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The Relation of Feed Consumed to Protein and Energy Retention

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TABLE OF CONTENTS

	Page
Introduction	3
Outline of experiment	4
Procedure	4
Quarters and Rations	5
Quantity of feed consumed and gains in weight	5
Quantity of nutrients consumed	7
Slaughter house procedure	7
Slaughter house records	7
Physical analyses of carcasses and observations on cured cuts	7
Slaughter tests on lard and bacon type hogs	9
Weights of wholesale cuts, untrimmed	9
Weights of wholesale cuts trimmed	10
Wholesale cuts, percentage of carcasses	10
Shrinkage of fresh meat when pickled and smoked	12
Weights of wholesale cuts after curing	13
Lard tests	13
Chemical analyses	13
Weight of animals and losses during preparation of material for analysis	15
Composition of swine, analytical data	15
Composition of animals, live weight basis	18
Composition of animals, empty weight basis	18
Effect of type on composition of swine	19
Edible constituents in swine	19
Gain in protein and fat by swine	20
Energy stored by swine	20
Gain in live weight and in nutrients for each 100 lbs. of feed consumed.....	20
Feed required per lb. gain in live weight in nutrients	21
Relation of feed consumed to the retention of energy by swine	21
Gain in edible protein and in edible fat by swine	22
Edible energy stored by swine	22
Relation of feed consumed to the retention of edible energy by swine	23
Energy consumed and retained per day	24
Distribution of energy consumed	24
Energy consumed and retained daily, per square meter body surface	25
Energy consumed and retained daily per kilogram live weight	25
Cost of gains in energy as affected by age	26
Growth as indicated by weights and measurements	27
Weight of swine	28
Measurements of swine	29
Measurement of surface area	30
Summary	30

The Relation of Feed Consumed to Protein and Energy Retention

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Abstract.—In the experiment here reported eight pigs of lard type and eight of bacon type were under observation, one of each type being slaughtered at each of the following weights: 100, 150, 200, 250, and 300 pounds. The feed requirement per unit gain was calculated at each 50-pound stage, also the cost of protein gains and the cost of fat gains. A detailed physical examination of each carcass is reported, including comparison of the wholesale cuts of meat produced by the two types. Chemical analyses were also made in each instance. A determination was made of the amount of net energy consumed by these animals and the percentage stored in their tissues. The daily maintenance requirement was calculated in terms both of body surface and of live weight. A formula was devised for calculating the surface area of swine.

The general subject of growth may be considered from many different aspects. To the grower of livestock however one of the most important is concerned with gains in live weight, and the character of the gains made. It is well known that young animals commonly achieve a high rate of increase in body weight, and that the rate usually declines until it reaches zero sometime after maturity is attained. For example, 10 pigs each weighing 100 pounds will gain more in one day than 4 pigs, each weighing 250 pounds. It is also well known that the character of the material stored at various periods is quite different. During the early part of the growing period water makes up a considerable portion of the gains. At the end of the growing period the gains are chiefly fat along with a small amount of water, and an insignificant quantity of protein. Obviously the energy value per pound gained must be much higher at maturity than in the early part of the growing period. These statements are of course consistent with the well known fact that the amount of feed required to produce a pound of gain in weight tends to increase constantly from birth to maturity.

In connection with the preceding paragraph several questions arise. It has been suggested that food is "utilized to better advantage" by young animals than is possible by those more mature. So far as we are aware there is no evidence to support that view. Henry and Morrison¹ state that in general the ability to digest feed does not increase with age. In this same connection there is also the possibility that early in life a larger percentage of the net energy available for storage may be retained than is possible later in life. Apparently however there is no support for

that view. In fact Armsby² indicates that the percentage retention of net energy may even increase with age. Another suggestion that has been repeatedly verified, is that young animals consume more feed in proportion to weight. In the case of swine for example Henry and Morrison³ present data showing that on a daily basis young pigs consume over twice as much feed per 100 pounds live weight as do hogs weighing 300-350 pounds. Because of this large food intake it is possible then that the young animals have more energy available for storage after the maintenance requirements are supplied.

The data of Henry and Morrison and the statement of Armsby just cited may seem contradictory, but the contradiction is only apparent. The total quantity of energy retained by the older animal per unit weight may be less than that retained by the younger. If the maintenance requirement of the latter is sufficiently high however, the older animal will still retain a larger percentage of the energy consumed.

EXPERIMENTAL

The problem formulated for attack is briefly as follows: What is the relative retention of energy, both protein and total, during various growth periods of swine? From an economic standpoint the problem has two phases, (1) the length of time swine may be fed and still give a reasonable return in the form of protein; (2) the length of time swine may be fed and still give a reasonable return in the form of energy; that is, fat or fat and protein combined.

Procedure.—Sixteen pigs in all were used, with initial weights of approximately 100 pounds each. Beginning at this weight, and at 50-pound intervals up to 300 pounds, two pigs were killed and analyzed. This arrangement provided four 50-pound intervals. For the first period there were fourteen animals, for the second twelve, for the third ten, and for the fourth, ending with an average weight of 300 pounds, there were eight. One point requires an explanatory statement, that of type. Half of the animals were Poland Chinas of the big type and half were Large Yorkshires. The treatment of the two breeds was identical in all respects, and one of each was killed at each of the weight intervals mentioned.

Individual records of feed consumption were kept, and the pigs were weighed at weekly intervals. Each pig analyzed was photographed at the time of slaughtering, and group pictures were also taken of all representatives of the breed then under observation. When the photographs were taken, a number of measurements were also made of each animal. The right side of the carcass was used for a chemical analysis, and the left side for a physical analysis. The surface area of each animal slaughtered

was determined by removing one-half the hide (from the right side) tracing the outline on paper, and measuring the area of the tracing.

Quarters and Rations.—The animals were confined throughout the experimental period to the University swine barn. Each pig was in a separate pen provided with a cement floor. It also had access to an outdoor lot of ample size for exercise. The floor of the outdoor lot was of the natural earth, but free of vegetation. Clean water was constantly available. All animals received the same feed, a mixture of corn 45 per cent, shorts 45 per cent, and tankage 10 per cent. The composition of the mixture was practically unchanged throughout the experimental period. The animals were fed twice daily, and given all they would consume.

Quantity of Feed Consumed and Gains in Weight.—A large number of feeding trials have been conducted that indicate the approximate quantity of feed and nutrients required at different ages to produce gains in weight. Our chief interest in that point therefore lies in a comparison of the two types of swine, and we have calculated our results so as to show the average daily gain of each type, the daily feed consumption, and the amount of feed required per pound gain in weight. Our calculations appear in Tables 1 and 2.

TABLE 1.—AVERAGE GAINS IN WEIGHT AND FEED CONSUMED BY PIGS FROM THE 100-POUND STAGE TO THE SUCCEEDING STAGES INDICATED.

Weight	150-lb Stage	200-lb. Stage	250-lb. Stage	300-lb. Stage
No. of individuals of each type	7	6	5	4
Days fed.....	Type B† 56 Type L 49	77 77	105 105	154 140
Initial wt. lbs.....	Type B 93.9 Type L 92.7	94.4 93.4	95.2 95.2	94.1 94.1
Final wt. lbs.....	Type B 160.9 Type L 167.2	202.9 204.5	244.3 255.9	318.1 302.6
Gain lbs.	Type B 67.0 Type L 74.5	108.5 111.1	149.1 160.7	224.0 208.5
Daily gain lbs.....	Type B 1.20 Type L 1.52	1.41 1.44	1.42 1.53	1.45 1.49
Feed consumed lbs.	Type B 296.43 Type L 305.07	440.17 491.54	662.65 729.20	1139.31 1042.19
Feed consumed daily lbs.....	Type B 5.29 Type L 6.23	5.72 6.38	6.31 6.94	7.40 7.44
Feed (lbs.) consumed per lb. gained	Type B 4.42 Type L 4.09	4.06 4.42	4.44 4.54	5.09 5.00

†B-Bacon type, L-Lard type.

Table 1 gives the impression that the lard type hogs consume more feed, and make larger daily gains than the bacon type. Table 2, however, in our opinion shows that such is not a necessary conclusion. When the stages are examined separately, it is seen that there are no consistent differences between the breeds in daily gain, daily feed-consumption, or feed required per pound gain. There is another factor to be considered. The two breeds were not in the same condition at the beginning of the feeding period. The Yorkshires were sleek and thrifty when they were placed under observation. The Poland Chinas, on the other hand, seemed to have developed more slowly. It is our experience that when healthy animals have had their growth retarded (at least by limiting their rations) they make exceptional gains when later fed for maximum growth. We believe therefore that our results do not indicate any differences between the breeds in rate of gain, or in the amount of feed required to produce gains.

TABLE 2.—AVERAGE GAINS IN WEIGHT AND FEED CONSUMED BY PIGS BY 50-POUND STAGES.

Stage	100-150 lb.	150-200 lb.	200-250 lb.	250-300 lb.
No. of individuals of each type	7	6	5	4
Days fed.....	Type B 56 Type L 49	21 28	28 28	49 35
Initial wt. lbs.	Type B 93.9 Type L 92.7	160.3 167.6	201.6 204.5	242.1 253.7
Final wt. lbs.	Type B 160.9 Type L 167.2	202.9 204.5	244.3 255.9	318.1 302.6
Gain lbs.	Type B 67.0 Type L 74.5	42.6 36.9	42.7 51.4	76.0 48.9
Daily gain lbs.	Type B 1.20 Type L 1.52	2.03 1.32	1.52 1.84	1.55 1.40
Feed consumed lbs.	Type B 296.43 Type L 305.07	144.42 187.87	225.35 238.00	483.37 306.62
Feed consumed daily lbs.	Type B 5.29 Type L 6.23	6.88 6.71	8.05 8.50	9.86 8.76
Feed (lbs.) consumed per lb. gained.....	Type B 4.42 Type L 4.09	3.39 5.09	5.28 4.63	6.36 6.27

It will be noted in these tables as in many others that follow, that there are numerous irregularities. If the data are presented graphically, the curves are far from smooth. Our explanation is that in the first place, there is considerable variability among the individuals. Furthermore the computations are based on the analysis of one individual at

each stage. Individual variation need not be great to cause discrepancies in calculated data.

TABLE 3.—NUTRIENTS CONSUMED PER PIG FOR THE STAGES INDICATED.

Type*	Stage lbs.	Protein lbs.	Fat lbs.	Crude fiber lbs.	N-Free extract lbs.
B	100-150	55.284	12.491	14.355	169.546
L	100-150	57.959	13.551	14.906	172.921
B	100-200	82.121	18.768	20.603	252.125
L	100-200	92.138	22.192	22.644	280.671
B	100-250	121.019	29.173	29.226	383.692
L	100-250	133.365	32.354	32.510	423.906
B	100-300	207.077	50.602	49.683	665.416
L	100-300	190.786	47.038	45.214	606.791
B	150-200	26.972	6.308	6.284	82.955
L	150-200	34.440	8.704	7.765	108.553
B	200-250	39.445	10.531	8.762	133.194
L	200-250	41.294	10.175	9.888	143.423
B	250-300	87.296	21.733	20.758	285.586
L	250-300	56.276	14.400	12.435	179.143

*B—Bacon type, L—Lard type.

Slaughter House Procedure and Data.—The animal was stunned with a hammer, hoisted to an overhead scale and weighed. It was bled by sticking, and the hair and scurf removed by scalding and scraping. The weights of both the blood, and the hair and scurf, were determined by difference. The latter material was discarded.

The internal organs, including the tongue, were removed in the usual manner and weighed. The alimentary tract was opened, and was washed with water after removal of the contents. The loss in weight was called the "fill". The carcass was divided into the right and left sides as evenly as possible and the brain and spinal cord removed and weighed.

The various internal organs were divided into edible and inedible parts. The edible portion included the tongue, marketable heart, liver, brain, the caul and intestinal fat. The inedible portion included the eyes, genito-urinary system, spleen, pancreas, alimentary tract, gall bladder (without contents), lungs, inedible portion of the heart, the kidneys, diaphragm, and hide.

