, the stomachs, and the small and large intestines were all about twice as great as those for the pigs in the other lots.

TABLE 13.—WEIGHTS OF BLOOD AND RESPIRATORY AND DIGESTIVE ORGANS

(Results expressed in pounds)

Animal	Lot	Blood	Respiratory (lungs, etc.)	Digestive organs			Total
				Stomach	Intestines		
					Small	Large	
1	I	5.01	1.03	0.97	1.746	2.065	4.781
5	II	8.05	1.29	1.28	2.374	2.344	6.000
7	II	5.94	1.08	1.29	2.011	1.867	5.168
Average	II	6.99	1.18	1.28	2.192	2.105	5.584
16	III	7.03	1.17	1.32	1.860	1.974	5.155
13	III	5.93	1.48	1.30	2.556	2.168	6.024
Average	III	6.48	1.32	1.31	2.208	2.071	5.589
26	IV	2.86	0.89	0.78	1.482	1.016	3.278
44	IV	2.66	0.73	0.69	1.293	1.109	3.092
Average	IV	2.76	0.81	0.73	1.387	1.062	3.185

TABLE 14.—RELATION OF WEIGHTS OF BLOOD AND RESPIRATORY AND DIGESTIVE ORGANS TO NET LIVE WEIGHT

(Results expressed in percent)

Animal	Lot	Blood	Respiratory (lungs, etc.)	Digestive organs			Total
				Stomach	Intestines		
					Small	Large	
1	I	2.96	0.610	0.575	1.033	1.221	2.829
5	II	2.89	0.556	0.552	1.023	1.010	2.585
7	II	3.18	0.569	0.684	1.065	0.989	2.738
Average	II	3.03	0.562	0.618	1.044	0.999	2.661
16	III	3.54	0.498	0.562	0.791	0.839	2.192
13	III	3.38	0.844	0.740	1.455	1.235	3.430
Average	III	3.36	0.671	0.651	1.123	1.037	2.811
26	IV	4.91	1.531	1.330	2.539	1.741	5.610
44	IV	5.06	1.386	1.323	2.464	2.112	5.899
Average	IV	4.98	1.458	1.326	2.501	1.926	5.754

WEIGHTS OF HEART, LIVER, SPLEEN, PANCREAS, GALL BLADDER, AND TONGUE

The weights of the heart, liver, spleen, pancreas, gall bladder, and tongue will be found in Table 15. These also varied apparently directly with the live weights. Thus, in Lots II and III, the values for Pigs 5 and 16 ran higher than those for the lighter pigs, Nos. 7 and 13. Likewise, the values for the pig in Lot I compared more favorably with those for Pigs 7 and 13 than with those for Pigs 5 and 16. Between the corresponding pigs of Lots II and III, there was very little difference. The organs of Pig 1 on the low-protein ration did not develop to the same extent as those of Nos. 5 and 16 of Lots II and III, to which Pig 1 was most closely related. On the contrary, they were most nearly like those of Pigs 7 and 13, tho the weight of the liver was distinctly less.

Expressed in percent of the net live weight, the results for Lots I, II, and III were very close, except in the case of the liver of Pig 1, which was apparently lower than the corresponding weights for Lots II and III. The differences between the values within the lots, altho small, were greater than those between the lots. In the case of the heart, there was a slight suggestion that the weights varied inversely with the amount of protein fed.

A comparison of the data for Lot IV with those for Lots II and III will show that in the case of the younger pigs the average weight of the heart was about one-third to one-half as great as the corresponding weights for the older pigs, the weight of the liver about one-half as great, the weight of the spleen from one-third to one-half as

TABLE 15.— WEIGHTS OF THE HEART, LIVER, SPLEEN, PANCREAS, GALL BLADDER, AND TONGUE

Animal	Lot	Heart	Liver	Spleen	Pancreas	Gall bladder	Tongue
		oz.	*lbs.*	*oz.*	*oz.*	*oz.*	*oz.*
1	I	9.496	2.159	3.122	2.974	0.215	8.183
5	II	12.760	3.622	4.159	4.332	0.233	7.623
7	II	9.887	3.002	2.501	4.349	0.219	7.379
Average	II	11.323	3.312	3.330	4.340	0.226	7.501
16	III	11.400	3.677	4.014	2.832	0.282	8.497
13	III	8.617	2.758	3.203	3.369	0.123	7.175
Average	III	10.008	3.217	3.608	3.100	0.202	7.836
26	IV	4.250	1.637	1.464	2.547	0.339	6.554
44	IV	3.947	1.626	0.988	1.855	0.360	5.743
Average	IV	4.098	1.631	1.226	2.201	0.349	6.148

great, the weight of the pancreas from one-tenth to one-half as great, the weight of the gall bladder from one and two-tenths to three times as great, and the weight of the tongue about three-fourths as great.

TABLE 16.—RELATION OF WEIGHTS OF HEART, LIVER, SPLEEN, PANCREAS, GALL BLADDER, AND TONGUE TO NET LIVE WEIGHT

(Results expressed in percent)

Animal	Lot	Heart	Liver	Spleen	Pancreas	Gall bladder	Tongue
1	I	0.351	1.277	0.115	0.110	0.008	0.303
5	II	0.344	1.560	0.112	0.117	0.006	0.205
7	II	0.327	1.590	0.083	0.144	0.007	0.244
Average	II	0.335	1.575	0.097	0.130	0.006	0.224
16	III	0.303	1.563	0.107	0.075	0.007	0.226
13	III	0.307	1.571	0.114	0.120	0.004	0.255
Average	III	0.305	1.567	0.110	0.097	0.005	0.240
26	IV	0.455	2.806	0.157	0.273	0.036	0.702
44	IV	0.470	3.097	0.118	0.221	0.043	0.684
Average	IV	0.462	2.951	0.137	0.247	0.039	0.693

WEIGHTS OF URINARY ORGANS AND ORGANS OF CENTRAL NERVOUS SYSTEM

From the data given in Table 17, it will be seen that the weights of the kidneys of the low-protein lot were from 40 to 50 percent lower than those of the pigs of Lots II and III. On comparing the results for the pigs on the medium- and the high-protein rations, it will be noted that the differences within the lots were greater than those between them. The differences between Lots II and III were insignificant also in the case of the weights of the other urinary organs and the organs of the central nervous system. The weights of the kidneys, bladder, and spinal cord of the control pigs, Nos. 26 and 44, were considerably lower than those of Lots II and III, tho the weights of their brains were almost the same.

Expressed in percent of the net live weight, the data for the three lots show that the individual variations, excepting those for the kidneys (page 96), were greater than the lot variations. In the case of the pigs of the control lot, the percentage values for the kidneys, brains, and spinal cord were higher than those for the older and more mature pigs.

TABLE 17.—WEIGHTS OF URINARY ORGANS AND ORGANS OF CENTRAL NERVOUS SYSTEM

(Results expressed in ounces)

Animal	Lot	Urinary organs			Nerve centers		
		Kidneys	Bladder, etc.	Total	Brain	Spinal cord	Total
1	I	5.559	8.504	14.063	3.129	2.067	5.196
5	II	10.470	8.755	19.225	3.831	1.831	5.662
7	II	9.086	5.820	14.906	3.683	1.915	5.598
Average	II	9.778	7.287	17.065	3.757	1.873	5.630
16	III	11.560	8.882	20.442	3.372	1.718	5.090
13	III	8.889	7.429	16.318	1.683	2.166	3.849
Average	III	10.224	8.155	18.380	2.527	1.942	4.469
26	IV	3.735	1.693	5.428	3.072	0.935	4.007
44	IV	4.039	1.601	5.640	2.882	0.938	3.820
Average	IV	3.887	1.647	5.534	2.977	0.936	3.913

TABLE 18.—RELATION OF WEIGHTS OF URINARY ORGANS AND ORGANS OF CENTRAL NERVOUS SYSTEM TO NET LIVE WEIGHT

(Results expressed in percent)

Animal	Lot	Urinary organs			Nerve centers		
		Kidney	Bladder, etc.	Total	Brain	Spinal cord	Total
1	I	0.206	0.314	0.520	0.116	0.076	0.192
5	II	0.281	0.236	0.517	0.103	0.049	0.152
7	II	0.301	0.193	0.494	0.122	0.063	0.185
Average	II	0.291	0.214	0.505	0.112	0.056	0.168
16	III	0.307	0.236	0.543	0.090	0.046	0.136
13	III	0.316	0.264	0.580	0.120	0.077	0.197
Average	III	0.311	0.250	0.561	0.105	0.061	0.166
26	IV	0.400	0.181	0.581	0.329	0.100	0.429
44	IV	0.481	0.191	0.672	0.343	0.112	0.455
Average	IV	0.440	0.186	0.626	0.336	0.106	0.442

WEIGHTS OF MISCELLANEOUS PARTS

In Table 19 will be found the weights of the miscellaneous parts of the carcasses—the head, feet, tail, and skin, hair, and toes. These data are of interest chiefly from the standpoint of the completeness of the record for the entire bodies of the slaughtered pigs. The data for Pig 1 were slightly the lowest in the case of the head, feet, and tail. Between the corresponding animals of Lots II and III, the differences

were comparatively slight. The lot averages were nearly the same. Figured on the basis of the net live weight, the data indicate that the weights of the different parts were fairly close, and that the differences within the lots were greater than those between them.

