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A Statistical Analysis of Growth and Carcase Measurements of Baconers.*

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I. INTRODUCTION.

For several years systematic feeding trials have been conducted with bacon pigs by officers of the Department of Agriculture at two of the Agricultural Schools, Cedara and Potchefstroom. The main objects of these trials were to investigate the suitability of different breeds of pigs and their crosses, when fed different balanced rations, for the production of first grade bacon carcases. Each separate trial was reported on by the officer who was in charge and in 1930, Romyn and others issued a report on all the trials completed at that time. These trials showed clearly that some breeds and crosses (Middle White and Berkshire) were unsuitable for bacon production. Since 1928 the work was concentrated on the following three breeds and their crosses: Large White, Large Black, and Tamworth. A large number of rations have been tested out since 1928, and the results indicated that with the balanced rations used the effect on the type of the carcases was not great. Different rations had influence on the rate of gain, thickness of back fat, and the firmness of the fat, and so indirectly may have influenced some of the carcase measurements. When the results of the different sows and boars were grouped it was found that the differences within a breed between different individuals, were much greater than the differences between crosses or between the rations that were used. Since the influence of the rations on the carcase measurements were relatively small and all being balanced and the pigs not being starved, no attention will be given to these factors in the present analysis of the data.

The object of this paper is to make a study of the growth of the baconers that were used and their carcase measurements and how these vary under different conditions such as size, degree of fatness, etc. The importance of having such data is, that when standards are to be drawn up when pig recording, for instance, is started, there is something definite on which they can be based. The same applies for standards which will be necessary when "Utility Classes" at shows are started. When bacon factories start paying out on quality basis for bacon pigs, such results will enable them to base their prices on scientific information. Hansson (1927) and Schmidt and others (1929) have made analysis of pigs recorded and tested out and their findings have been of much value, not only in the proper selection of the breeding animals, for which purpose recording and testing have been started in the first instance, but also for drawing up standards for shows and as information for the bacon factories when paying out on quality. In England [Davidson (1930), Duckham (1929) and Menzies Kitchen (1930), Hammond (1922)] researchers have made analyses of data, and from the information obtained standards have been drawn up.

One cannot, however, just adopt standards of another country where different conditions exist. Danish standards, for instance, would be unsuitable for South Africa and would not serve their purpose at all, since the largest percentage of pigs slaughtered in this country would not conform to them. It would be more an ideal to strive at than a standard. It is, therefore, only by analysing such material obtained from animals of about the average type in the

country from which suitable standards could be drawn up, so that most of the animals killed could conform to them. As there is improvement in the country these standards could be gradually raised. Since no outstanding breeding animals were used in these trials, it is reckoned that standards based on the results obtained will not be too severe.

Another very important aspect of such a statistical analysis of data that have accumulated during several years, is that even when results are not conclusive, one can get very useful information as regards the lines on which future investigations could be conducted. Much unnecessary work can therefore be eliminated beforehand, and the investigator knows just what to look for. This enables one also to avoid certain pitfalls since one knows already the influence and effect of certain conditions.

II. MATERIALS AND METHODS.

In the present paper an analysis is made of the growth and carcase measurements of 450-550 baconers of the Large White × Large Black (sow) and Tamworth × Large Black (sow) crosses. All the baconers were bred and fed at the two Agricultural Schools, Potchefstroom and Cedara.

Before 1929 no weights were taken of the pigs before they were weaned, but the pigs were regularly weighed after they were put in the different feeding trials. Towards the end of 1929 we started taking the birth weights of the pigs and at 4, 6, 8, and 9 weeks of age and after weaning (which took place at 8 weeks) as was done previously. When the pigs had reached weights of 190 to 210 lb. on the farm they were despatched to the Farmers' Co-operative Bacon Factory, Estcourt, Natal. They were weighed before trucking and again immediately after being unloaded at the factory. Cedara is 62 miles from Estcourt and Potchefstroom 415 miles. Those sent from Cedara were not watered or fed en route but those sent from Potchefstroom received water and some whole maize.

After the carcases had been dressed and the weights taken, each carcase was measured (the same side of each carcase) by the officer responsible for the particular trial. After that each carcase was graded by the manager of the of the factory, Mr. Welsh, and the officer. The carcases were classified into Nos. 1 and 2 " Lean Sizable ", Nos. 1 and 2 " Medium ", " Fat ", and " Overfat " grades. The following description of the grades was given by Romyn and others (1930):—

" The No. 1 ' Lean Sizable ' represents the type of side most in demand on the London market. Though well finished this type of carcase has the thinnest layer of back fat of all grades. It should also show good quality.