Each half of the carcass was weighed, and removed to the refrigerator to cool. The slaughter house data are reproduced in Table 4.

Physical Analyses of Carcasses and Observations on Cured Cuts.—After a carcass had been in the refrigerator for 48 hours, it was removed for further study. Each half of the carcass was reweighed to determine the shrinkage. As is to be expected the lighter carcasses lost most in weight, chiefly because they have a thinner covering of fat and so allowed more rapid evaporation of moisture. It is seen that as the animals increase in weight the dressing percentages also increase, and that there

TABLE 4.—SLAUGHTER HOUSE RECORDS

No. of Pig and Type	13B-y*	60B-p	3B-y	6B-p	53B-y	12B-p	33S-y	40S-p	33B-y	10B-p
Age, Days	127	123	176	183	198	206	226	229	275	264
Live Weight at Swine Barn	99.0	97.5	165.0	163.0	203.0	205.0	251.0	262.0	295.0	314.0
Live Weight at Slaughter House	97.0	90.3	163.0	166.0	198.0	198.0	246.0	260.0	288.0	305.0
Empty Weight	87.65	84.32	151.90	153.03	186.80	190.05	236.70	248.00	280.70	294.30
Blood	4.25	3.30	4.50	4.60	5.00	6.00	7.30	9.00	5.30	6.95
Hair and Scurf	0.80	0.50	1.00	0.90	3.00	0.75	1.00	4.40	1.00	1.00
Genito-Urinary System	0.50	0.30	0.59	0.55	0.80	0.75	1.00	1.60	0.70	1.00
Spleen	0.15	0.20	0.20	0.18	0.30	0.20	0.40	0.30	0.60	0.30
Pancreas	0.18	0.10	0.30	0.28	0.30	0.20	0.65	0.50	0.30	0.45
Gullet	0.18	0.10	0.30	0.20	0.20	0.20	0.10	0.20	0.20	0.30
Stomach	1.20	1.05	1.40	1.53	1.90	1.90	2.35	2.20	2.30	2.50
Small Intestine	3.35	3.00	4.05	4.00	4.20	3.50	4.35	4.50	4.70	5.30
Large Intestine	†2.80	2.50	4.10	3.40	4.25	3.70	3.80	4.75	5.10	7.30
Caul and Intestinal Fat	0.70	1.00	2.30	2.00	3.00	3.00	4.80	3.75	6.20	5.50
Liver and Gall bladder	2.25	2.40	3.45	3.95	3.65	3.40	4.25	5.25	4.20	5.40
Heart, Edible	0.30	0.25	0.40	0.40	0.40	0.40	0.45	0.50	0.60	0.70
Heart, Inedible	0.10	0.13	0.10	0.20	0.20	0.10	0.20	0.20	0.20	0.20
Lungs	1.00	1.00	2.00	2.00	1.50	2.40	3.45	3.20	3.10	2.70
Trachea	0.20	0.15	0.20	0.20	0.35	0.20	0.30	0.30	0.40	0.30
Diaphragm	0.30	0.10	0.15	0.16	0.28	0.50	0.50	0.55	0.60	0.70
Tongue	0.40	0.50	0.70	0.65	0.90	0.80	0.80	1.00	0.80	1.10
Brain	0.20	0.20	0.20	0.25	0.20	0.20	0.20	0.30	0.20	0.25
Spinal Cord	0.10	0.05	0.10	0.10	0.10	0.10	0.10	0.10	---	---
Tail	0.20	0.10	0.20	0.20	0.20	0.25	0.25	0.25	0.20	0.30
Contents Urinary Bladder	0.00	0.00	0.00	0.15	0.40	0.35	0.00	0.20	0.20	0.40
Contents Alimentary Tract	9.35	5.98	11.10	12.82	10.80	7.60	9.30	11.80	7.10	10.30
Carcass and Head	69.0	68.0	126.0	124.5	153.5	159.0	197.0	206.0	240.0	247.0
Right Half	34.5	33.0	61.0	63.0	78.5	80.0	97.0	102.0	120.0	123.0
Left Half	34.5	33.0	63.0	62.0	76.0	80.0	98.0	103.0	120.0	124.0
Kidney, Right	0.18	0.20	0.30	0.30	0.30	0.20	0.30	0.40	0.30	0.40
Kidney, Left	0.20	0.20	0.35	0.30	0.30	0.20	0.30	0.40	0.30	0.50
Skeleton	13.80	10.74	17.79	17.97	23.33	22.89	24.75	25.20	28.03	26.80
Length—Small Intestine	51 ft. 2 in.	57 ft. 10 in.	70 ft. 5 in.	61 ft. 4 in.	69 ft. 4 in.	69 ft.	68 ft.	73 ft. 2 in.	77 ft.	66 ft. 5 in.
Length—Large Intestine	14 ft.	11 ft. 11 in.	16 ft.	15 ft. 10 in.	18 ft. 9 in.	18 ft. 4 in.	19 ft. 6 in.	18 ft.	17 ft.	18 ft. 8 in.

*Each pig is identified by a numeral and large capital. The capital letter also indicates whether an individual is a barrow or sow. The small letter following the dash indicates the breed. For example, 13 B-y is a Yorkshire barrow, and 40 S-p is a Poland China sow.

†An error in our records makes this value uncertain, so we are using a weight derived by calculation rather than the one recorded. The uncertainty of course also extends to the empty weight of the animal.

is no consistent difference between Yorkshires and Poland Chinas of the same weight.

The weight of the caul and intestinal fat varied from 0.7 pounds in the lightest Yorkshire to 6.2 pounds in the heaviest Yorkshire. On a percentage basis there is little difference between the two breeds at the same weight. Neither are there any appreciable differences between the breeds as regards quantity of leaf fat.

TABLE 5.—SLAUGHTER TESTS.

Stage	Live weight, (lbs.)	Dressed wt. (lbs.)	Dressing percentage	Wt. of carcass after chilling (lbs.)	Caul and Intest. fat, per cent live weight	Leaf fat, percentage of chilled weight
100 lbs.						
Yorkshire---	97	69	71.1	67.0	0.7	0.9
Poland -----	90	68	75.0	64.5	1.1	0.6
150 lbs.						
Yorkshire---	163	124	76.1	120	1.4	1.4
Poland -----	166	125	75.3	122	1.2	1.4
200 lbs.						
Yorkshire---	198	155	77.7	151	1.5	1.6
Poland -----	198	160	80.0	156	1.5	1.6
250 lbs.						
Yorkshire---	246	197	80.0	194	1.9	2.9
Poland -----	260	206	79.0	202	1.4	2.2
300 lbs.						
Yorkshire---	288	240	83.0	240	2.1	3.5
Poland -----	305	247	81.0	244	1.8	3.5

TABLE 6.—WEIGHTS OF WHOLESALE CUTS, UNTRIMMED.

Stage	Shoulder	Loin	Ham	Bacon	Jowl	Leaf fat	Head	Sparerib
	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>
100 lbs.								
Yorkshire-----	9.1	7.0	8.6	3.5	1.6	0.3	2.7	0.8
Poland-----	8.3	6.5	8.7	3.7	1.3	0.2	4.0	0.7
150 lbs.								
Yorkshire-----	14.0	14.5	14.9	7.3	2.9	0.9	5.2	1.2
Poland-----	14.1	13.5	15.0	8.6	2.9	0.9	4.8	1.1
200 lbs.								
Yorkshire-----	18.0	19.1	17.5	9.5	2.6	1.2	4.8	1.4
Poland-----	19.6	17.0	18.7	10.5	2.8	1.3	5.1	1.2
250 lbs.								
Yorkshire-----	22.3	25.3	21.9	12.9	3.4	3.1	5.4	2.0
Poland-----	24.8	20.9	25.4	15.1	3.6	2.2	6.2	2.1
300 lbs.								
Yorkshire-----	29.0	31.8	26.8	16.8	2.7	3.0	6.0	2.1
Poland-----	25.4	27.7	26.9	21.5	2.2	4.0	6.0	2.3

After the carcass had chilled thoroughly (48 hours), the left side was divided into head, jowl, shoulder, loin, bacon, sparerib, and ham. The leaf fat had been removed from both sides before cutting up the carcasses. Examination of the records (Tables 6 and 7) indicates that there are breed differences in the weight of the loin and bacon. The loin from the

Yorkshire was consistently the heavier, due presumably to the fact as shown in figure 4 (page 32) that this breed has a longer body. On the other hand the larger percentage of bacon was with equal consistency obtained from the Poland China carcasses. It would seem that this must have been due to greater thickness or depth, but if so the difference was

TABLE 7.—WEIGHTS OF WHOLESALE CUTS TRIMMED.

Stage	Shoulder	Loin	Ham	Bacon
	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>
100 lbs.				
Yorkshire.....	6.6	5.5	7.2	2.3
Poland.....	6.6	4.9	7.3	2.4
150 lbs.				
Yorkshire.....	11.0	9.8	12.6	5.5
Poland.....	10.5	8.7	12.7	6.4
200 lbs.				
Yorkshire.....	12.9	11.0	15.00	6.2
Poland.....	14.3	10.6	16.1	7.5
250 lbs.				
Yorkshire.....	17.1	14.7	18.6	10.0
Poland.....	18.8	13.7	21.5	11.5
300 lbs.				
Yorkshire.....	20.8	15.0	22.9	12.1
Poland.....	20.0	14.0	22.0	16.2

TABLE 8.—UNTRIMMED WHOLESALE CUTS, PERCENTAGE OF CARCASSES.

Stage	Shoulder	Loin	Ham	Bacon	Jowl	Leafat	Head	Sparerib
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
100 lbs.								
Yorkshire.....	27.1	20.8	25.7	10.4	2.3	0.9	12.6	0.6
Poland.....	25.7	20.1	26.9	11.4	2.0	0.6	13.0	0.6
150 lbs.								
Yorkshire.....	23.3	24.1	24.8	12.1	2.4	1.5	11.7	0.5
Poland.....	23.1	22.1	24.6	14.0	2.3	1.4	12.3	0.5
200 lbs.								
Yorkshire.....	23.8	25.2	23.1	12.5	1.7	1.6	13.3	0.4
Poland.....	25.1	21.8	23.8	13.4	1.8	1.6	12.3	0.5
250 lbs.								
Yorkshire.....	23.0	26.0	22.5	13.2	1.7	3.2	12.5	0.3
Poland.....	24.5	20.6	25.1	14.9	1.7	2.2	10.9	0.4
300 lbs.								
Yorkshire.....	24.2	26.5	22.3	14.0	1.1	2.5	8.4	0.3
Poland.....	20.8	22.7	22.0	17.6	2.4	3.2	10.9	0.4

not evident on mere inspection. The differences among the other cuts were slight or not consistent as between breeds. It seems worthwhile to note that as the animals became heavier, the percentages of shoulder and sparerib to carcass constantly decrease; also to a lesser extent the percentage of ham. There is a similar tendency for the percentage of head to decrease, but this is not consistent. On the other hand there is a tendency for the loin and bacon to increase in percentage of the carcass as the animals grow and fatten.

TABLE 9.—LEAN, FAT, AND BONE IN WHOLESALE CUTS.