TABLE 19.—WEIGHTS OF MISCELLANEOUS PARTS

(Results expressed in pounds)

Animal	Lot	Head	Feet	Tail	Skin, hair, and toes
1	I	14.68	3.299	0.131	10.556
5	II	19.62	3.804	0.188	12.849
7	II	15.13	3.547	0.187	11.196
Average	II	17.37	3.675	0.187	12.022
16	III	19.27	4.168	0.198	14.542
13	III	15.85	3.425	0.191	9.727
Average	III	17.56	3.796	0.194	12.134

TABLE 20.—RELATION OF WEIGHTS OF MISCELLANEOUS PARTS TO NET LIVE WEIGHT

(Results expressed in percent)

Animal	Lot	Head	Feet	Tail	Skin, hair, and toes
1	I	8.68	1.95	0.077	6.24
5	II	8.45	1.64	0.081	5.53
7	II	8.01	1.88	0.099	5.93
Average	II	8.23	1.76	0.090	5.73
16	III	8.19	1.77	0.084	6.18
13	III	9.03	1.95	0.109	5.54
Average	III	8.61	1.86	0.096	5.86

PHYSICAL MEASUREMENTS OF LEG BONES[1]

The weights, lengths, diameters, and breaking strengths were determined for the bones in the green state. The bones used were those from the left hind leg of Pig 5 and from both of the hind legs of

[1]The authors wish hereby to acknowledge their indebtedness to Mr. Carl Christopher for carrying out much of the detailed work on the physical measurements of the bones. They are indebted also to Messrs. W. A. Slater and D. A. Abrams of the Department of Theoretical and Applied Mechanics of the College of Engineering for generous assistance and advice in carrying out these measurements. To Mr. Slater special acknowledgment is due for calculating the moduli of rupture and the section moduli.

each of the four other pigs. In removing the flesh from the bones in preparing them for these determinations, care was taken to avoid cutting the periosteum.

The weights were recorded in grams. The lengths and the minimum diameters of the bone shafts were obtained with a micrometer, the values given being the averages of three readings. The breaking strengths were obtained with an Olsen testing machine, the usual precautions being taken to place bones of the same kind in the same position in the machine, to measure the span, and to observe the direction in which the load was applied.

Weights of the Bones.—From the data in Table 21, it is quite evident that the weights of the bones of the pigs in Lots II and III were very nearly the same. The data fall into two groups, the bones of Pigs 5 and 16 having been distinctly heavier than those of Pigs 7 and 13. In general, the weights of the humerus and femur of Pig 1, which was a litter mate of Pig 5 and by the same sire as Pig 16, corresponded much more closely to those of Pigs 7 and 13 than to those of Pigs 5 and 16, while the weights of the tibia agreed much more closely with those of Pigs 5 and 16. The average values for Lots II and III were 220 and 223 grams, respectively, and the value for Pig 1, 202 grams.

Lengths and Diameters of the Bones.—The data for the lengths of the leg bones given in Table 22 show only slight differences between the individual pigs and the lots. The diameters of the bones, expressed in inches, are given in Table 23. As in the case of the weights, it is quite apparent that these measurements for the younger pigs, Nos. 7 and 13, were significantly less than those for the older pigs, Nos. 5 and 16. Unlike the weights, the diameters of the bones of Pig 1 were generally higher than the corresponding diameters of Pigs 7 and 13, and midway between those of Pigs 5 and 16.

Breaking Strengths of the Bones.—The data for the breaking strengths of the leg bones are given in Tables 24 and 25. Again, as in the case of the weights and diameters of the bones, it is quite evident that the breaking strengths of the bones of the animals of Lots II and III fall into two groups, the bones of the older and heavier pigs, Nos. 5 and 16, having been much stronger than those of the younger pigs, Nos. 7 and 13. In all cases the breaking strengths of the bones for Pig 1 were distinctly less than those for any of the other pigs. Calculated on the basis of 100 pounds live weight, the data again show that the bones of Pig 1 had the lowest breaking strength, altho the differences noted within Lots II and III were not significant. If the data for the live weights of the pigs (Table 9) are compared with those for the breaking strengths (Table 24) with respect to the x and y axes, the resulting curves will show that the strength of the bones increased in the following order: Pigs Nos. 1, 13, 7, 16, and 5. That is, Pig 1 of Lot I had the weakest bones of all, and, while for

Lots II and III the strength of the bones increased in general with the live weight, the bones from the pigs of Lot II were stronger than those from the corresponding pigs of Lot III.

Figs 7 and 8[1] in the Appendix show the appearance of the cross-sections of the leg bones nearest the point of breaking. It is suggested by these figures that the bones of the pig on the low-protein ration had the thinnest walls and the largest spaces for marrow, while those of the pigs on the high-protein ration had the smallest diameters, the thickest walls, and the smallest spaces for marrow.

Moduli of Rupture of the Bones.—The modulus of rupture is a measure of the quality of the bone material—the higher the value, the better the quality of the bone. From the data given in Table 26, it will be noted that there were frequently marked differences between the right and left bones of the same and different animals. If the averages for the three kinds of bones are considered, it seems apparent that the quality of the leg bones of Pig 1 was probably somewhat significantly inferior to that of the four other pigs. Also, considering the averages, it seems probable that the differences between the individuals, and the lot differences exhibited by the medium- and high-protein lots were insignificant.

Section Moduli of the Bones.—The section moduli represent a measure of the economy of distribution of the material with reference to the axis of the section thru which the load is applied, provided corresponding axes are chosen for each test. From the data given in Tables 27 and 28, it is apparent that the average differences in these results were in general similar to those shown by the weights, the diameters, and the breaking strengths. That is, the older and heavier pigs, Nos. 5 and 16 of Lots II and III, respectively, showed higher values than the younger and lighter pigs, Nos. 7 and 13, of the same two lots, while the value for Pig 1 of Lot I, the lowest, corresponded more closely to the values for the younger pigs, Nos. 7 and 13, than to those for the older pigs. However, in some instances there were marked differences between the right and left bones, while in the average results for the three bones there were very pronounced differences between the values for the different pigs within the lots.

Calculated on the basis of 100 pounds live weight, the data show that the section moduli tended to become constant. In other words, the economic distribution of the bone material with respect to strength increased as the pigs became heavier, regardless of the differences in the rations.

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[1]See Appendix, pages 134 and 135.

TABLE 21.—WEIGHTS OF LEG BONES
(Results expressed in grams)

Pig	Lot	Humerus			Tibia			Femur			Average		
		Right	Left	Average	Right	Left	Average	Right	Left	Average	Right	Left	Average
1	I	202	199	201	168	168	168	234	238	236	201	202	202
5	II	260	...	260	174	...	174	274	...	274	236	...	236
7	II	220	222	221	147	150	149	241	248	244	203	207	205
Average	II	240	...	241	160	...	161	248	...	259	219	...	220
16	III	276	264	270	181	173	177	285	285	285	247	241	244
13	III	220	205	212	147	154	151	247	238	243	205	199	202
Average	III	248	234	241	164	164	164	266	262	264	226	220	223

TABLE 22.—LENGTHS OF LEG BONES
(Results expressed in inches)

Pig	Lot	Humerus			Tibia			Femur			Average		
		Right	Left	Average	Right	Left	Average	Right	Left	Average	Right	Left	Average
1	I	6.4	6.4	6.4	6.6	6.6	6.6	7.2	7.2	7.2	6.7	6.7	6.7
5	II	6.5	...	6.5	5.9	...	5.9	7.2	...	7.2	6.5	..	6.5
7	II	6.5	6.5	6.5	6.0	6.1	6.0	7.1	7.2	7.1	6.5	6.6	6.5
Average	II	6.5	...	6.5	5.9	...	5.9	7.1	...	7.1	6.5	...	6.5
16	III	6.6	6.6	6.6	6.5	6.2	6.3	7.5	7.5	7.5	6.9	6.8	6.8
13	III	6.3	6.3	6.3	6.0	6.3	6.1	7.1	7.1	7.1	6.5	6.6	6.5
Average	III	6.4	6.4	6.4	6.2	6.2	6.2	7.3	7.3	7.3	6.7	6.7	6.6

TABLE 23.—DIAMETERS OF LEG BONES

(Results expressed in inches)