" A No. 1 ' Medium ' suits the north of England trade, but does not command a ready sale on the London market. This type of carcase is thicker in back fat than the No. 1 ' Lean Sizable '. In other respects they are similar.

" The No. 2 ' Lean Sizable ' and No. 2 ' Medium ' sides represent types similar to their respective No. 1's, but lack somewhat in quality.

" The No. 1 ' Fat ' or ' Stout ' carcase is between the No. 1 ' Medium ' and ' Overfat ' in thickness of back fat. This type of carcase is becoming more and more undesirable as the demand for lean bacon increases. These carcases should also show good quality.

" The ' Overfat ' is self explanatory. Bacon is not made from this grade of side ".

In the present paper we propose working only with the following four main groups. The Nos. 1 " Lean Sizable " and " Medium " remain as they are. The Nos. 2 " Lean Sizable " and " Medium " fall in a class which will be known as " Inferior ", and the the " Stout " and " Overfat " carcases will all be put together and form an " Overfat " class.

Particulars of some of the weights and measurements that were taken are given below:—

The dressed weight consists of the two sides with the head, feet, leaf fat, kidneys, and blade bones still on and which will be removed before the sides go into the cure. After the sides had been cured and smoked, the same side of every pig was again weighed. The shoulder was then cut off between the third and fourth ribs and also weighed.

The length was taken from the front edge of the aitch bone to the front edge of the first rib. The thickness of the back fat was taken at the thickest (shoulder) and thinnest (loin) parts and two measurements were taken over the ham. These measurements were then averaged. The depth of the side was obtained by measuring the depth behind the shoulder and at the flank on the outside and these were averaged. The circumference of the ham was taken where it was the greatest.

No measurements were made of the thickness of the belly, but it was judged by eye and points awarded. This was also done with the marbling of the cured sides and which were judged after the shoulders had been cut off. Points were awarded as follows: A perfect score = 10 points, very good = 9, good = 8, good medium = 7, medium = 6, and poor = 5.

All the weights were taken in pounds and the measurements in inches.

Before the measurements were taken or the grading done, samples of the back fat from one side of each carcase were taken, chopped up and rendered at the factory at a constant temperature of 110° C. The rendered fat samples were then despatched to the Chemical Division, Pretoria, where the refractive indices were determined under the supervision of Mr. Van Wyk. The refractive indices are given at 40° C.

III. ANALYSIS OF THE DATA.

PART A.—GROWTH.

1. *Preweaning Results.*

Since the data collected of the pigs before they were weaned, are limited, no detailed analysis is possible. Some of the averaged results will therefore only be given.

For 39 farrowings the average gestation period was 113·7 days for Large Black and Large White sows. This is nearly 1 day less than found by Carmichael and Rice (1920), their figure being 114·6 days for 7 different breeds. Of the 39 farrowings the shortest gestation period was 105 days and the longest 118 days, 77 per cent., however, being from 112 to 115 days.

The average birth weight of 494 pigs born alive was 2·89 lb. There were 271 males and 223 females and their birth weights were 2·99 lb. and 2·78 lb. respectively. 8·6 per cent. and 8·3 per cent. of the males and females respectively, were born dead. When the pigs are grouped according to the number born per litter, then there is a continuous decrease in the birth weights of both sexes as shown in table 1:—

TABLE 1.—*Birth Weights of Pigs.*

Litter Size.	6–8.		9–11.		12–14.		15–17.	
Sex.....	M.	F.	M.	F.	M.	F.	M.	F.
No. of pigs.....	38	26	108	103	79	64	22	20
Average weight, lb.....	3·5	3·17	3·08	2·75	2·69	2·67	2·34	2·21

Carmichael and Rice (1920) found the same, but the birth weight of the males (2·59 lb.) was only ·08 lb. more than that of the females (2·51 lb.). Litters of less than 8 pigs at birth were heavier (2.67 lb) than the average for all the pigs (2·55 lb. for 5,188 pigs). The litters of more than 8 pigs at birth had an average weight of 2·47 lb. Eaton (1932) states that in the case of guinea pigs litter size and length of gestation period determines more than 60 per cent. of the birth weight. Haines (1931), also working with guinea pigs, found the same influence and also that mortality increased with increase in litter size, and in the rabbit Hammond (1925) states this to be the case also.