Stage	100-lb. Stage		150-lb. Stage		200-lb. Stage		250-lb. Stage		300-lb. Stage	
	Yorkshire	Poland	Yorkshire	Poland	Yorkshire	Poland	Yorkshire	Poland	Yorkshire	Poland
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
Shoulder										
Lean.....	76.5	74.7	72.3	72.9	69.0	66.9	63.6	65.8	62.8	59.3
Fat.....	9.3	10.2	14.8	15.4	17.2	23.0	26.6	24.5	28.9	30.0
Bone.....	14.2	15.1	12.8	11.7	13.8	10.1	9.7	9.7	8.3	10.7
Ham										
Lean.....	75.0	76.9	72.7	71.6	71.4	71.7	62.9	69.9	60.9	59.3
Fat.....	11.7	7.7	20.6	18.5	17.1	18.6	28.2	21.4	30.4	30.4
Bone.....	13.3	15.4	6.6	9.9	11.5	9.7	8.9	8.7	8.7	10.3
Bacon										
Lean.....	82.3	73.6	57.9	58.8	46.3	56.1	47.7	36.7	38.8	41.4
Fat.....	17.7	26.4	42.1	41.2	53.7	43.9	53.5	63.3	61.2	58.6
Bone.....	---	---	---	---	---	---	---	---	---	---
Loin										
Lean.....	68.1	67.9	76.1	65.1	61.8	66.3	63.3	69.2	57.1	62.0
Fat.....	8.6	9.7	8.0	14.0	14.5	11.8	17.6	11.5	22.4	17.9
Bone.....	23.3	22.4	15.9	20.9	23.7	21.9	19.1	19.3	20.5	20.1

Since the left side was used in curing tests, the physical analyses were made on the right side. The skin was removed first, the remainder was divided into the usual wholesale cuts, and then the lean, fat, and bone were separated. The weight of fat thus obtained is of course too low, for some fat was removed and weighed with the hides. The data expressed as percentages, appears in Table 9. So far as the breeds are concerned we believe the data show no significant differences. As we would expect however, there are differences between the younger hogs, and those that are older and heavier. The percentages of bone and lean constantly decrease as the animals gain in weight, while the percentage of fat increases.

TABLE 10.—SHRINKAGE OF FRESH MEAT WHEN PICKLED AND SMOKED.

Stage	Ham	Bacon	Shoulder	Jowl
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
100 lbs.				
Yorkshire.....	12.6	19.0	12.4	13.3
Poland.....	11.0	22.9	12.3	16.0
150 lbs.				
Yorkshire.....	7.2	7.2	7.3	9.0
Poland.....	9.0	13.5	10.8	12.0
200 lbs.				
Yorkshire.....	10.8	14.7	11.0	16.6
Poland.....	8.9	10.8	9.1	7.1
250 lbs.				
Yorkshire.....	3.7	6.0	4.6	11.7
Poland.....	5.2	3.6	4.3	5.7
300 lbs.				
Yorkshire.....	4.8	4.2	4.9	3.8
Poland.....	8.1	7.4	8.5	8.0

The wholesale cuts from the left side were then cured and smoked. They were weighed before and after they were placed in the brine, and again after smoking. The cuts from hogs of the same weight made about the same gains while in the brine. The losses during the curing process were calculated as percentages of the fresh cuts, and the results are presented in Table 10. The shrinkage of the meat while being cured is governed chiefly by the age and weight of the animal. As would be expected, the shrinkage decreases as the weight of the cuts increases. Apparently there are no breed differences in regard to shrinkage. The weights of the cured cuts are given in Table 11.

The fat backs and trimmings from the left side, and the fat separated from the right side were rendered for lard. The fat and lard were weighed and the percentage of rendered lard calculated (Table 12). This varied from 38.6 to 87.3 per cent. In every case but one when comparing animals of equal weight, the Yorkshires yielded the larger percentage of lard, the difference varying from nothing to 10.3 per cent. The per-

centage of water varied from 6.0 to 29.6 per cent, and was larger for the Poland Chinas by 4 to 5 per cent. We are not certain however that any significance should be attached to these differences.

TABLE 11.—WEIGHTS OF WHOLESALE CUTS AFTER CURING.

Stage	Shoulder	Ham	Bacon	Jowl
	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>
100 lbs.				
Yorkshire.....	5.7	6.2	1.7	1.3
Poland.....	5.7	6.45	1.85	1.05
150 lbs.				
Yorkshire.....	10.1	11.6	5.1	2.0
Poland.....	9.0	11.2	5.1	2.2
200 lbs.				
Yorkshire.....	11.3	13.2	5.2	2.0
Poland.....	12.9	14.6	6.6	2.6
250 lbs.				
Yorkshire.....	16.3	17.9	9.4	3.0
Poland.....	17.5	19.8	10.5	3.3
300 lbs.				
Yorkshire.....	19.4	21.4	11.3	2.5
Poland.....	18.3	20.3	15.0	4.6

TABLE 12.—LARD TESTS, COMBINED FAT BACKS, LEAF FAT, AND FAT FROM THE PHYSICAL ANALYSIS.

Stage	Weight of fat	Rendered lard	Cracklings	Water in fat
	<i>lbs.</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
100 lbs.				
Yorkshire.....	6.8	44.0	26.4	29.6
Poland.....	5.7	38.6	33.4	28.0
150 lbs.				
Yorkshire.....	18.7	71.0	14.0	15.0
Poland.....	23.0	63.4	14.9	21.7
200 lbs.				
Yorkshire.....	35.0	70.0	12.9	17.1
Poland.....	28.2	64.0	18.0	18.0
250 lbs.				
Yorkshire.....	50.0	79.0	10.0	11.0
Poland.....	47.0	79.0	10.5	10.5
300 lbs.				
Yorkshire.....	75.0	87.3	6.7	6.0
Poland.....	67.0	77.0	9.6	13.4

CHEMICAL ANALYSES

After the carcass had been in the refrigerator 48 hours and was thoroughly chilled, the right half was removed from the refrigerator and prepared for sampling. The skin was removed, and then the lean, fat, and bone separated as completely as possible by hand. These portions were then weighed. At this stage it is seen that the animal was divided into the following parts: (1) blood, (2) inedible offal, (3) the edible portion of the internal organs, (4) lean, composed of muscle tissue, (5) hand-separated fat, excluding caul and intestinal fat, (6) bone.

In order to reduce the number of analyses, these six portions were finally reduced to three. The blood and inedible offal were ground up together, being run through the sausage grinder three times, using as fine a plate as possible. This material was called the inedible offal, and was labeled Sample A. The bone was ground in a bone cutter, and analyzed separately. This formed Sample B. The edible portion of the internal organs was then ground and set aside. The lean and fat were then ground separately, using care to insure that the material was homogeneous. The material was run through a sausage grinder, mixed by hand, then run through the grinder again. After another mixing by hand, aliquots were weighed out from the lean, fat, and edible internal organs. These were mixed by hand, run through a small sausage mill, and again mixed by hand. This mixture, designated as Sample C, contained the edible portion of the animal, excepting of course such edible matter as can be obtained from the bones.

The process of separating the lean, fat, and bone was very time-consuming, and as most of the animals were slaughtered in hot weather, the losses due to evaporation were quite large. The method of correcting for this loss will be explained later.

Methods of Analysis.—The samples were analyzed for water, fat, protein, and ash following closely the methods of the Association of Official Agricultural Chemists. All analyses were run in triplicate.

Water.—Each sample was weighed out and placed in a glass extraction tube which had been prepared as follows. The tube was stuffed rather firmly with absorbent cotton that had been extracted with ether, and then dried to constant weight in an electrically heated vacuum oven. When the sample was ready for analysis, the greater part of the cotton was removed from the tube and spread upon a piece of smooth clean glass. A sample of 4-5 grams was then weighed out and thoroughly incorporated in the cotton. The mixture was pushed back into the extraction tube again, transferred to a vacuum desiccator, and with the usual precautions dried to constant weight. In the case of the bones, the procedure was the same, but because of the difficulty in obtaining a representative sample, samples of 30 and 40 grams were used.

Fat.—After the determination of moisture had been completed the same sample was used for fat extraction. After it had been dried to constant weight, it was transferred to a Soxhlet fat extractor, and extracted with anhydrous ether for 24 hours. Essentially the same precautions were observed in drying to constant weight as in the water determination, and all ether soluble material was called fat. It is sometimes the practice to grind the bones after the first extraction and then subject them to a second extraction. The percentage of fat determined is increased

slightly by this procedure but the quantity is usually less than the experimental error, and we did not believe the extra precaution necessary.

Ash.—Samples of 4-5 grams were heated in porcelain crucibles at a faint red heat until constant weights were obtained. When material high in fat is ignited, the oxidation is much accelerated if a wick of ashless filter paper is placed in the crucible and lighted. Practically all the fat can be removed in that manner.

TABLE 13.—WEIGHT OF ANIMALS AND OF LOSSES DURING PREPARATION OF MATERIAL FOR ANALYSIS.

No. of pig	Live weight		Empty weight		Weight after preparation for analysis		Loss of water during preparation for analysis		
	lbs.	kgm	lbs.	kgm	lbs.	kgm	lbs.	kgm	per cent
13B	97	43.999	87.65	39.758	83.70	37.965	3.95	1.793	4.51
60B	90.3	40.960	84.32	38.248	77.00	34.929	7.32	3.319	8.68
3B	163	73.937	151.90	68.902	139.49	63.270	12.42	5.631	8.17
6B	166	75.298	153.03	69.414	143.42	65.055	9.61	4.359	6.28
53B	198	89.813	186.80	84.732	179.94	81.621	6.86	3.111	3.67
12B	198	89.813	190.05	86.207	180.85	82.033	9.20	4.173	4.84
33S	246	111.586	236.70	107.367	224.55	101.853	12.16	5.514	5.14
40S	260	117.936	248.00	112.493	235.09	106.637	12.91	5.856	5.20
33S	288	130.637	280.70	127.326	267.32	121.257	13.38	6.068	4.77
10B	305	138.348	294.30	133.494	283.51	128.597	10.80	4.897	3.67

Nitrogen and Protein.—The nitrogen determinations were made in the usual manner. Copper instead of mercury was used as a catalyst during the digestion, and of course potassium sulphide was omitted from the solution of strong sodium hydroxide. The sulphuric acid digestion was carried out in 800 c.c. Kjeldahl flasks of Pyrex glass. The nitrogen as determined was multiplied by the conventional factor 6.25 to calculate the protein present.

Our analytical data are presented in tabular form. Table 13 shows the weights on which our calculations are based. Table 14 contains the results of our analyses as actually made. In Table 15 are presented the calculated analyses on a live-weight basis, and in Table 16 the calculations on an empty-weight basis.

TABLE 14.—COMPOSITION OF SWINE, ANALYTICAL DATA.*

13B. Bacon Type, Weight 97 lbs.

Sample	A		B		C		Total	
	%	grams	%	grams	%	grams	%	grams
Weight.....	100	9608	100	6260	100	22097	100	37965
Moisture.....	64.64	6210.61	53.45	3345.97	62.68	13850.40	61.65	23406.98
Nitrogen.....	2.57	246.93	2.94	184.04	2.49	550.21	2.59	981.18
Protein.....	16.06	1543.31	18.38	1850.25	15.56	3438.81	16.15	6132.37
Fat.....	17.57	1688.13	13.78	862.63	20.69	4571.87	18.76	7122.63
Ash.....	0.89	85.51	14.24	891.42	1.00	220.97	3.16	1197.90
Total.....	99.16	9527.56	99.85	6250.27	99.93	22082.05	99.72	37859.88

*As previously explained, the animal was divided in three parts for chemical analysis. A represents the inedible offal, B the bone, and C the edible material.

60B. Lard Type, weight 90.3 lbs.

Sample	A		B		C		Total	
	%	grams	%	grams	%	grams	%	grams
Weight.....	100	9439	100	4870	100	20620	100	34929
Moisture.....	65.28	6161.78	51.37	2501.72	65.70	13547.34	63.59	22210.84
Nitrogen.....	2.48	234.09	3.17	154.38	2.55	525.81	2.62	914.28
Protein.....	15.50	1463.06	19.81	964.88	15.94	3286.31	16.36	5714.25
Fat.....	19.29	1820.78	9.89	481.64	18.81	3878.62	17.70	6181.04
Ash.....	0.84	79.29	18.01	877.09	1.16	239.19	3.42	1195.57
Total.....	100.91	9524.91	99.08	4825.33	101.61	20951.46	101.07	35301.70

3B Bacon Type, weight 163 lbs.