Pig	Lot	Humerus			Tibia			Femur			Average		
		Right	Left	Average	Right	Left	Average	Right	Left	Average	Right	Left	Average
1	I	0.804	0.800	0.802	0.755	0.733	0.744	0.950	0.955	0.952	0.836	0.829	0.833
5	II	0.900	....	0.900	0.904	....	0.904	0.975	....	0.973	0.926	....	0.926
7	II	0.550	0.770	0.660	0.720	0.722	0.722	0.911	0.915	0.913	0.727	0.803	0.765
Average	II	0.725	....	0.780	0.812	....	0.813	0.943	....	0.944	0.826	....	0.845
16	III	0.836	0.849	0.842	0.715	0.759	0.737	0.920	0.933	0.926	0.824	0.847	0.835
13	III	0.756	0.745	0.750	0.705	0.680	0.692	0.890	0.890	0.890	0.784	0.773	0.777
Average	III	0.796	0.717	0.796	0.710	0.719	0.714	0.905	0.911	0.908	0.804	0.809	0.806

TABLE 24.—BREAKING STRENGTHS OF LEG BONES

(Results expressed in pounds)

Pig	Lot	Humerus			Tibia			Femur			Average		
		Right	Left	Average	Right	Left	Average	Right	Left	Average	Right	Left	Average
1	I	820	800	810	687	594	640	466	455	460	658	616	637
5	II	1740	....	1740	1368	...	1368	786	...	786	1298	...	1298
7	II	1160	1070	1135	802	771	786	537	494	515	833	778	805
Average	II	1450	....	1427	1085	...	1077	661	...	650	1065	...	1052
16	III	1320	1445	1382	970	972	971	742	706	724	1011	1041	1026
13	III	1140	1067	1104	758	715	736	560	562	564	821	782	801
Average	III	1230	1256	1243	864	843	853	654	634	644	916	911	914

TABLE 25.—BREAKING STRENTHS OF LEG BONES

(Results expressed in pounds per 100 pounds live weight)

Pig	Lot	Humerus			Tibia			Femur			Average		
		Right	Left	Average	Right	Left	Average	Right	Left	Average	Right	Left	Average
1	I	474.0	462.4	468.2	397.1	343.4	370.2	269.4	263.0	266.2	380.3	356.1	368.2
5	II	729.3	....	729.3	573.3	....	573.3	329.4	....	329.4	544.0	....	544.0
7	II	594.3	548.2	571.2	410.9	395.0	402.9	275.1	253.1	264.1	426.7	398.6	412.6
Average	II	661.8	....	650.2	492.1	....	488.1	302.2	....	296.7	485.3	....	478.3
16	III	548.2	600.1	574.1	402.8	403.7	403.2	308.1	293.2	300.6	419.9	432.3	426.1
13	III	627.8	587.6	607.7	417.4	393.7	405.5	311.7	309.5	310.6	452.1	430.6	441.3
Average	III	588.0	593.8	590.9	410.1	398.7	404.3	309.9	301.3	305.6	436.0	431.4	433.7

TABLE 26.—MODULI OF RUPTURE OF LEG BONES

(Results expressed in thousands of pounds per square inch of bone area)

Pig	Lot	Humerus			Tibia			Femur			Average		
		Right	Left	Average	Right	Left	Average	Right	Left	Average	Right	Left	Average
1	I	10.9	12.4	11.6	14.6	15.5	15.0	12.3	10.5	11.4	12.6	12.8	12.7
5	II	16.0	....	16.0	14.7	....	14.7	13.3	....	13.3	14.7	....	14.7
7	II	12.9	16.9	14.9	18.3	15.9	17.1	11.4	10.5	10.9	14.2	14.4	14.3
Average	II	14.4	....	15.4	16.5	....	15.9	12.3	....	12.1	14.4	....	14.5
16	III	12.5	14.8	13.6	18.7	17.7	18.2	10.1	13.9	12.0	13.8	15.5	14.6
13	III	14.5	15.7	15.1	14.4	17.7	16.0	13.4	15.1	14.2	14.1	16.2	15.1
Average	III	13.5	15.2	14.3	16.5	17.7	17.1	11.7	14.5	13.1	13.9	15.8	14.8

TABLE 27.—SECTION MODULI OF LEG BONES

(Results expressed in inches to the third power)

Pig	Lot	Humerus			Tibia			Femur			Average		
		Right	Left	Average	Right	Left	Average	Right	Left	Average	Right	Left	Average
1	I	0.075	0.065	0.070	0.060	0.050	0.055	0.051	0.065	0.058	0.062	0.060	0.061
5	II	0.109	....	0.109	0.116	....	0.116	0.081	....	0.081	0.102	....	0.102
7	II	0.090	0.065	0.077	0.056	0.063	0.059	0.065	0.071	0.068	0.070	0.066	0.068
Average	II	0.099	....	0.093	0.086	....	0.087	0.073	....	0.074	0.086	....	0.085
16	III	0.111	0.098	0.104	0.066	0.071	0.068	0.112	0.078	0.095	0.096	0.082	0.089
13	III	0.080	0.068	0.074	0.067	0.051	0.059	0.059	0.057	0.058	0.069	0.059	0.064
Average	III	0.095	0.083	0.089	0.066	0.061	0.063	0.085	0.067	0.076	0.082	0.070	0.076

TABLE 28.—SECTION MODULI OF LEG BONES

(Results expressed per 100 pounds live weight)

Pig	Lot	Humerus			Tibia			Femur			Average		
		Right	Left	Average	Right	Left	Average	Right	Left	Average	Right	Left	Average
1	I	0.043	0.038	0.040	0.035	0.029	0.032	0.029	0.038	0.033	0.036	0.035	0.035
5	II	0.046	....	0.046	0.049	....	0.049	0.034	....	0.034	0.043	....	0.043
7	II	0.046	0.033	0.039	0.029	0.032	0.030	0.033	0.036	0.034	0.036	0.034	0.035
Average	II	0.046	....	0.042	0.039	....	0.039	0.033	....	0.034	0.039	....	0.039
16	III	0.046	0.041	0.043	0.027	0.029	0.028	0.047	0.032	0.039	0.040	0.034	0.037
13	III	0.044	0.037	0.040	0.037	0.028	0.032	0.032	0.031	0.031	0.038	0.032	0.035
Average	III	0.045	0.039	0.041	0.032	0.028	0.030	0.039	0.031	0.035	0.039	0.033	0.036

SUMMARY

1. *Plan of Experiment.*—Of fourteen carefully selected Berkshire pigs weighing upon an average 51 pounds, two were slaughtered at the beginning of the experiment. The remaining twelve were then divided into three lots of four each in such a way that all of the lots were as nearly alike as possible in regard to age, ancestry, weight, and condition. Lot I was fed a low-protein ration; Lot II, a medium-protein ration; and Lot III, a high-protein ration. The rations consisted of ground corn, blood meal, and rock phosphate. The pigs of the three lots were kept and fed under exactly the same conditions thruout the experiment. Each pig was fed separately. Two animals of Lots II and III, and one of Lot I were subjected to a detailed slaughter test.

2. *Digestible Nutrients Consumed.*—The following average amounts of digestible nutrients were consumed daily per 100 pounds live weight by the pigs slaughtered at the end of the experiment: Pig 1 of the low-protein lot—protein 0.32, carbohydrates 1.55, and fat 0.061 pound; Pigs 5 and 7 of the medium-protein lot—protein 0.70, carbohydrates 1.44, and fat 0.059 pound; and Pigs 16 and 13 of the high-protein lot—protein 0.94, carbohydrates 1.32, and fat 0.056 pound.

3. *Energy Values of Digestible Nutrients.*—The average energy values of the digestible nutrients of the feedstuffs consumed per pig per 100 pounds live weight were as follows: Pig 1 of Lot I, 3.79; Pigs 5 and 7 of Lot II, 4.28; and Pigs 16 and 13 of Lot III, 4.49 therms.

4. *Ash and Phosphorus Consumed.*—The following average quantities of ash and phosphorus were consumed daily per 100 pounds live weight: by Pig 1 of the low-protein lot—ash 71.24, and phosphorus 11.03 grams; by Pigs 5 and 7 of the medium-protein lot—ash 64.24, and phosphorus 9.65 grams; and by Pigs 16 and 13 of the high-protein lot—ash 59.06, and phosphorus 8.73 grams.

5. *Live Weights.*—The live weights at the time of slaughtering were as follows: Pig 1 of Lot I, 180.1 pounds; Pigs 5 and 7 of Lot II, 249.4 and 199.6 pounds, respectively; and Pigs 16 and 13 of Lot III, 248.4 and 189.3 pounds, respectively. Pigs 7 and 13 were twenty days younger than Pigs 1, 5, and 16.

6. *Gains in Weight.*—The average daily gains were as follows: Pig 1 of Lot I, 0.64 pound; Pigs 5 and 7 of Lot II, 0.96 pound; and Pigs 16 and 13 of Lot III, 0.94 pound.