The birth weight being correlated with the later weights, as shown by Eaton (1932), and the mortality also being higher among the lighter pigs [Wenck (1931) and Haines (1931)], it is important to strive at heavier pigs at birth. This, however, is not the only factor to be considered since for economic pig production a sow should not raise less than 8 pigs per litter, so that one should find out what the optimum number is when these two factors are taken together. The weight of the litter at 4 or 8 weeks of age is quite a good indication, although the milk supply of the sow plays an

important part. For commercial purposes, however, this is what counts. In table 2 an indication is given of the influence of the litter size on the total litter weight at 8 weeks of age.

TABLE 2.—*Influence of Litter Size on Litter Weight at 8 Weeks.*

Litter Size.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
No. of litters..	3	3	3	5	7	8	7	7	2	1	1	1
No. of pigs weaned.....	14	20	20	34	56	59	63	63	18	6	9	12
No. of pigs weaned per litter.	4·7	6·7	6·7	6·8	8·0	7·4	9·0	9·0	9·0	6·0	9·0	12·0
Total litter wt. at 8 weeks, lb.	173	227	240	248	256	225	309	264	243	179	215	336

Although not quite consistent on account of the small number of observations, there is nevertheless an increase at first with an increase in litter size up to 12 pigs per litter, when the weights start decreasing. Investigators working with much larger numbers have found the same thing. The percentage weaned per litter decreased with increase in litter size, but the decrease was found to be much more rapid with litters of more than 12 pigs at birth. Wild (1929), for instance, got the following percentages: when all pigs born (including those born dead) were taken, the average for all taken together being 72 per cent. weaned. In litters of over 17 pigs, only 35 per cent. were weaned, 12 to 16 pigs, 60 per cent., and 8 to 11 pigs, 80 per cent., and those with less than 8 pigs, 85 per cent. Wenck's (1931) results also showed a very high mortality for litters above 13 pigs at birth, and he comes to the conclusion that one should strive at 8 to 12 pigs per litter with as high a weight at 4 weeks of age as possible. Buchanan Smith (1930) reckons that the ideal litter size is from 10 to 12 pigs at birth.

Of the pigs that were born alive, 81 per cent. of the males and 76 per cent. of the females were weaned. Whether the difference in birth weight caused this difference is difficult to say. Under the same conditions one would expect that more females would reach weaning age than males. From Wenck's (1931) and Haines' (1931) investigations it seems quite likely that the difference in the percentage weaned of the two sexes may have been influenced by the difference in birth weight, since the mortality among the lighter pigs is higher than among the heavier ones. Haines analysing the data of 30,000 guinea pigs, found that of those born alive 1 per cent. more males than females were raised to weaning.

The sows and the idividual pigs were only weighed at 14 days intervals after the pigs were 4 weeks old. No data are therefore available of the loss of weight of the sows from farrowing up to 4 weeks after farrowing. From 4 to 8 weeks after farrowing the sows lost on an average 27 lb. per sow. It also appears that the heavier the total litter weight at weaning, the larger is the loss in weight of the sow as indicated in table 3.

TABLE 3.—*Loss in Weight by the Sows before Weaning.*

Total litter weight, lb.....	180	200	220	240	260	280	300	320	340
No. of sows.....	4	2	6	8	10	2	3	1	5
Loss in live weight, lb.....	8	9	16	30	30	28	18	59	44

Huszti (1930) regularly weighed 22 Mangalicza sows every 2 weeks after farrowing and he found that during the first 4 weeks the sows lost 13·2 Kg. During the 5th week their weights remained constant and from the 6th week started to gain in live weight, so that at 9 weeks the total loss was 10·6 Kg. per sow. In the abstract no litter weights are given, but the average daily gain of the pigs up to weaning was only 128 gm. or ·28 lb., whereas those under investigation gained ·52 lb. The Mangalicza sows are probably poor milkers and therefore start gaining in weight at 5 weeks.

2. *The Weights at Different Ages.*

When pig recording is started then it is important to have a standard growth curve by which to compare the pigs coming from all parts of the country. As conditions differ so much in different countries, the standard of one country may not be applicable to another country. In table 4 and Diagram I the weights of pigs are given at different ages up to 21 weeks of age. After that period the quickest growers were killed, so that the average weights after 21 weeks of age will not be representative. For the sake of comparison the results of other investigators are also included.