Sample	A		B		C		Total	
	%	grams	%	grams	%	grams	%	grams
Weight.....	100	14550	100	8070	100	40650	100	63270
Moisture.....	59.35	8635.42	46.94	3788.06	52.57	21369.71	53.41	33793.19
Nitrogen.....	2.44	355.02	3.10	250.17	2.26	918.69	2.41	1523.88
Protein.....	15.25	2218.88	19.38	1563.56	14.13	5741.81	15.05	9524.25
Fat.....	26.01	3784.46	15.48	1249.24	31.73	1289.25	28.34	17931.95
Ash.....	0.79	114.95	18.48	1491.34	0.78	317.07	3.04	1923.36
Total.....	101.40	14753.71	100.28	8092.20	99.21	40326.84	99.84	63172.75

6B Lard Type, weight 166 lbs.

Sample	A		B		C		Total	
	%	grams	%	grams	%	grams	%	grams
Weight.....	100	15280	100	8150	100	41625	100	65055
Moisture.....	58.17	8888.38	47.45	3867.18	52.47	21810.64	53.13	34566.20
Nitrogen.....	2.73	417.14	3.22	262.43	2.11	878.29	2.39	1557.86
Protein.....	17.06	2607.13	20.13	1640.19	13.19	5489.31	14.97	9736.63
Fat.....	28.56	4361.97	16.08	1310.52	34.87	14514.64	31.03	20187.13
Ash.....	0.73	111.54	17.84	1453.96	0.97	403.76	3.03	1969.26
Total.....	104.52	15969.02	101.50	8271.85	101.50	42218.35	102.16	66459.22

53B Bacon Type, weight 198 lbs.

Sample	A		B		C		Total	
	%	grams	%	grams	%	grams	%	grams
Weight.....	100	15726	100	10580	100	55315	100	81621
Moisture.....	60.64	9536.25	46.26	4894.31	48.44	26794.59	50.51	41225.15
Nitrogen.....	2.93	460.77	3.13	331.15	2.12	1172.68	2.41	1964.59
Protein.....	18.31	2879.81	19.56	2069.69	13.25	7329.25	15.04	12278.75
Fat.....	22.31	3508.47	17.54	1855.73	37.28	20621.43	31.84	25985.63
Ash.....	0.73	114.80	16.46	1741.47	0.73	403.80	2.77	2260.07
Total.....	101.99	16039.33	99.82	10561.20	99.70	55149.19	100.16	81749.60

12B Lard Type, weight 198 lbs.

Sample	A		B		C		Total	
	%	grams	%	grams	%	grams	%	grams
Weight.....	100	16616	100	10384	100	55033	100	82033
Moisture.....	59.17	9831.69	44.00	4568.08	50.99	28061.33	51.76	42461.10
Nitrogen.....	2.79	463.59	3.10	321.84	2.21	1216.23	2.44	2001.66
Protein.....	17.44	2897.44	19.38	2011.50	13.81	7601.44	15.25	12510.38
Fat.....	22.50	3738.60	17.08	1772.25	34.78	19140.48	30.05	24651.33
Ash.....	0.72	119.64	17.06	1771.17	0.74	407.24	2.80	2298.05
Total.....	99.83	13587.37	97.52	10123.00	100.32	55210.49	99.86	81920.86

RELATION OF FEED CONSUMED TO PROTEIN & ENERGY RETENTION 17

33S Bacon Type, Weight 246 Lbs.

Sample	A		B		C		Total	
	%	grams	%	grams	%	grams	%	grams
Weight.....	100.00	17478.00	100	11224.00	100.00	73151.00	100	101853.00
Moisture.....	61.93	10824.13	40.58	4554.70	41.75	30540.54	45.08	45919.37
Nitrogen.....	2.69	470.16	3.21	360.29	1.83	1338.66	2.13	2169.11
Protein.....	16.81	2938.50	20.06	2251.81	11.44	8355.63	13.31	13556.94
Fat.....	23.56	4117.82	16.17	1814.92	46.00	33649.46	38.86	39582.20
Ash.....	0.75	131.09	20.08	2253.78	0.59	431.59	2.77	2816.40
Total.....	102.05	18011.54	96.89	10875.21	99.78	72988.22	100.02	101874.97

40S Lard Type, Weight 260 Lbs.

Sample	A		B		C		Total	
	%	grams	%	grams	%	grams	%	grams
Weight.....	100.00	21246.00	100.00	11432.00	100.00	73959.00	100.00	106637.00
Moisture.....	59.91	12728.48	42.61	4871.18	46.28	34228.23	48.60	51827.89
Nitrogen.....	2.85	605.51	3.01	344.10	1.97	1456.99	2.26	2406.60
Protein.....	17.81	3784.44	18.81	2150.63	12.31	9106.19	14.11	15041.26
Fat.....	20.76	4410.67	17.21	1967.45	40.31	29812.87	33.94	36190.99
Ash.....	0.80	169.97	20.79	2376.71	0.74	547.30	2.90	3093.98
Total.....	99.38	21093.56	99.42	11365.97	99.64	73694.59	99.55	106154.12

33B Bacon Type, Weight 288 Lbs.

Sample	A		B		C		Total	
	%	grams	%	grams	%	grams	%	grams
Weight.....	100.00	18836.00	100	12716.00	100	89705.00	100	121357.00
Moisture.....	53.02	9986.85	40.17	5108.02	36.55	32787.18	39.49	47882.05
Nitrogen.....	2.50	470.90	3.27	415.81	1.70	1524.99	1.99	2411.70
Protein.....	15.63	2943.13	20.44	2598.81	10.63	9531.19	12.44	15073.13
Fat.....	29.77	5607.48	19.07	2424.94	51.85	46512.04	44.99	54544.46
Ash.....	0.65	122.43	16.63	2114.67	0.57	511.32	2.27	2748.42
Total.....	99.07	18659.89	96.31	12246.44	99.60	85341.73	99.19	121066.60

10B Lard Type, Weight 305 Lbs.

Sample	A		B		C		Total	
	%	grams	%	grams	%	grams	%	grams
Weight.....	100.00	26809.00	100.00	12156.00	100.00	89632.00	100.	128597.00
Moisture.....	51.36	13769.10	39.44	4794.33	37.10	33253.47	40.29	51816.90
Nitrogen.....	2.50	670.23	3.23	392.64	1.59	1425.15	1.94	2488.02
Protein.....	15.63	4188.94	20.19	2454.00	9.94	8907.19	12.09	15550.13
Fat.....	30.88	8278.62	19.82	2409.32	51.67	46312.79	44.33	57000.73
Ash.....	0.68	182.30	17.32	2094.48	0.54	484.01	2.15	2760.79
Total.....	98.55	26418.96	96.77	11752.13	99.25	88957.46	98.86	127128.55

In the calculation of the water lost during preparation of the material for analysis, the weight of the material when ready for analysis was subtracted from the empty weight. In estimating the water as given in Tables 15 and 16, this water lost by evaporation was added to the amount as actually determined by analysis. There was also a small loss of solids, but this was insignificant and the amount could not be determined.

TABLE 15.—COMPOSITION OF ANIMALS LIVE WEIGHT BASIS*.

Number of Pig and stage.	Type†	Moisture per cent	Protein per cent	Fat per cent	Ash per cent	Fill per cent
100 lbs.						
13B	B	57.27	13.94	16.19	2.72	9.64
60B	L	62.33	13.95	15.09	2.92	6.62
150 lbs.						
3B	B	53.32	12.88	24.25	2.60	6.81
6B	L	51.69	12.93	26.81	2.62	7.81
200 lbs.						
53B	B	49.36	13.67	28.93	2.52	5.66
12B	L	51.92	13.93	27.44	2.56	4.02
250 lbs.						
33S	B	46.09	12.15	35.47	2.52	3.78
40S	L	48.91	12.75	30.69	2.62	4.62
300 lbs.						
33B	B	41.30	11.54	41.75	2.10	2.53
10B	L	40.99	11.24	41.20	2.00	3.51

*Weight taken just before slaughtering

†B-Bacon type, L-Lard type.

TABLE 16.—COMPOSITION OF ANIMALS, EMPTY WEIGHT BASIS*.

Number of Pig	Type*	Moisture per cent	Protein per cent	Fat per cent	Ash per cent
100 lbs.					
13B	B	63.38	15.43	17.92	3.01
60B	L	66.76	14.94	16.16	3.12
150 lbs.					
3B	B	57.21	13.82	26.02	2.81
6B	L	56.07	14.03	29.08	2.83
200 lbs.					
53B	B	52.32	14.49	30.67	2.66
12B	L	53.99	14.48	28.54	2.66
250 lbs.					
33S	B	47.90	12.63	36.87	2.62
40S	L	51.28	13.37	32.14	2.75
300 lbs.					
33B	B	42.40	11.83	42.81	2.18
10B	L	42.48	11.63	42.64	2.06

*Live weight at Slaughter house minus weight of contents of the alimentary tract.

†B-Bacon type; L-Lard type.

Concerning the tables themselves little comment is necessary. It is well known that as animals grow and gain in weight, the percentage of fat increases, and the percentage of other constituents decreases. In this connection a comparison of our analyses with others that have been reported suggests itself. C. O. Swanson⁴ of the Kansas Station has

RELATION OF FEED CONSUMED TO PROTEIN & ENERGY RETENTION 19

recently reported the analyses of a number of swine used in their investigations. We are not sure that our results are strictly comparable, for we infer that Swanson did not make a correction for water lost during preparation of the material for analysis. However, a few of their analyses, of animals that presumably made normal growth and that weighed approximately the same as some of ours, are reproduced below.

TABLE 17.—ANALYSES OF SWINE REPORTED BY THE KANSAS STATION.

Empty weight	Moisture	Ash	Protein	Ether extract
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
<i>lbs.</i> 192.20	44.86	2.61	12.30	44.20
195.66	41.18	2.46	12.03	40.72
199.71	44.78	2.74	12.69	40.84
209.95	36.49	1.96	10.81	51.21
211.22	39.33	2.10	12.65	46.71
245.15	37.39	2.02	11.33	46.30
318.93	32.68	1.60	10.37	52.42

A comparison of Table 17 with Tables 14, 15 or 16 shows clearly that the animals analyzed by the Kansas Station contained a larger percentage of fat and a smaller percentage of protein than those used in our investigations. Their researches as described in the report cited ended in 1915; ours were conducted in 1921. The Missouri pigs were either of the present-day "Big Type" Poland Chinas, or Large Yorkshires; theirs were presumably of the quicker maturing type which feeders of that time preferred. To our mind a comparison of these analyses indicates clearly the change that has taken place in the selection and breeding of swine.

On the following pages is presented a series of calculations, giving the edible material in the animals when slaughtered, the gains in protein, fat and energy, and the relation of feed consumed to gains in weight and nutrients.

TABLE 18.—QUANTITY AND CHARACTER OF THE EDIBLE CONSTITUENTS OF ANIMALS SLAUGHTERED.

Number of pig, and stage.	Type†	Protein		FAT	
		Percentage of empty weight	Percentage of total protein	Percentage of empty weight	Percentage of total fat
100 lbs.—13B	B	8.65	56.08	11.50	64.19
60B	L	8.59	57.51	10.14	62.76
150 lbs.—3B	B	8.33	60.29	18.71	71.90
6B	L	7.91	56.38	20.91	71.90
200 lbs.—53B	B	8.65	59.61	24.34	79.36
12B	L	8.82	60.76	22.20	77.64
250 lbs.—33S	B	7.79	61.71	31.34	85.01
40S	L	8.10	60.54	26.50	82.38
300 lbs.—33B	B	7.49	63.23	36.53	85.27
10B	L	6.67	57.28	34.69	81.25

†B—Bacon type, L—Lard type.

TABLE 19.—AMOUNT PROTEIN AND FAT STORED BY HOGS AT VARIOUS STAGES OF GROWTH.