7. *Physical Condition.*—All the pigs of the low-protein lot except No. 1 lacked appetite. With the exception of Pig 4, they were sluggish and walked with difficulty. All appeared unthrifty and underfed. Three of the four pigs of the low-protein lot died during the experiment, apparently as the result of poor nourishment. The pigs of the medium- and the high-protein lots were active. They

appeared to be thrifty and in good condition for animals kept in pens, and the only abnormal physical condition they exhibited was stiffness during extremely cold weather.

8. *Blood Examination.*—The differences between the values within the lots were so great in the percentage of hemoglobin, in the number of red cells, and in the differential count in percent of the total white cells, that it was impossible to make out significant differences between the lots. The lot averages for the white blood cells were: Lot I, 26,222; Lot II, 19.339; and Lot III, 20,405. The number of leucocytes in the blood of the pigs of Lot I was unusually large and may have indicated an abnormal condition.

9. *Post-Mortem Examination.*—The post-mortem examination demonstrated that the kidneys of the three pigs of the low-protein lot subjected to examination were clearly and unmistakably affected with chronic paranchymatous nephritis, while none of the pigs of the medium- and high-protein lots were so affected. The weight, the length, and the width of the kidneys of the pigs on the low-protein ration were significantly less than the corresponding values for the kidneys of the pigs on the medium- and the high-protein rations. The livers of the pigs on the low-protein ration were distinctly smaller than those of Lots II and III, but in other respects, appeared to be normal. There was nothing abnormal in the other organs that could be attributed to the rations.

10. *Judging of Dressed Carcasses.*—Pig 1 of the low-protein lot, Pig 7 of the medium-protein lot, and Pig 13 of the high-protein lot were classed as "light loin" or "shipper" hogs; Pig 5 of the medium-protein lot, as "light butcher;" and Pig 16 of the high-protein lot, as "medium butcher." The dressed carcass of Pig 1 had probably less fat on the sides, brisket, and flanks than the carcasses of the pigs of Lots II and III.

11. *Judging of Cross-Sections of Half-Carcasses.*—It seemed apparent from the examination of the cross-sections that the carcass of Pig 1 of the low-protein lot differed from the carcasses of the pigs of the medium- and high-protein lots as follows: first, its fat and lean were somewhat darker in color; second, its fat was softer; and third, the marrow of its bones was lighter in color. It was impossible to make out definite group differences between the cross-sections of the carcasses of the animals of Lots II and III.

12. *Measurements of the Cross-Sections of Half-Carcasses.*—From the measurements of the cross-sections of the sides of the carcasses it seemed apparent that the carcass of Pig 1 of the low-protein lot showed less fat than the carcasses of the other four pigs, tho practically the same amount of lean.

13. *Weights of Dressed Carcasses.*—There were no significant differences between the weights of the carcasses of the different lots of pigs other than those due to differences in the live weights

of the animals when slaughtered. The weights of dressed pork in percent of the live weight yielded by the five animals slaughtered were as follows: Pig 1 of the low-protein lot, 71.04; Pigs 5 and 7 of the medium-protein lot, 70.87 and 72.08 percent, respectively; and Pigs 16 and 13 of the high-protein lot, 73.13 and 68.67 percent, respectively.

14. *Weights of Cuts of Pork.*—The weights of the cuts of pork—ham, shoulder, and side—varied in general directly as the live weights. The average weights of the three cuts for the five animals in percent of the live weight were: hams, 7.88; shoulders, 9.90; and sides, 17.79 percent.

15. *Weights of Boneless Meat and Skeletons.*—The weights of the boneless meat in the cuts varied directly as the net live weight of the pigs. The average values for all five pigs for the boneless meat were: ham, 27.58 pounds; shoulder, 34.54 pounds; and side, 62.98 pounds. The weights of the skeleton showed marked differences within the lots, but the lot averages agreed closely.

16. *Weights of Blood.*—Calculated on the basis of the net live weights, the amounts of blood were fairly constant for the five pigs, ranging from 2.89 percent for Pig 5 to 3.38 percent for Pig 13, with an average for all of 3.15 percent. The percentage of blood for the animals of the control group was distinctly higher, being 4.98 percent.

17. *Weights of Heart, Liver, Spleen, Pancreas, Gall Bladder, and Tongue.*—The weights of the heart, liver, spleen, pancreas, gall bladder, and tongue of Pigs 1, 5, 7, 16, and 13 varied more or less directly with the live weights of the animals. Expressed in percent of the net live weight, the results for the different pigs were quite similar, except in the case of the livers. The percentage values for the younger pigs, Nos. 26 and 44, were distinctly higher than those for the older animals.

18. *Weights of Urinary Organs and Organs of Central Nervous System.*—The weights of the kidneys of the pigs of the low-protein lot were about 50 percent lower than those of the pigs of the medium- and high-protein lots. The data for the other urinary organs and for the organs of the central nervous system did not show any lot differences that seem to be significant. In the case of the pigs of the control lot, the percentage values for the kidneys, brain, and spinal cord were higher than those for the older and more mature pigs.

19. *Weights, Lengths, and Diameters of Bones.*—The weights of the bones varied in general directly as the live weights of the animals. The differences between the lots in the lengths and diameters of the bones were slight.

20. *Breaking Strengths of Bones.*—The leg bones of the pig of the low-protein lot were thinner walled and had a larger space for marrow than those of any of the four other pigs. Further, the

bones of the pigs of the high-protein lot had thicker walls and smaller spaces for marrow than those of the pigs of the medium-protein lot. The breaking strengths of the bones of Pig 1 of Lot I were in all cases lower than those of any of the other pigs.

21. *Moduli of Rupture of Bones.*—From the average data for the moduli of rupture, it seems probable that the quality of the leg bones of the pig of the low-protein lot was significantly inferior to that of the four other pigs, and that there was little difference between the values for the pigs of Lots II and III.

22. *Section Moduli of Bones.*—The average values for the section moduli of the bones of the older and heavier pigs, Nos. 5 and 16 of Lots II and III, were higher than those of the younger and lighter pigs, Nos. 7 and 13, while those for Pig 1 of Lot I were the lowest. Calculated on the basis of 100 pounds live weight, the section moduli tended to become constant, i. e., the economic distribution of the material increased proportionally with the live weight.

CONCLUSIONS

The conclusions drawn from the experimental data reported in this bulletin were as follows:

1. A daily ration of ground corn, blood meal, and an ample amount of calcium phosphate, containing only 0.32 pound of digestible protein, and yielding only 3.79 therms of metabolizable energy per 100 pounds live weight, is not sufficient for the normal nutrition of young, growing pigs. It is impossible to account for this fact definitely, but it is probable that the ration either does not contain enough of the right kind of protein or does not yield enough energy.

2. Daily rations of ground corn, blood meal, and an ample amount of calcium phosphate, containing respectively 0.70 and 0.94 pound of digestible protein, and yielding respectively 4.28 and 4.49 therms of metabolizable energy per 100 pounds live weight, are sufficient for the normal nutrition of young, growing pigs.

3. The difference between 0.70 and 0.94 pound of digestible protein and 4.28 and 4.49 therms of metabolizable energy per 100 pounds live weight per day in a ration consisting of ground corn, blood meal, and an ample amount of calcium phosphate does not exert any apparent effect upon the nutrition of young growing pigs.

These experiments in regard to the influence of the quantity of protein consumed by growing pigs on the development of their bodies will be continued by this station to further confirm the results here reported.

The authors wish to acknowledge their indebtedness to Professors Wm. Dietrich and L. D. Hall for helpful suggestions and assistance in the planning and conducting of this experiment, and to Messrs. P. A. Hoffman and W. H. Balis for much aid in the routine work. They desire also to express to Miss Leonora Perry their appreciation of her very efficient editorial criticism.

APPENDIX

TABLE 1.—LIVE WEIGHTS, GAINS, AND AMOUNTS OF FEEDS CONSUMED
LOT I, LOW-PROTEIN RATION

(Results expressed in pounds per period of 28 days)

Animal	Period	Date	Live weight		Feeds consumed daily per 100 pounds live weight			Average daily gain	Total weights of feeds per 100 pounds gain
			Beginning of period	Average for period	Ground corn	Blood meal	Total		
1	1	Dec. 25–Jan. 21	67.9	74.89	3.17	0.10	3.26	0.52	466.0
	2	Jan. 22–Feb. 18	82.6	92.30	3.12	0.11	3.23	0.59	508.8
	3	Feb. 19–Mch. 18	99.0	110.75	2.59	0.20	2.79	0.81	379.1
	4	Mch. 19–Apr. 15	121.8	130.13	1.89	0.27	2.16	0.56	502.2
	5	Apr. 16–May 13	137.5	144.30	1.57	0.32	1.89	0.49	550.4
	6	May 14–June 17	151.4	163.56	1.42	0.33	1.75	0.82	348.9
Average.....		Dec. 25–June 17	110.0	119.32	2.29	0.22	2.51	0.63	459.2
3[1]	1	Dec. 25–Jan. 21	51.9	58.12	3.26	0.10	3.36	0.46	....[1]
	2	Jan. 22–Feb. 18	63.7	71.22	3.15	0.11	3.26	0.41	....
	3	Feb. 19–Mch. 18	76.5	83.62	2.54	0.20	2.74	0.56	....
	4	Mch. 19–Apr. 15	93.5	91.74	1.16	0.18	1.34	–0.22	....
	5	Apr. 16–May 13	84.0	78.87	1.91	0.06	1.98	–0.71	....
	6	May 14–June 17	....	....	....	....	....	....	....
Average.....		Dec. 25–June 17	73.9	76.71	2.40	0.13	2.54	0.10	....
4[2]	1	Dec. 25–Jan. 21	42.4	45.92	3.35	0.10	3.45	0.23	....[2]
	2	Jan. 22–Feb. 18	49.0	51.90	2.53	0.11	2.65	0.13	....
	3	Feb. 19–Mch. 18	52.5	50.60	0.90	0.12	1.02	–0.11	....
	4	Mch. 19–Apr. 15	49.7	52.52	1.52	0.24	1.76	0.19	....
	5	Apr. 16–May 13	54.0	51.22	0.57	0.19	0.76	–0.27	....
	6	May 14–June 17	47.7	46.36	0.60	0.32	0.92	–0.07	....
Average.....		Dec. 25–June 17	46.2	49.75	1.58	0.18	1.76	0.02	....

[1]Died May 30, before experiment closed.

[2]Died June 19, before experiment closed.

TABLE 2.—LIVE WEIGHTS, GAINS, AND AMOUNTS OF FEEDS CONSUMED
LOT II, MEDIUM-PROTEIN RATION
(Results expressed in pounds per period of 28 days)

Animal	Period	Date	Live weight		Feeds consumed daily per 100 pounds live weight			Average daily gain	Total weights of feeds per 100 pounds gain
			Beginning of period	Average for period	Ground corn	Blood meal	Total		
5	1	Dec. 25–Jan. 21	62.9	75.05	3.15	0.68	3.83	1.00	287.9
	2	Jan. 22–Feb. 18	90.8	103.97	2.87	0.66	3.53	0.82	449.7
	3	Feb. 19–Mch. 18	113.7	130.91	2.35	0.73	3.08	1.22	328.9
	4	Mch. 19–Apr. 15	148.0	161.61	1.68	0.85	2.53	1.02	401.1
	5	Apr. 16–May 13	176.5	190.95	1.59	0.86	2.45	1.08	431.0
	6	May 14–June 17	206.9	228.00	1.23	0.90	2.13	1.21	400.6
Average.....		Dec. 25–June 17	133.1	148.41	2.14	0.78	2.92	1.06	383.2
7	1	Dec. 25–Jan. 21	49.9	58.91	3.15	0.69	3.84	0.77	293.8
	2	Jan. 22–Feb. 18	71.4	82.19	2.95	0.67	3.62	0.85	250.8
	3	Feb. 19–Mch. 18	103.7	107.86	2.36	0.73	3.09	0.94	354.4
	4	Mch. 19–Apr. 15	121.6	132.90	1.58	0.82	2.40	0.80	399.2
	5	Apr. 16–May 13	144.0	154.65	1.50	0.83	2.33	0.87	411.0
	6	May 14–June 17	168.5	183.77	1.14	0.80	1.94	0.89	400.6
Average.....		Dec. 25–June 17	109.8	120.05	2.11	0.76	2.87	0.85	368.3
8	1	Dec. 25–Jan. 21	49.4	60.89	3.08	0.65	3.73	0.90	252.6
	2	Jan. 22–Feb. 18	74.6	83.77	2.66	0.58	3.24	0.66	411.0
	3	Feb. 19–Mch. 18	101.6	103.39	1.93	0.68	2.61	0.76	355.7
	4	Mch. 19–Apr. 15	114.3	123.57	1.14	0.82	1.96	0.58	420.1
	5	Apr. 16–May 13	130.5	135.66	1.02	0.88	1.90	0.57	451.2
	6	May 14–June 17	146.5	151.65	1.66	0.73	2.39	0.30	706.9
Average.....		Dec. 25–June 17	102.8	109.82	1.91	0.72	2.64	0.63	432.9
Aver. Lot II		**Dec. 25–June 17**	**115.2**	**126.09**	**2.05**	**0.75**	**2.81**	**0.85**	**394.8**

TABLE 3.— LIVE WEIGHTS, GAINS, AND AMOUNTS OF FEEDS CONSUMED
LOT III, HIGH-PROTEIN RATION

(Results expressed in pounds per period of 28 days)

Animal	Period	Date	Live weight		Feeds consumed daily per 100 pounds live weight			Average daily gain	Total weights of feeds per 100 pounds gain
			Beginning of period	Average for period	Ground corn	Blood meal	Total		
16	1	Dec. 25–Jan. 21	62.9	77.19	3.10	1.11	4.22	1.14	285.9
	2	Jan. 22–Feb. 18	94.7	111.40	2.69	1.03	3.72	1.19	348.8
	3	Feb. 19–Mch. 18	128.0	146.01	2.13	1.11	3.23	1.18	400.8
	4	Mch. 19–Apr. 15	161.0	177.51	1.56	1.25	2.81	1.23	405.2
	5	Apr. 16–May 13	195.5	207.75	1.31	1.16	2.47	1.00	513.7
	6	May 14–June 17	223.5	234.46	0.71	0.97	1.68	0.71	555.4
Average.....		Dec. 25–June 17	144.3	159.05	1.92	1.10	3.02	1.07	418.3
13	1	Dec. 25–Jan. 21	44.9	51.41	2.84	1.00	3.84	0.56	355.2
	2	Jan. 22–Feb. 18	60.4	70.72	2.66	1.01	3.66	0.76	341.6
	3	Feb. 19–Mch. 18	81.7	94.32	2.35	1.16	3.51	0.91	361.9
	4	Mch. 19–Apr. 15	107.3	120.68	1.83	1.30	3.13	0.92	411.9
	5	Apr. 16–May 13	133.0	142.56	1.24	1.20	2.44	0.90	388.2
	6	May 14–June 17	158.1	172.50	1.07	1.17	2.25	0.89	436.5
Average.....		Dec. 25–June 17	97.6	108.70	2.00	1.14	3.14	0.82	382.5
15	1	Dec. 25–Jan. 21	62.9	76.47	3.10	1.11	4.21	1.05	306.4
	2	Jan. 22–Feb. 18	92.3	106.85	2.61	0.98	3.59	1.04	368.1
	3	Feb. 19–Mch. 18	121.5	138.31	2.05	0.99	3.04	1.04	405.4
	4	Mch. 19–Apr. 15	150.6	164.50	1.52	1.07	2.59	1.02	419.7
	5	Apr. 16–May 13	179.0	189.93	1.25	1.10	2.35	0.66	675.7
	6	May 14–June 17	197.5	201.79	0.42	0.29	0.71	0.18	802.2
Average.....		Dec. 25–June 17	134.0	146.31	1.82	0.92	2.75	0.83	496.2
Aver. Lot III		Dec. 25–June 17	125.3	138.02	1.91	1.05	2.97	0.91	432.3

TABLE 4.— AMOUNTS OF DIGESTIBLE NUTRIENTS CONSUMED
LOT I, LOW-PROTEIN RATION

(Results expressed in pounds and therms per period of 28 days)

Animal	Period	Date	Digestible nutrients consumed daily per 100 pounds live weight				Energy of digestible nutrients per 100 pounds live weight	Nutritive ratio
			Dry substance	Protein (N x 6.25)	Carbohydrates	Fat		
			lbs.	*lbs.*	*lbs.*	*lbs.*	*therms*	
1	1	Dec. 25–Jan. 21	2.564	0.285	2.140	0.083	4.90	1:8.2
	2	Jan. 22–Feb. 18	2.541	0.295	2.109	0.082	4.86	1:7.8
	3	Feb. 19–Mch. 18	2.185	0.322	1.747	0.069	4.18	1:5.9
	4	Apr. 16–Apr. 18	1.691	0.326	1.275	0.051	3.23	1:4.3
	5	Mch. 19–May 13	1.476	0.336	1.063	0.042	2.82	1:3.4
	6	May 14–June 17	1.366	0.337	0.958	0.038	2.61	1:3.1
Average.....		Dec. 25–June 17	1.970	0.317	1.549	0.061	3.77	1:5.3
3[1]	1	Dec. 25–Jan. 21	2.639	0.296	2.202	0.086	5.05	1:8.1
	2	Jan. 22–Feb. 18	2.565	0.298	2.130	0.083	4.90	1:7.8
	3	Feb. 19–Mch. 18	2.148	0.320	1.713	0.068	4.11	1:5.8
	4	Mch. 19–Apr. 15	1.050	0.211	0.783	0.032	2.01	1:4.1
	5	Apr. 16–May 13	1.553	0.176	1.293	0.050	2.97	1:8.0
	6	May 14–June 17	....	....	....	....	....	....
Average.....		Dec. 25–June 17	1.991	0.260	1.624	0.064	3.81	1:6.8
4[2]	1	Dec. 25–Jan. 21	2.708	0.299	2.263	0.088	5.18	1:8.2
	2	Jan. 22–Jan. 21	2.073	0.254	1.708	0.067	3.96	1:7.3
	3	Feb. 19–Mch. 18	0.797	0.148	0.607	0.024	1.52	1:4.5
	4	Mch. 19–Apr. 15	1.379	0.278	1.029	0.041	2.64	1:4.0
	5	Apr. 16–May 13	0.597	0.179	0.386	0.016	1.14	1:2.4
	6	May 14–June 17	0.717	0.271	0.409	0.017	1.37	1:1.6
Average.....		Dec. 25–June 17	1.378	0.238	1.067	0.042	2.63	1:4.9

[1]Died May 30, before experiment closed.