Type-Stage	Initial weight	Final weight	Initial protein content	Final protein content	Gain in protein	Initial fat content	Final fat content	Gain in fat
	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>	<i>lbs.</i>
B 100-150	93.9	160.9	13.09	20.72	7.63	15.20	39.02	23.82
L 100-150	92.7	167.2	12.93	21.62	8.69	13.99	44.83	30.84
B 100-200	94.4	202.9	13.16	27.74	14.58	15.28	58.70	43.42
L 100-200	93.4	204.5	13.03	28.49	15.46	14.09	56.11	42.02
B 100-250	95.2	244.3	13.27	29.68	16.41	15.41	86.65	71.24
L 100-250	95.2	255.9	13.28	32.63	19.35	14.37	78.54	64.17
B 100-300	94.1	318.1	13.12	36.71	23.59	15.23	132.81	117.58
L 100-300	94.1	302.6	13.13	34.01	20.88	14.20	124.67	110.47
B 150-200	160.3	202.9	20.65	27.74	7.09	38.87	58.70	19.83
L 150-200	167.6	204.5	21.67	28.49	6.82	44.93	56.11	11.18
B 200-250	201.6	244.3	27.56	29.68	2.12	58.32	86.65	28.33
L 200-250	204.5	255.9	28.49	32.63	4.14	56.11	78.54	22.43
B 250-300	242.1	318.1	29.42	36.71	7.29	85.87	132.81	46.94
L 250-300	253.7	302.6	32.35	34.01	1.66	77.86	124.67	46.81

TABLE 20.—QUANTITY AND CHARACTER OF ENERGY STORED BY SWINE AT VARIOUS STAGES.

Description of Animal		Protein stored		Fat stored		Total energy stored Therms
Type	Stage (lbs.)	Pounds	Therms	Pounds	Therms	
B.....	100-150	7.63	19.650	23.82	102.540	122.190
L.....	100-150	8.69	22.379	30.84	132.760	155.139
B.....	100-200	14.58	37.548	43.42	186.914	224.462
L.....	100-200	15.46	39.814	42.02	180.888	220.702
B.....	100-250	16.41	42.261	71.24	306.674	348.935
L.....	100-250	19.35	49.832	64.17	276.239	326.071
B.....	100-300	23.59	60.751	117.58	506.158	566.909
L.....	100-300	20.88	53.772	110.47	475.551	529.323
B.....	150-200	7.09	18.259	19.83	85.364	103.623
L.....	150-200	6.82	17.564	11.18	48.128	65.692
B.....	200-250	2.12	5.460	28.33	121.955	127.415
L.....	200-250	4.14	10.662	22.43	96.557	107.219
B.....	250-300	7.29	18.774	46.94	202.067	220.841
L.....	250-300	1.66	4.275	46.81	201.508	205.783

TABLE 21.—GAIN IN LIVE WEIGHT AND IN NUTRIENTS FOR EACH 100 POUNDS OF FEED CONSUMED.

Type	Stage (lbs.)	Live weight (lbs.)	Protein gained		Fat gained	
			Total pounds	Edible pounds	Total pounds	Edible pounds
B.....	100-150	22.60	2.57	1.74	8.04	6.17
L.....	100-150	24.42	2.85	1.56	10.11	7.69
B.....	100-200	24.65	3.31	2.08	9.86	8.35
L.....	100-200	22.60	3.15	2.00	8.55	7.06
B.....	100-250	22.50	2.48	1.64	10.75	9.62
L.....	100-250	22.04	2.65	1.66	8.80	7.64
B.....	100-300	19.66	2.07	1.39	10.32	9.08
L.....	100-300	20.01	2.00	1.14	10.60	8.86
B.....	150-200	29.50	4.91	2.83	13.73	12.90
L.....	150-200	19.64	3.63	2.71	5.95	5.99
B.....	200-250	18.95	.94	.84	12.57	12.15
L.....	200-250	21.60	1.74	1.03	9.42	8.88
B.....	250-300	15.72	1.51	1.04	9.71	8.33
L.....	250-300	15.95	.54	-----	15.26	12.11

RELATION OF FEED CONSUMED TO PROTEIN & ENERGY RETENTION 21

TABLE 22.—FEED REQUIRED PER POUND GAIN IN LIVE WEIGHT AND IN NUTRIENTS.

Description of Animal			Gain*			
Type	Stage (lbs.)	Live weight gained (lbs.)	Protein		Fat	
			Total pounds	Edible pounds	Total pounds	Edible pounds
B.....	100-150	4.42	38.91	57.47	12.44	16.21
L.....	100-150	4.10	35.09	64.10	9.89	13.00
B.....	100-200	4.06	30.21	48.08	10.14	11.98
L.....	100-200	4.42	31.75	50.00	11.70	14.16
B.....	100-250	4.44	40.32	60.98	9.30	10.40
L.....	100-250	4.54	37.74	60.24	11.36	13.09
B.....	100-300	5.09	48.31	71.94	9.69	11.01
L.....	100-300	5.00	50.00	87.71	9.43	11.29
B.....	150-200	3.39	20.37	35.34	7.28	7.75
L.....	150-200	5.09	27.55	36.90	16.81	16.69
B.....	200-250	5.28	106.38	119.05	7.96	8.23
L.....	200-250	4.63	57.47	97.09	10.62	11.26
B.....	250-300	6.36	66.23	96.15	10.30	12.00
L.....	250-300	6.27	185.19	-----	6.55	8.26

*The following examples, taken from the first horizontal line, are used to indicate more clearly the meaning of the table. While gaining from 100 to 150 lbs., the bacon type pigs consumed 4.42 pounds of feed while gaining one pound in live weight. While gaining one pound of protein (total) they consumed 38.91 pounds of feed. While gaining one pound of edible protein, they consumed 57.47 pounds of feed. While gaining one pound of fat (total) they consumed 12.44 pounds of feed, and while gaining one pound of edible fat they consumed 16.21 pounds of feed. It is probably unnecessary to add that we have not attempted to calculate separately the feed required for protein or fat formation.

The tables are self explanatory, but it may be well to point out some of the facts we consider relatively important. As shown in Tables 21 and 22, gains in live weight constantly become more expensive. Gains in protein also become more expensive. Surprising as it may seem, however, the cost of gains in fat constantly decreased.

TABLE 23.—RELATION OF FEED CONSUMED TO THE RETENTION OF ENERGY BY SWINE AT VARIOUS STAGES OF GROWTH.

Type	Stage	Feed consumed	Energy stored	Feed consumed per therm stored
	<i>lbs.</i>	<i>lbs.</i>	<i>therms</i>	<i>lbs.</i>
B.....	100-150	296.43	122.190	2.43
L.....	100-150	305.07	155.139	1.97
B.....	100-200	440.17	224.462	1.96
L.....	100-200	491.54	220.702	2.23
B.....	100-250	662.65	348.935	1.90
L.....	100-250	729.20	326.071	2.24
B.....	100-300	1139.31	566.909	2.01
L.....	100-300	1042.19	529.323	1.97
B.....	150-200	144.42	103.623	1.39
L.....	150-200	187.87	65.692	2.86
B.....	200-250	225.35	127.415	1.77
L.....	200-250	238.00	107.219	2.22
B.....	250-300	483.37	220.841	2.19
L.....	250-300	306.67	205.783	1.49

It would seem that the heavier maintenance cost, due to the longer feeding period, would begin to overtake the increasing tendency to deposit fat. Up to a weight of 300 pounds however, that is not the case.

It is thus indicated that within the limits of our experimental periods, the cost of protein stored constantly increases, and the cost of fat tends to decrease. In this connection an interesting question suggests itself, does the cost of total energy deposited in the pigs' body increase or decrease? In order to bring out that point more clearly we have calculated the amount of feed required per therm gain. The results are given in Table 23.

TABLE 24.—GAIN IN EDIBLE PROTEIN AND IN EDIBLE FAT BY SWINE AT VARIOUS STAGES OF GROWTH.

Type and stage	Initial weight lbs.	Final weight lbs.	Initial protein content lbs.	Final protein content lbs.	Gain in protein lbs.	Initial fat content lbs.	Final fat content lbs.	Gain in fat lbs.
B 100-150	93.9	160.9	7.34	12.49	5.15	9.76	28.06	18.30
L 100-150	92.7	167.2	7.44	12.19	4.75	8.78	32.23	23.45
B 100-200	94.4	202.9	7.38	16.54	9.16	9.81	46.58	36.77
L 100-200	93.4	204.5	7.49	17.31	9.82	8.84	43.56	34.72
B 100-250	95.2	244.3	7.44	18.32	10.88	9.89	73.66	63.77
L 100-250	95.2	255.9	7.64	19.75	12.11	9.02	64.70	55.68
B 100-300	94.1	318.1	7.36	23.21	15.85	9.78	113.25	103.47
L 100-300	94.1	302.6	7.55	19.48	11.93	8.91	101.29	92.38
B 150-200	160.3	202.9	12.45	16.54	4.09	27.95	46.58	18.63
L 150-200	167.6	204.5	12.22	17.31	5.09	32.30	43.56	11.26
B 200-250	201.6	244.3	16.43	18.32	1.89	46.28	73.56	27.38
L 200-250	204.5	255.9	17.31	19.75	2.44	43.56	64.70	21.14
B 250-300	242.1	318.1	18.16	23.21	5.05	73.00	113.25	40.25
L 250-300	253.7	302.6	19.58	19.48	-1.10	64.14	101.29	37.15

TABLE 25.—EDIBLE ENERGY STORED BY SWINE AT VARIOUS STAGES OF GROWTH.

Type	Stage lbs.	Protein stored therms	Fat stored therms	Total edible energy stored therms
B.....	100-150	13.263	78.778	92.041
L.....	100-150	12.233	100.948	113.181
B.....	100-200	23.590	158.287	181.877
L.....	100-200	25.289	149.463	174.752
B.....	100-250	28.019	274.517	302.536
L.....	100-250	31.187	239.691	270.878
B.....	100-300	40.819	445.418	486.237
L.....	100-300	30.723	397.677	428.400
B.....	150-200	10.533	80.198	90.731
L.....	150-200	13.108	48.472	61.580
B.....	200-250	4.867	117.865	122.732
L.....	200-250	6.284	91.003	97.287
B.....	250-300	13.005	173.268	186.273
L.....	250-300	-----	159.923	159.923

Reference to the last column of Table 26 indicates that the costs of gains in energy were practically constant throughout the feeding period. As a matter of fact we believe the cost actually declined. If the average

RELATION OF FEED CONSUMED TO PROTEIN & ENERGY RETENTION 23

TABLE 26.—RELATION OF FEED CONSUMED TO THE RETENTION OF EDIBLE ENERGY BY SWINE, AT VARIOUS STAGES OF GROWTH.

Type	Stage lbs.	Feed consumed per therm edible protein stored lbs.	Feed consumed per therm (total edible) stored lbs.
B.....	100-150	22.35	3.22
L.....	100-150	24.94	2.70
B.....	100-200	18.66	2.42
L.....	100-200	19.44	2.81
B.....	100-250	23.65	2.19
L.....	100-250	23.38	2.69
B.....	100-300	27.91	2.34
L.....	100-300	33.92	2.43
B.....	150-200	13.71	1.59
L.....	150-200	14.33	3.05
B.....	200-250	46.30	1.84
L.....	200-250	37.83	2.45
B.....	250-300	37.17	2.59
L.....	250-300	-----	1.92

feed requirement of the two breeds during each period is calculated, there is a distinct tendency towards a decrease in the amount of food consumed per therm stored. There is considerable evidence available to support this observation and we believe the conclusion drawn is correct. Our explanation is that during the first part of the feeding period a much larger percentage of the feed consumed was used for maintenance than was used for that purpose at the end of the period. On the basis of 100 pounds live weight, the younger pigs consume more feed daily than the older ones. They also make larger daily gains of energy on this basis, but the percentage retention of net energy is less than that of the older animals. In other words, at the close of the feeding trial a larger portion of the feed was available for gains than was the case at the beginning. A larger percentage of the net energy consumed was available for retention, and this may have been about equal to the increased maintenance cost due to the longer period of feeding.

According to Armsby⁵ the net energy value of our feed mixture for swine is 1.12 therms per pound. On the average 2.11 pounds of feed were required to produce a gain of one therm. These animals then had retained about 42 per cent of the net energy consumed.