[2]Died June 19, before experiment closed.

TABLE 5.— AMOUNTS OF DIGESTIBLE NUTRIENTS CONSUMED

LOT II, MEDIUM-PROTEIN RATION

(Results expressed in pounds and therms per period of 28 days)

Animal	Period	Date	Digestible nutrients consumed daily per 100 pounds live weight				Energy of digestible nutrients per 100 pounds live weight	Nutritive ratio
			Dry substance	Protein (N x 6.25)	Carbohydrates	Fat		
			lbs.	*lbs.*	*lbs.*	*lbs.*	*therms*	
5	1	Dec. 25–Jan. 21	2.986	0.702	2.128	0.085	5.71	1:3.3
	2	Jan. 22–Feb. 18	2.755	0.673	1.939	0.079	5.27	1:3.1
	3	Feb. 19–Mch. 18	2.396	0.685	1.589	0.065	4.59	1:2.5
	4	Mch. 19–Apr. 15	1.957	0.725	1.134	0.047	3.74	1:1.7
	5	Apr. 16–May 13	1.896	0.728	1.073	0.045	3.63	1:1.6
	6	May 14–June 17	1.647	0.734	0.831	0.036	3.15	1:1.2
Average.....		Dec. 25–June 17	2.273	0.708	1.449	0.059	4.35	1:2.2
7	1	Dec. 25–Jan. 21	2.996	0.710	2.130	0.086	5.73	1:3.3
	2	Jan. 22–Feb. 18	2.823	0.684	1.993	0.081	5.40	1:3.2
	3	Feb. 19–Mch. 18	2.408	0.687	1.597	0.065	4.60	1:2.5
	4	Mch. 19–Apr. 15	1.864	0.700	1.071	0.045	3.57	1:1.7
	5	Apr. 16–May 13	1.799	0.699	1.010	0.042	3.44	1:1.6
	6	May 14–June 17	1.497	0.653	0.770	0.033	2.86	1:1.3
Average.....		Dec. 25–June 17	2.231	0.689	1.428	0.059	4.27	1:2.3
8	1	Dec. 25–Jan. 21	2.913	0.680	2.080	0.084	5.57	1:3.3
	2	Jan. 22–Feb. 18	2.528	0.601	1.795	0.072	4.83	1:3.3
	3	Feb. 19–Mch. 18	2.029	0.624	1.302	0.054	3.88	1:2.3
	4	Mch. 19–Apr. 15	1.516	0.668	0.773	0.033	2.90	1:1.3
	5	Apr. 16–May 13	1.464	0.703	0.690	0.030	2.80	1:1.1
	6	May 14–June 17	1.861	0.643	1.123	0.047	3.56	1:1.9
Average.....		Dec. 25–June 17	2.052	0.653	1.294	0.053	3.92	1:2.2
Aver. Lot II		Dec. 25–June 17	2.185	0.683	1.390	0.057	4.18	1:2.2

TABLE 6.— AMOUNTS OF DIGESTIBLE NUTRIENTS CONSUMED

LOT III, HIGH-PROTEIN RATION

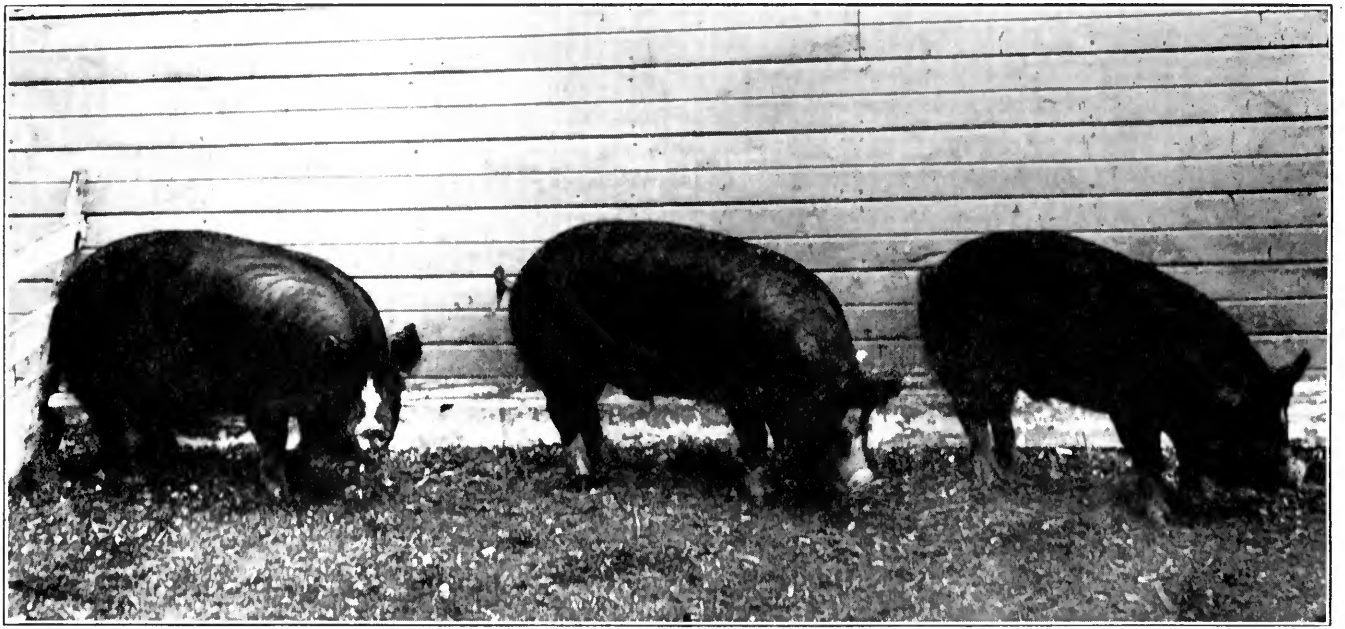
(Results expressed in pounds and therms per period of 28 days)

Animal	Period	Date	Digestible nutrients consumed daily per 100 pounds live weight				Energy of digestible nutrients per 100 pounds live weight	Nutritive ratio
			Dry substance	Protein (N x 6.25)	Carbohydrates	Fat		
			lbs.	*lbs.*	*lbs.*	*lbs.*	*therms*	
16	1	Dec. 25–June 17	3.278	1.013	2.096	0.086	6.27	1:2.3
	2	Jan. 22–Jan. 21	2.888	0.924	1.817	0.075	5.52	1:2.1
	3	Feb. 19–Feb. 18	2.505	0.942	1.437	0.060	4.79	1:1.7
	4	Mch. 19–Mch. 18	2.169	1.010	1.052	0.046	4.15	1:1.1
	5	Apr. 16–Apr. 15	1.904	0.927	0.885	0.039	3.64	1:1.0
	6	May 14–May 13	1.289	0.749	0.479	0.023	2.47	1:0.7
Average.....		Dec. 25–June 17	2.339	0.927	1.294	0.055	4.47	1:1.5
13	1	Dec. 25–June 17	2.985	0.914	1.918	0.079	5.71	1:2.3
	2	Jan. 22–Jan. 21	2.847	0.907	1.794	0.074	5.44	1:2.2
	3	Feb. 19–Feb. 18	2.720	0.998	1.585	0.067	5.20	1:1.7
	4	Mch. 19–Mch. 18	2.418	1.063	1.235	0.053	4.62	1:1.3
	5	Apr. 16–Apr. 15	1.879	0.952	0.837	0.037	3.59	1:1.0
	6	May 14–May 13	1.728	0.919	0.726	0.033	3.31	1:0.9
Average.....		Dec. 25–June 17	2.429	0.959	1.349	0.057	4.64	1:1.5
15	1	Dec. 25–June 17	3.274	1.013	2.093	0.086	6.26	1:2.3
	2	Jan. 22–Jan. 21	2.790	0.886	1.761	0.073	5.34	1:2.2
	3	Feb. 19–Feb. 18	2.358	0.851	1.388	0.058	4.51	1:1.8
	4	Mch. 19–Mch. 18	2.001	0.876	1.027	0.044	3.83	1:1.3
	5	Apr. 16–Apr. 15	1.809	0.877	0.846	0.037	3.46	1:1.1
	6	May 14–May 13	0.548	0.235	0.286	0.012	1.05	1:1.3
Average.....		Dec. 25–June 17	2.130	0.790	1.233	0.052	4.07	1:1.7
Aver. Lot III		Dec. 25–June 17	**2.299**	**0.892**	**1.292**	**0.055**	**4.39**	**1:16**

Low-protein lot: Pig 4
Age, 37 weeks, 4 days
Live weight, 51.22 pounds

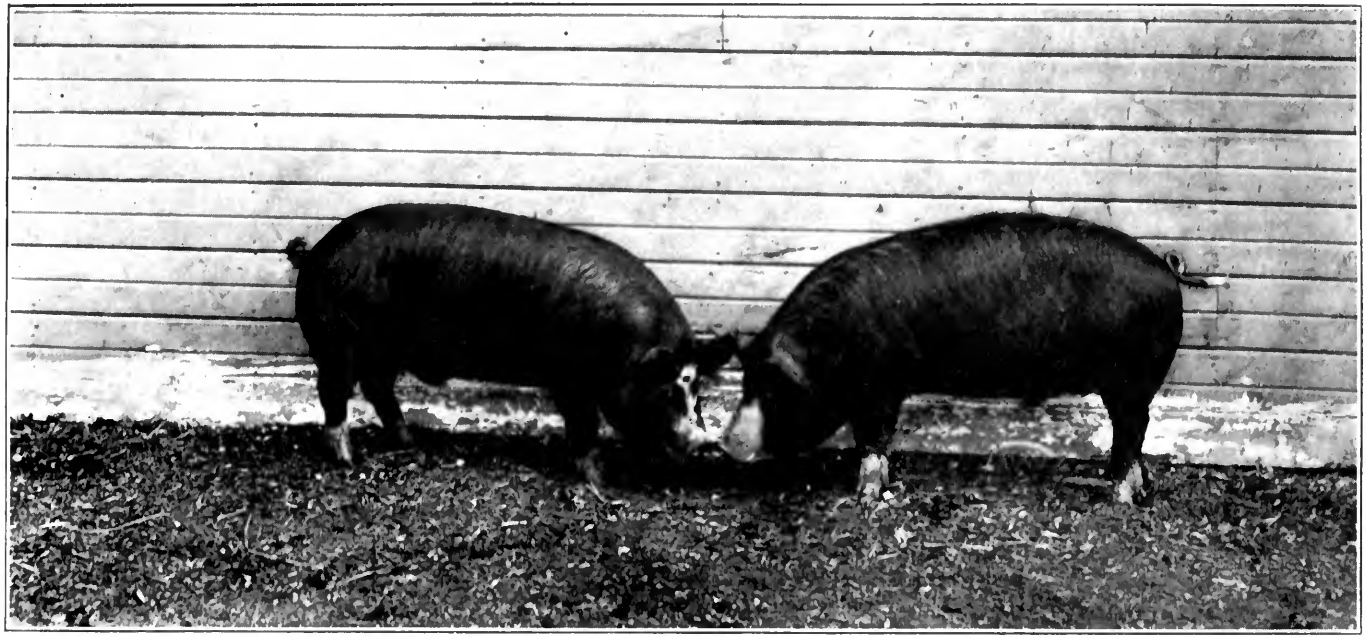
Low-protein lot: Pig 1
Age, 37 weeks, 4 days
Live weight, 144.30 pounds

FIG. 1.—PIGS 4 AND 1 ON THE 139TH DAY OF THE EXPERIMENT



High-protein lot: Pig 16	Medium-protein lot: Pig 5	Low-protein lot: Pig 1
Age, 37 weeks, 5 days Live weight, 207.75 pounds	Age, 37 weeks, 4 days Live weight, 190.95 pounds	Age, 37 weeks, 4 days Live weight, 144.30 pounds

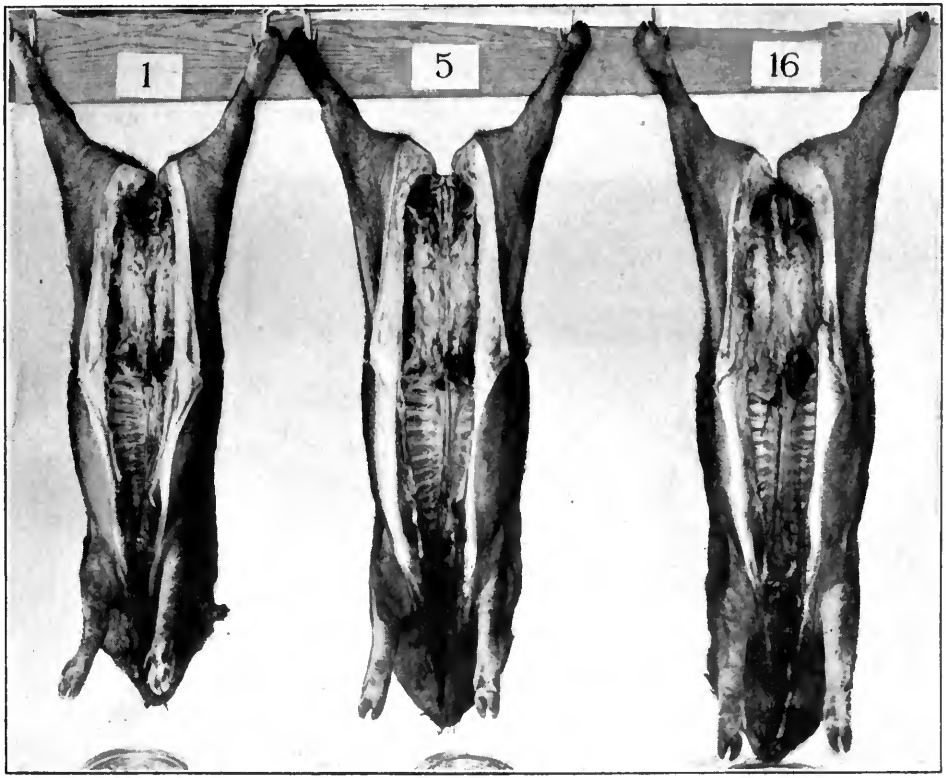
FIG. 2.—PIGS 16, 5, AND 1 ON THE 139TH DAY OF THE EXPERIMENT



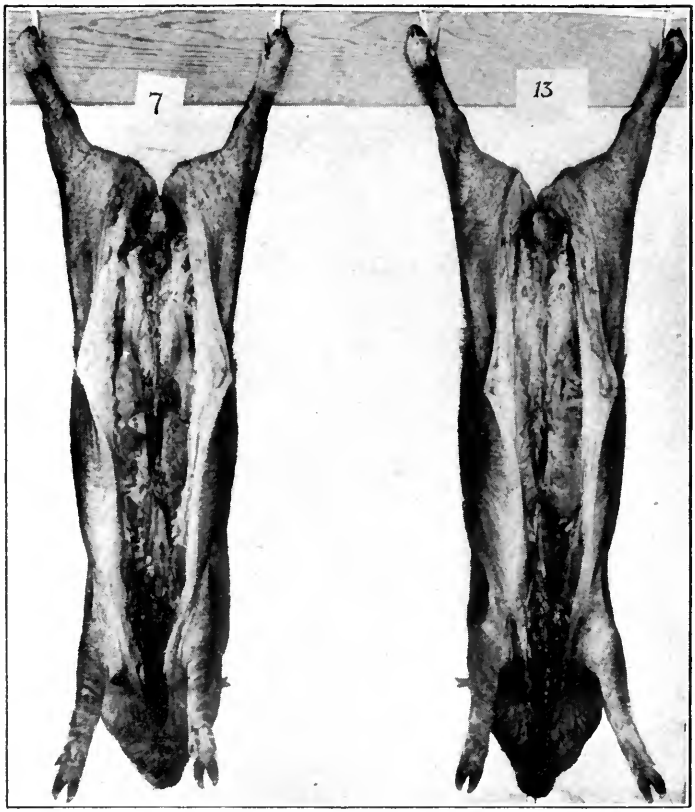
High-protein lot: Pig 13
Age, 34 weeks, 3 days
Live weight, 142.56 pounds

Medium-protein lot: Pig 7
Age, 34 weeks, 3 days
Live weight, 154.65 pounds

FIG. 3.—PIGS 13 AND 7 ON THE 139TH DAY OF THE EXPERIMENT



Low-protein lot	Medium-protein lot	High-protein lot
Fasted live weight, 173.0 pounds	Fasted live weight, 238.6 pounds	Fasted live weight, 240.8 pounds