We have continued our computation, on the basis of net energy consumed and energy stored daily. The difference between these quantities is considered as the maintenance requirement per day. In addition these quantities have been calculated per unit surface area and per unit weight. There is some difficulty in the calculation of these values, for it is impossible to estimate exactly either the average weight or average surface area. In choosing a value for the surface therefore

we have merely taken the mean of the surface areas of the animals slaughtered. For example in our calculation of the average surface area of Type B, weight 100-150 pounds, the area of the 100-pound pig was 10,972 square centimeters and of the 150-pound animal 14,759 square

TABLE 27.—ENERGY CONSUMED AND RETAINED, PER DAY, AT VARIOUS STAGES OF GROWTH.

Type	Stage	Net energy consumed	Energy stored			Maintenance
			Protein	Fat	Total	
		<i>cal.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>
B.....	100-150	5876	350	1831	2181	3695
L.....	100-150	6921	456	2714	3170	3751
Mean.....	100-150	6398	403	2272	2675	3723
B.....	100-200	6354	487	2430	2917	3437
L.....	100-200	7087	515	2348	2863	4224
Mean.....	100-200	6720	501	2389	2890	3830
B.....	100-250	7010	402	2921	3323	3687
L.....	100-250	7709	474	2632	3106	4603
Mean.....	100-250	7359	438	2776	3219	4145
B.....	100-300	8220	394	3287	3681	4539
L.....	100-300	8265	384	3403	3787	4478
Mean.....	100-300	8242	389	3345	3734	4508
B.....	150-200	7643	870	4067	4937	2706
L.....	150-200	7454	626	1719	2345	5109
Mean.....	150-200	7548	748	2893	3641	3907
B.....	200-250	8942	193	4360	4553	4389
L.....	200-250	9442	381	3451	3832	5610
Mean.....	200-250	9192	287	3905	4192	4999
B.....	250-300	10953	384	4136	4520	6433
L.....	250-300	9731	121	5760	5881	3850
Mean.....	250-300	10342	252	4948	5200	5141

TABLE 28.—USE OF NET ENERGY CONSUMED, AT VARIOUS STAGES OF GROWTH.

Type	Stage	Net energy stored as			Required for maintenance
		Protein	Fat	Total	
	<i>lbs.</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
B.....	100-150	5.96	31.16	37	63
L.....	100-150	6.59	39.21	46	54
Mean.....	100-150	6.30	35.51	42	58
B.....	100-200	7.66	38.24	46	54
L.....	100-200	7.26	33.13	40	60
Mean.....	100-200	7.45	35.55	43	57
B.....	100-250	5.73	41.67	47	53
L.....	100-250	6.15	34.14	40	60
Mean.....	100-250	5.95	37.72	44	56
B.....	100-300	4.79	39.99	45	55
L.....	100-300	4.64	41.17	46	54
Mean.....	100-300	4.72	40.58	45	55
B.....	150-200	11.38	53.21	65	35
L.....	150-200	8.39	23.06	31	69
Mean.....	150-200	9.91	38.33	48	52
B.....	200-250	2.16	48.76	51	49
L.....	200-250	4.03	36.55	41	59
Mean.....	200-250	3.12	42.48	46	54
B.....	250-300	3.50	37.76	41	59
L.....	250-300	1.24	59.19	60	40
Mean.....	250-300	2.44	47.84	50	50

RELATION OF FEED CONSUMED TO PROTEIN & ENERGY RETENTION 25

centimeters. The average surface for the period then is 12,865 square centimeters. The estimate of the average body weight was made in a similar manner. Using the example cited, the average initial weight of the pigs (Type B) was 92.9 pounds and the average final weight was 160.9. The mean of these weights, expressed in kilograms, is 57.787.

TABLE 29.—ENERGY CONSUMED AND RETAINED DAILY, PER SQUARE METER BODY SURFACE.

Type	Stage	Surface area	Net energy consumed per Sq. M.	Energy stored per Sq. M.	Maintenance per Sq. M.	Calories consumed per calorie stored
		<i>sq. M</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>
B.....	100-150	1.2865	4567	1695	2872	2.7
L.....	100-150	1.2663	5466	2503	2962	2.2
Mean.....	100-150	1.2764	5013	2099	2917	2.4
B.....	100-200	1.3589	4676	2146	2529	2.2
L.....	100-200	1.3386	5294	2139	3155	2.5
Mean.....	100-200	1.3487	4983	2142	2842	2.3
B.....	100-250	1.4187	4945	2342	2598	2.1
L.....	100-250	1.3990	5510	2220	3290	2.5
Mean.....	100-250	1.4088	5224	2281	2944	2.3
B.....	100-300	1.5151	5425	2429	2995	2.2
L.....	100-300	1.4875	5556	2546	3010	2.2
Mean.....	100-300	1.5013	5492	2487	3002	2.2
B.....	150-200	1.5483	4936	3189	1747	1.5
L.....	150-200	1.5424	4833	1520	3312	3.2
Mean.....	150-200	1.5453	4884	2354	2529	2.1
B.....	200-250	1.6795	5324	2710	2613	2.0
L.....	200-250	1.6756	5635	2289	3349	2.5
Mean.....	200-250	1.6775	5480	2499	2981	2.2
B.....	250-300	1.8857	5808	2397	3411	2.4
L.....	250-300	1.8245	5334	3223	2110	1.7
Mean.....	250-300	1.8551	5575	2810	2760	2.0

TABLE 30.—ENERGY CONSUMED AND STORED DAILY PER KILOGRAM LIVE WEIGHT.

Type	Stage	Average live wt.	Net energy consumed	Energy stored	Energy required for maintenance
	<i>lbs.</i>	<i>kgm.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>
B.....	100-150	57.787	102	38	64
L.....	100-150	58.944	117	53	64
Mean.....	100-150	58.365	109	45	64
B.....	100-200	67.426	94	43	51
L.....	100-200	67.562	105	42	63
Mean.....	100-200	67.494	100	43	57
B.....	100-250	76.997	91	43	48
L.....	100-250	79.628	97	39	58
Mean.....	100-250	78.312	94	41	53
B.....	100-300	93.485	88	39	49
L.....	100-300	89.970	94	43	51
Mean.....	100-300	91.927	90	41	49
B.....	150-200	82.372	93	60	33
L.....	150-200	84.390	88	28	60
Mean.....	150-200	83.381	90	44	46
B.....	200-250	101.128	88	45	43
L.....	200-250	104.416	90	37	53
Mean.....	200-250	102.772	89	40	49
B.....	250-300	127.051	86	36	50
L.....	250-300	126.166	77	47	30
Mean.....	250-300	126.608	81	41	40

It is difficult to say how much importance should be attached to the series of tables, Nos. 27-30. Evidently our values for net energy consumed, and for net energy required for maintenance both depend chiefly on Armsby's estimates of the net energy values of the feeds used. The fact should be emphasized however that the term maintenance requirement, as used in this connection, does not mean basal metabolism. Armsby's terminology for this value is "economic maintenance". At any rate our values seem to be high. The average maintenance requirement is a little less than 3000 calories per square meter of body surface daily. Determinations of the true maintenance requirement of swine as reported by Armsby⁶ agree with those commonly reported for other animals. These values are usually given at about 1000 calories per square meter daily. Possibly the bodily activity of our animals was sufficiently great to account for the difference.

It is evident from Table 29 that our estimates when calculated per unit body weight are also high. Armsby's calculations are based on the maintenance requirement per 100 pounds live weight daily. If recalculated so as to give the value per kilo the requirement is found to be about 27 calories daily per kilogram live weight. This of course represented minimum bodily activity. Our average is approximately 50 calories daily per kilogram.

One point brought out in Table 29 is we believe not generally appreciated. Reference to the last column indicates that, within reasonable limits, energy is stored more economically in the later rather than in the earlier months of the feeding period. It is well known that gains in protein and in live weight constantly become more expensive. The fact that gains in fat tend to become less expensive is not so generally recognized. Table 22 shows this to be true.

TABLE 31.—ENERGY CONSUMED AND ENERGY STORED (STEERS).

Stage	Net energy consumed	Energy stored	Therms consumed per therm stored
<i>lbs.</i>	<i>therms</i>	<i>therms</i>	<i>therms</i>
100-200	322.60	63.07	5.1
100-300	717.04	182.62	3.9
100-400	1147.28	266.34	4.3
100-500	1591.01	399.58	4.0
100-600	1958.31	517.00	3.8
100-700	2674.88	647.22	4.1
100-800	3245.44	833.23	3.9
100-900	3914.70	1175.77	3.3
100-1000	4499.67	1351.34	3.3
100-1100	5034.23	1684.37	3.0
100-1200	6472.92	1908.52	3.4
100-1300	5902.71	1892.92	3.1
100-1400	7046.80	2186.00	3.2
100-1500	8264.31	2669.11	3.1

In order to be more certain that our findings in this regard were not due to some unusual accident, we have attempted to verify them by a comparison with other data of a similar sort. In 1920 Professor T. L. Haecker published a valuable bulletin⁷ from the Minnesota Station, giving the composition of steers at different weights, and the feed required to produce gains. We have calculated the energy value of the gains, and by using Armsby's factors we have also computed the net energy consumed during the various stages. The factors chosen were as follows:

Feed	Net energy per 100 lbs.
	<i>therms</i>
Milk.....	29.01
Skim milk.....	14.31
Grain.....	75.40
Hay.....	40.42
Silage.....	15.90

From this data we have calculated the therms net energy consumed per therm stored (Table 31.) It is at once evident that the data of the Minnesota Station are in essential agreement with ours, and that the more mature animals made gains in energy more economically than those that were younger.

GROWTH AS INDICATED BY WEIGHTS AND MEASUREMENTS

Since to the experienced judge of swine there are distinct differences between the bacon and lard types, a number of measurements were taken at intervals during the investigation. It was expected that these measurements would indicate more definitely than photographs the real differences that may exist. For purposes of comparison the weights are tabulated with the measurements.

The data presented are in all cases averages of an unfortunately small number of individuals. There were eight animals of each type at the beginning of the investigation and four at the end. There was considerable variability within the groups. Since the animal removed from a group was always an average specimen, this decrease in numbers resulted in very slight loss of continuity as regards either weight or individual measurements.

So far as weight is concerned it is evident that the records of the two types are practically identical.

The measurements taken however, are quite different. Four of these, selected as typical, are presented as graphs. It seems clear that the bacon type is a taller and longer individual. Another point we consider worthy of comment is the apparent tendency of the lard type to stop growing at an earlier age than does the bacon type. During the last 50-pound interval the rate of gain in measurements was distinctly greater among the Yorkshires. This may suggest that the growing period of the Yorkshire is longer than that of the Poland China, and that the mature Yorkshire is a taller and longer animal. We limit this of course to the strains under observation.

There can be no question that at equal weights, the Yorkshires were taller and longer than the Poland Chinas. We expected therefore that we would be able to correlate that fact with some other characteristic. As a matter of fact we were unable to detect any consistent differences by chemical analysis, or by examination of the fresh or cured product. The only differences observed of which we feel certain are the heavier loin, and slightly lighter bacon of the bacon type. The external layer of fat seemed to be equally thick on both types. We assume that if specific differences other than those mentioned do exist, they are slight and masked by experimental error and individual variation.

TABLE 32.—AVERAGE WEIGHTS OF SWINE

Date	Bacon Type		Lard Type	
	Age	Weight	Age	Weight
	<i>days</i>	<i>lbs.</i>	<i>days</i>	<i>lbs.</i>
7- 1-21	120	93.9		
7- 8-21	127	101.5		
7-15-21	134	110.9	118	86.2
7-22-21	141	119.4	125	93.4
7-29-21	148	128.1	132	103.3
8- 5-21	155	139.3	139	114
8-12-21	162	148.3	146	125
8-19-21	169	160.7	153	136
8-26-21	176	missing	160	missing
9- 2-21	183	183.2	167	157
9- 9-21	190	190.8	174	169.4
9-16-21	197	204.8	181	179.3
9-23-21	204	208	188	186.2
9-30-21	211	216.8	195	192.2
10- 7-21	218	231.8	202	204.3
10-14-21	225	245.6	209	217.6
10-21-21	232	252	216	232
10-28-21	239	269	223	242
11- 4-21	246	278.2	230	257
11-11-21	253	289.8	237	264.3
11-18-21	260	301.2	244	274.3
11-25-21	267	306.2	251	281.8
12- 2-21	274	320	258	298.3
12- 9-21	281		265	298.8

TABLE 33.—AVERAGE OF MEASUREMENTS OF SWINE, IN CENTIMETERS.

	100-lb. stage		150-lb. stage		200-lb. stage		250-lb. stage		300-lb. stage	
	Bacon type	Lard type	Bacon type	Lard type	Bacon type	Lard type	Bacon type	Lard type	Bacon type	Lard type
Age, days.....	126	124	175	175	197	196	219	230	274	268
Average Weight lbs.....	100.4	92.6	160.6	169.4	204.8	192.1	231.8	257	277	304.2
Height at withers.....	50.1	48.4	61.6	58.5	64.2	61.7	67.8	64.8	71.6	66.0
Height at croup.....	58.6	53.9	66.8	65.1	70.5	69.7	72.6	71.0	77.2	72.5
Width at shoulder.....	25.5	24.6	30.7	31.8	32.2	34.5	35.0	36.1	40.2	38.0
Width of shoulder point.....	23.6	22.8	27.8	28.3	28.8	31.5	31.6	33.2	36.4	35.0
Width of hams.....	23.6	24.5	29.1	31.1	29.8	32.8	31.4	34.1	36.2	37.0
Width of ham points.....	19.9	19.3	24.9	25.0	27.0	28.3	28.8	29.6	32.1	31.2
Depth of chest.....	30.4	28.9	36.9	36.8	39.0	39.2	41.8	42.0	47.7	43.5
Width of head.....	12.6	13.3	15.8	16.3	16.9	17.9	17.2	18.6	20.5	19.0
Length shoulder to tail.....	75.6	65.2	85.3	84.3	94.3	88.5	97.4	93.8	102.5	96.2
Length poll to tail.....	94.3	80.4	105.7	100.8	114.0	108.0	117.2	114.8	127.2	115.5
Length nose to tail.....	113.4	104.0	124.4	120.7	135.5	129.2	139.8	135.7	150.7	136.5
Heart girth.....	80.0	74.7	95.3	98.4	101.7	105.7	111.6	120.2	125.7	123.0
Paunch girth.....	93.4	88.4	111.6	115.7	117.5	118.0	127.0	132.2	142.2	134.2
Flank girth.....	84.9	83.9	96.6	104.6	105.8	113.8	114.0	124.4	129.5	126.2
Circumference front shin.....	13.2	11.8	12.6	13.6	13.6	14.2	14.5	15.5	15.7	15.6
Circumference hind shin.....	13.8	11.8	12.7	13.5	13.7	14.2	14.5	15.9	15.7	15.8
Distance elbow to ground.....	27.0	22.1	30.2	26.8	28.5	29.7	29.6	28.5	28.2	29.0
Distance shoulder point to ground.....	25.9	23.6	33.8	30.6	31.3	30.5	32.4	31.7	34.2	32.7

MEASUREMENT OF SURFACE AREA

Our data pertaining to surface area have been published elsewhere,⁸ and that publication should be consulted for details.

We made an effort to devise a formula that would permit a fairly accurate calculation of the surface area of swine, and believe we were largely successful. Our formula is

$$S = L^{.6} \times W^{.4} \times K.$$

S is the surface area in square centimeters, L is the length of body in centimeters, W is the weight in kilograms, and K is the constant 175. L is secured by measuring with a tape from the point of withers to the root of the tail.

SUMMARY

Sixteen pigs were under observation, with an average initial weight of 100 pounds, and a final weight of 300 pounds. Two were slaughtered and analyzed at each of the following weights: 100, 150, 200, 250 and 300 pounds.

When gaining the first 50 pounds, more than 4 pounds of feed were required per pound gain. The feed requirement increased thereafter until during the last 50-pound interval, more than 6 pounds of feed were required for each pound gained.

A detailed physical examination was made of each carcass. The dressing percentages varied from 71 to 83. As the animals gained in weight, the shoulder and sparerib each made up a smaller percentage of the carcass. There was a tendency for ham and head to decrease also. On the other hand both the bacon and loin constantly gained in relative size as the carcasses became heavier.

The carcass analyses did not indicate any large differences between the types. However the Yorkshires consistently yielded the heavier loin and the Poland Chinas yielded the larger percentage of bacon.

The chemical analyses did not indicate consistent differences between the types.

The cost of gains in protein increased rapidly after the animals attained a weight of 200 pounds. On the other hand, gains in fat became constantly less expensive as the pigs grew from 100 to 300 pounds.

A little over 40 per cent of the net energy consumed by these animals was stored in their tissues.

The calculated daily maintenance requirement (including bodily activity) was approximately 2850 calories per square meter body surface, and 50 calories per kilogram live weight.

The two types of swine, bacon and lard, gained in weight at approximately the same rate. The growing period of the Yorkshires is longer than that of the Poland Chinas.

A formula has been devised for calculating the surface area of swine.

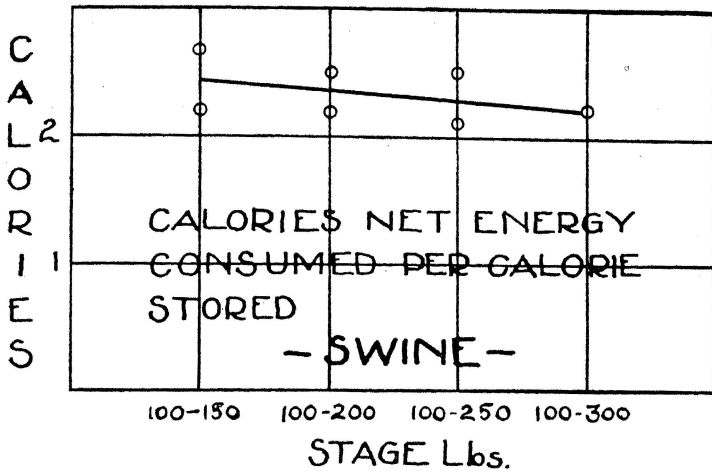


Fig. 1.—During the stage 100-150 pounds the pigs consumed approximately 2.4 calories while storing one calorie. During the stage 100-300 pounds 2.25 calories were consumed for each calorie stored. The results actually obtained by computation are indicated by circles. The heavy line is drawn to indicate a probable average. The same principle is used in plotting Fig. 2.

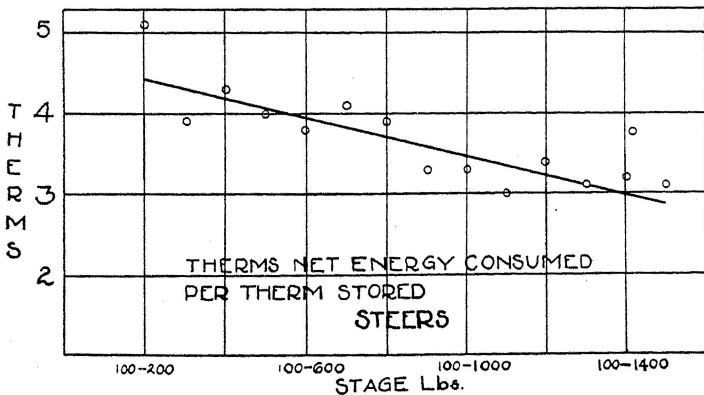


Fig. 2.—While gaining from 100 to 200 pounds approximately 4.4 therms were consumed for each therm stored. In gaining from 100 to 1400 pounds the consumption of energy per therm stored was reduced to approximately 3 therms.

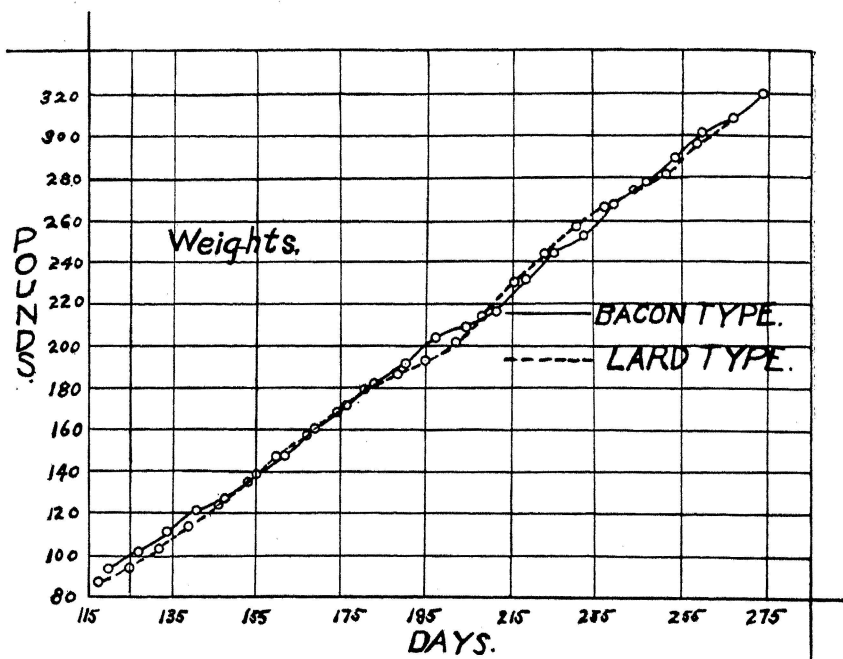


Fig. 3.—This chart presents graphically the average weights of the swine under observation at the ages indicated. The circles indicate the ages at which the weights were taken, also the recorded weights.

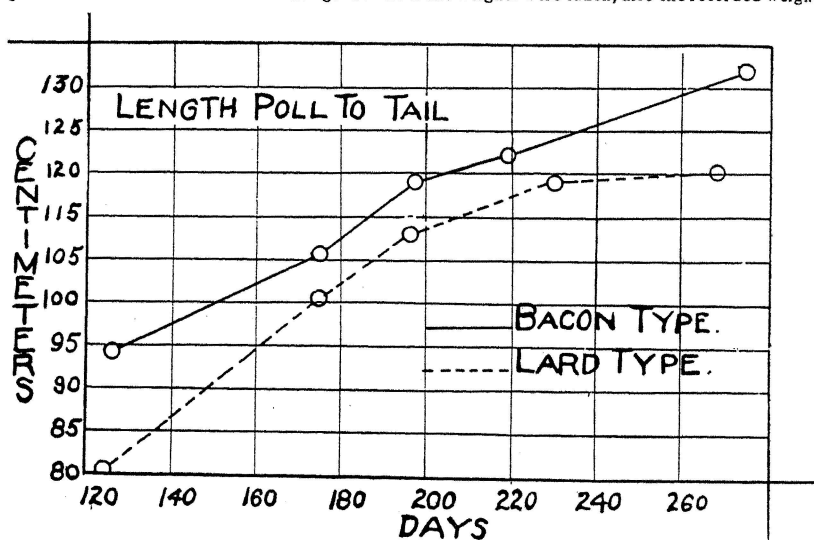


Fig. 4.—This measurement indicates the relative length of body of the two types at the ages indicated. The Yorkshires were apparently longer, and were growing more rapidly than the Poland Chinas when the last measurements were taken. In this chart and in those following the measurements as actually taken are indicated by circles.