Medium-protein lot
Fasted live weight, 195.2 pounds

High-protein lot
Fasted live weight, 181.6 pounds

FIG. 5.—CARCASSES OF PIGS 7 AND 13

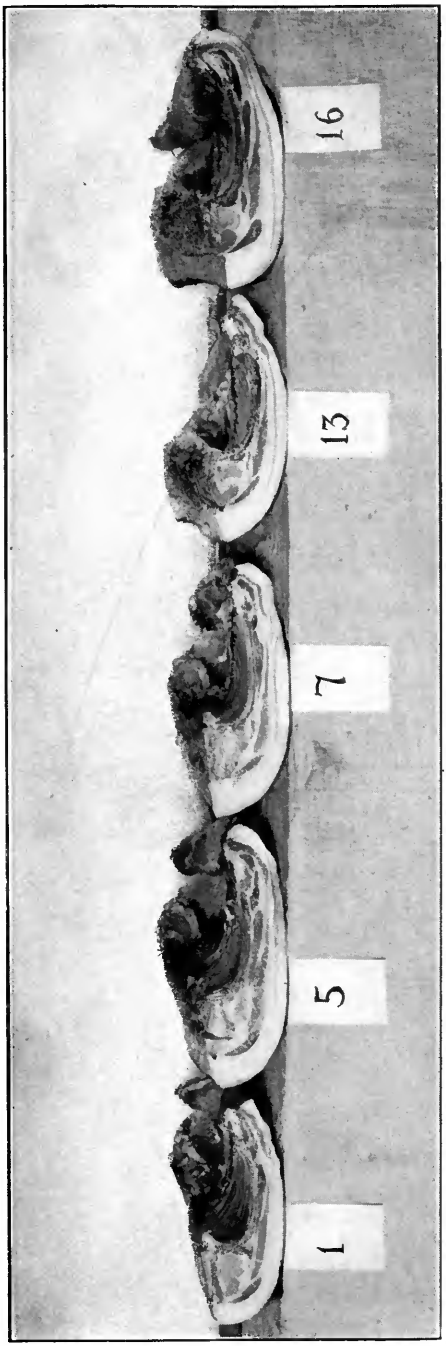
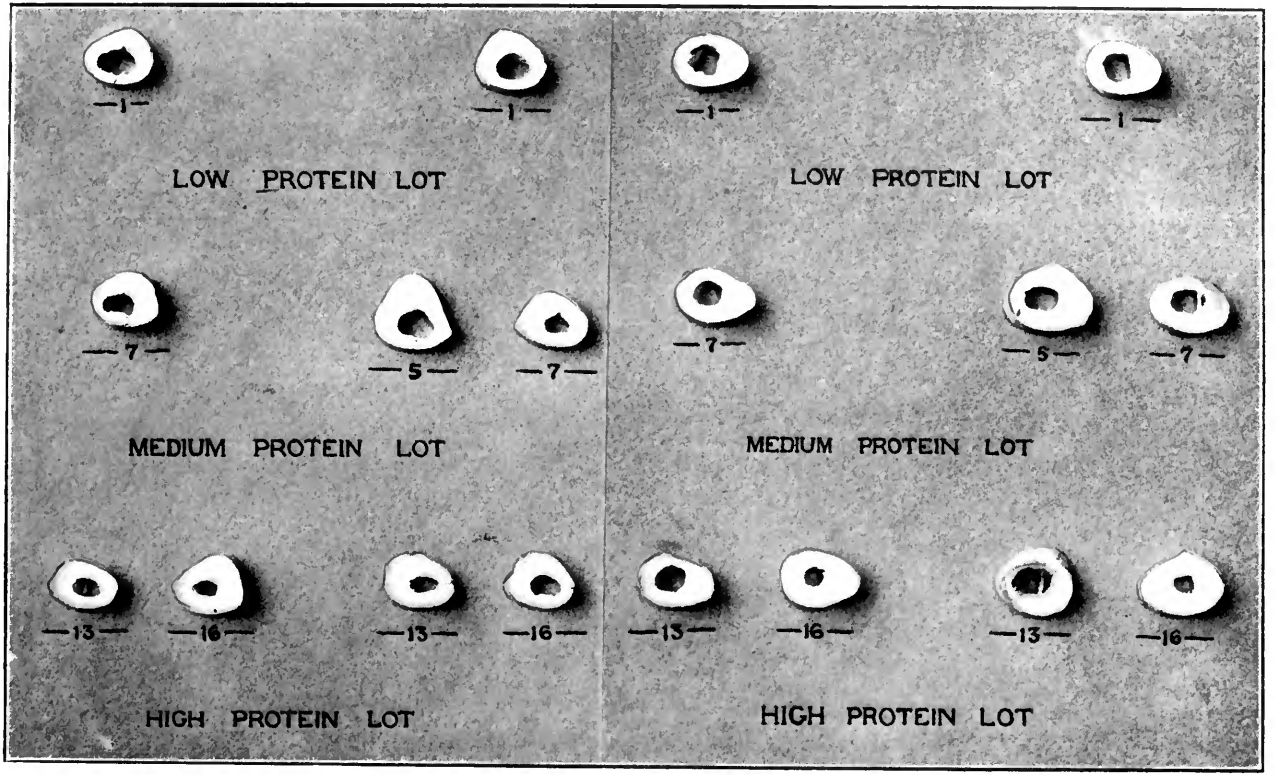
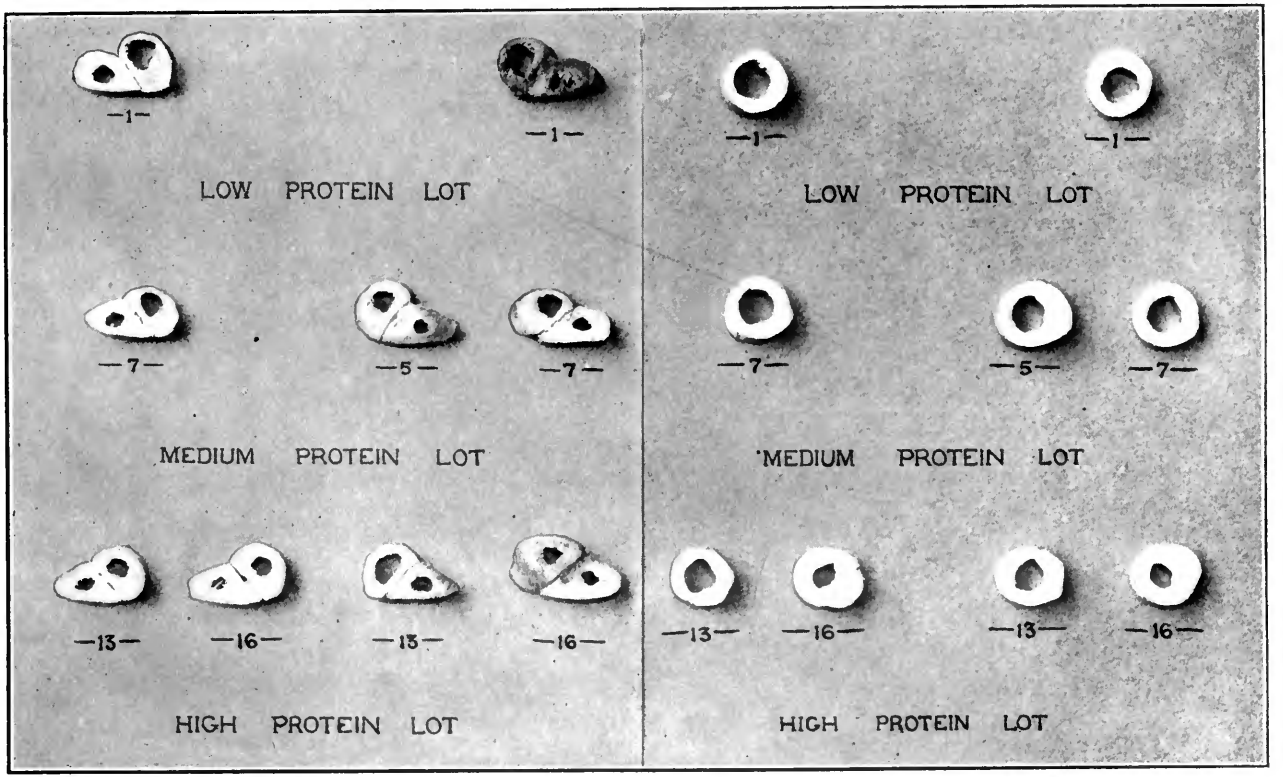


FIG. 6.—CROSS-SECTIONS OF CARCASSES OF PIGS 1, 5, 7, 13, AND 16



Left tibia Right tibia Left humerus Right humerus

FIG. 7.—CROSS-SECTIONS OF THE TIBIA AND HUMERUS



Left ulna and radius | Right ulna and radius | Left femur | Right femur

FIG. 8.—CROSS-SECTIONS OF THE ULNA, RADIUS, AND FEMUR