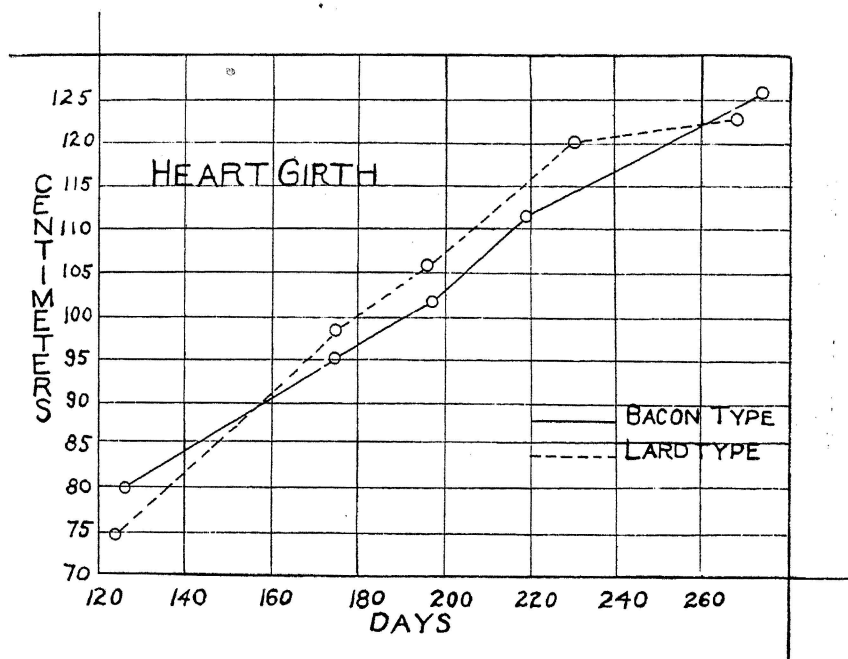


Fig. 5.—The heart girth is taken in the region just back of the elbow; the two breeds do not differ consistently in this measurement.

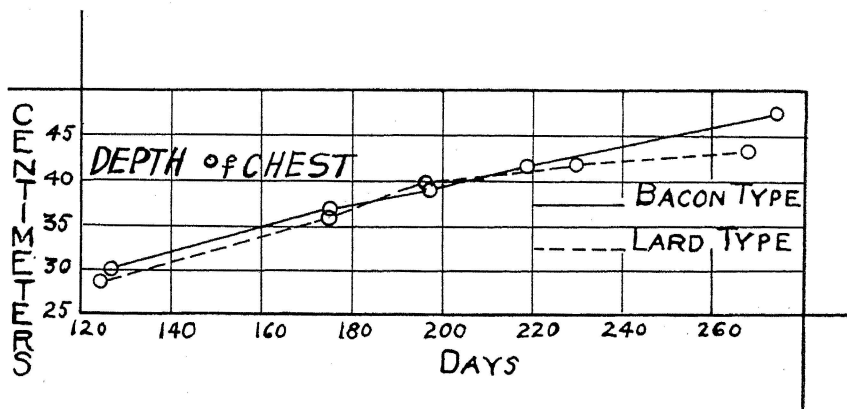


Fig. 6.—This measurement, as indicated by the name, is the vertical distance from the floor of the chest to the top of the back. Toward the close of the feeding period the bacon type became markedly deeper in this region than the lard type.

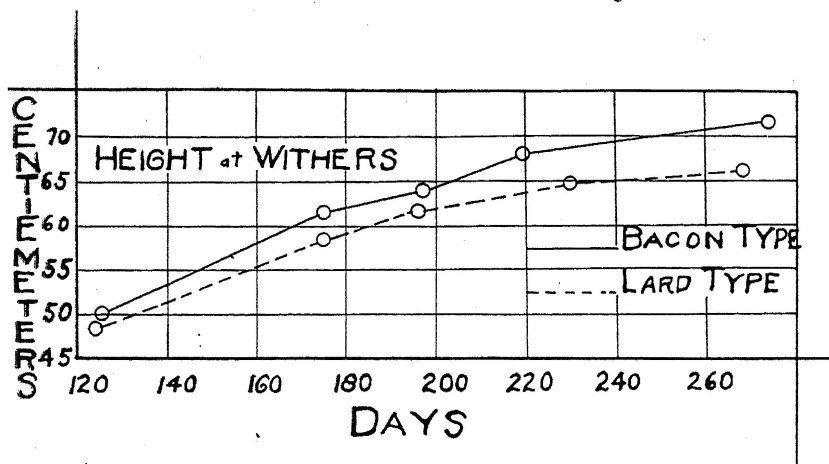


Fig. 7.—The Yorkshires were noticeably taller than the Poland Chinas at all stages. This measurement is the vertical distance from the point of withers to the ground.

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1. Henry and Morrison, Feeds and Feeding, Eighteenth Edition, p. 54 (1922)
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3. Same as 1, p. 599.
4. Swanson, C. O., Journal of Agricultural Research, Vol. 21, p. 279. (1921)
5. Same as 2, p. 722.
6. Same as 2, p. 287.
7. Haecker, T. L., Investigations in Beef Production. Bul. 193 Minnesota Agricultural Experiment Station.
8. Journal of Agricultural Research, Vol. 25, p. 419. (1923)

Figs. 8 to 13.—Photographs of swine at time of slaughtering.

100-lb. Stage.



Fig. 8.—13 B, Bacon Type.

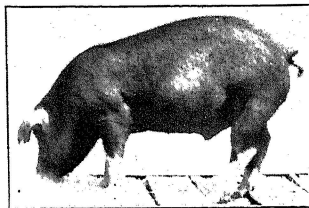


Fig. 9.—60 B, Lard Type.

150-lb. Stage.



Fig. 10.—3 B, Bacon Type.

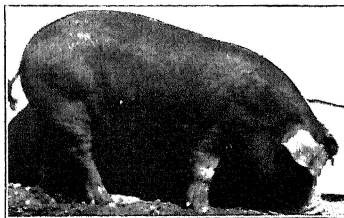


Fig. 11.—6 B, Lard Type.

200-lb. Stage.



Fig. 12.—53 B, Bacon Type.



Fig. 13.—12 B, Lard Type.

Figs. 14-17.—Photographs of swine, at time of slaughtering.

250-lb. Stage.

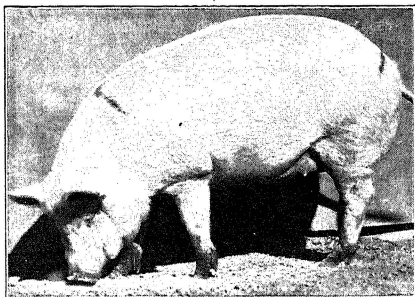


Fig. 14.—33 S, Bacon Type.

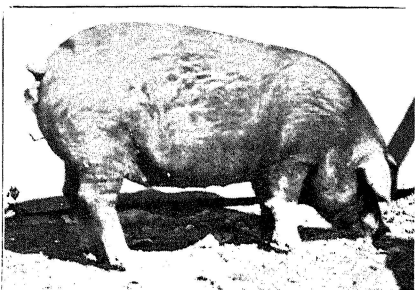


Fig. 15.—40 S, Lard Type.

300-lb. Stage.

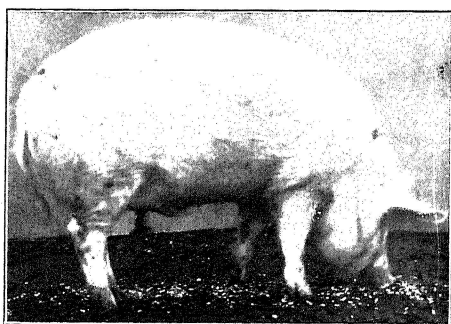


Fig. 16.—33 B, Bacon Type.

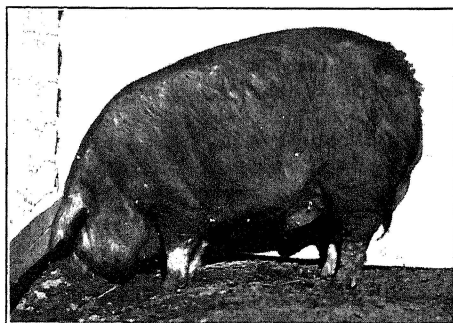


Fig. 17.—10 B, Lard Type

WHOLESALE CUTS, TRIMMED

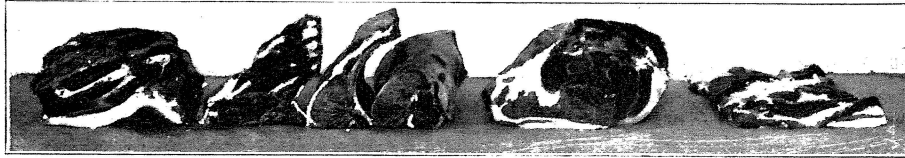


Fig. 18.—Bacon Type, 100 lb. Stage.



Fig. 19.—Lard Type, 100 lb. Stage. Pigs are seldom slaughtered at this weight, but the photographs are of value in comparing the two types.

CURED CUTS.

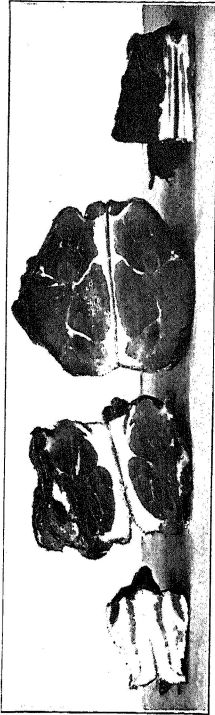


Fig. 20.—Bacon Type, 100-lb. Stage.

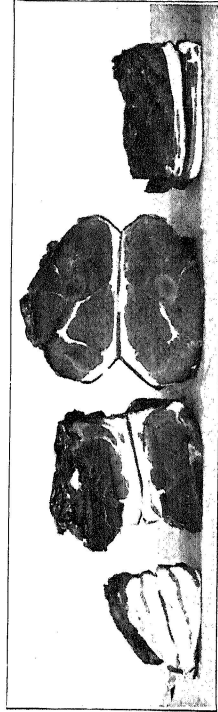


Fig. 21.—Lard Type, 100-lb. Stage.

WHOLESALE CUTS, TRIMMED



Fig. 22.—Bacon Type, 200-lb. Stage.

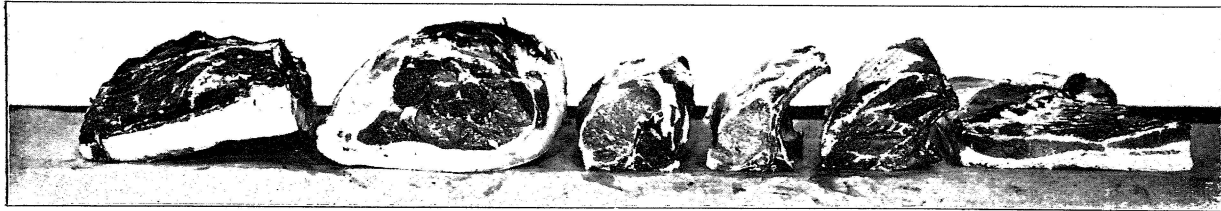


Fig. 23.—Lard Type, 200-lb. Stage.

CURED CUTS



Fig. 24.—Bacon Type, 200 lb. Stage.



Fig. 25.—Lard Type, 200-lb. Stage.

WHOLESALE CUTS, TRIMMED



Fig. 26.—Bacon Type, 300-lb. Stage.

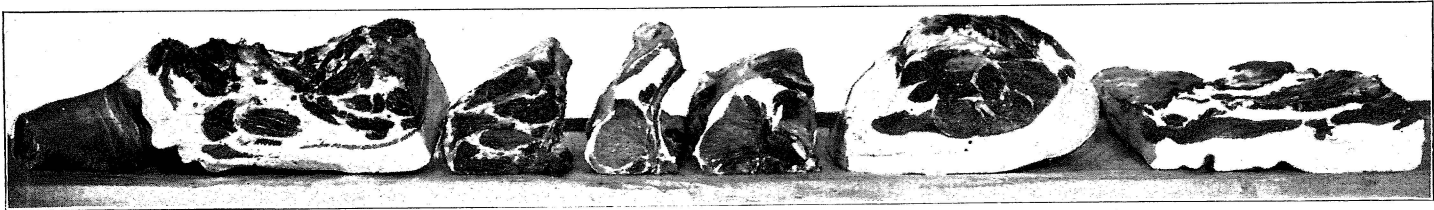


Fig. 27.—Lard Type, 300-lb. Stage.

CURED CUTS



Fig. 28.—Bacon Type, 300-lb. Stage.



Fig. 29.—Lard Type, 300-lb. Stage.