DIAGRAM I.
Normal Gains of Baconers.

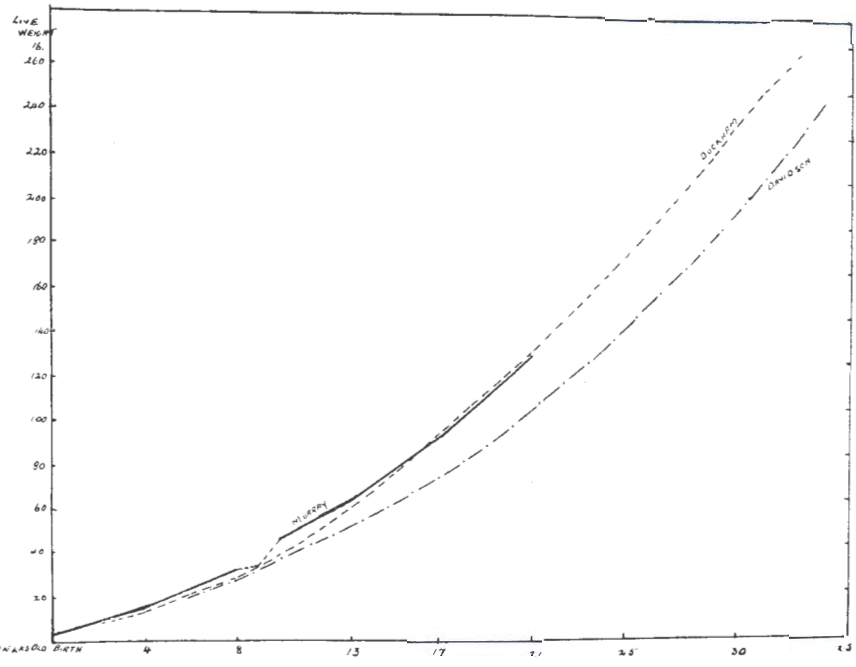


TABLE 4.—*Weights in lb. at Different Ages.*

	Age in Weeks.													
	Birth	2.	4.	6.	8.	9.	10.	13.	17.	21.	25.	29.	33.	37.
Murray.....	2·89	—	15·5	23·1	32·2	33·9	46·3	62·0	91·3	128·2	—	—	—	—
Duckham.... (1929)	2·5	9·0	14·0	21·0	28·0	33·0	39·0	59·0	93·0	129·0	170	215	261	302
Davidson.... (1930)	—	—	—	20·0	29·0	33·5	37·8	51·5	74·0	104·0	139	179	225	—
Stahl (1930)..	2·7	7·5	12·9	20·1	30·6	36·5	43·3	—	—	—	—	—	—	—
Schmidt..... (1929)	—	—	—	—	—	—	—	74·8	112·2	152·8	191·4	—	—	—

From the above table it is seen that our figures agree well with those of Duckham (1929) and which were used as the standard in the East Anglican Pig Recording Scheme. Our birth weights are higher than those of the others and also higher than the figure obtained by Carmichael and Rice (1920) which was 2·55 lb. Up to 15 weeks Duckham's curve is slightly below ours and after that slightly above. Stahl's (1930) results do not show a big difference either. Those of Schmidt (1929), which were obtained from the testing station, are much higher than the rest. From the age of 10 weeks onwards, Davidson's (1930) figures are lower than the rest. He reckons that Duckham's figures are on the high side for English conditions and that too large a percentage of sows are consequently penalised. As regards the weaning standard (8 weeks of age), the different figures correspond well and fall round 30 lb. per pig. The upper limit, i.e., the age when ready for bacon, however, show rather big differences. It would appear that our curve should be taken as the standard and only when it appears to be too high for the country should it be lowered.

Individual Variability in Weight.—An analyses has been made of the variability in the weights of the pigs at the different ages, the weights of the barrows and gilts being kept separately. The two measures of variability, viz., the standard deviation (S.D.) and the coefficient of variability (C.V.), have been determined and the results shown in table 5.

TABLE 5.—*Variability at Different Ages.*

	Age in Weeks.	Birth.	4.	6.	8.	9.	13.	17.	21.
Males.	No. of pigs.....	271	197	194	193	68	271	269	270
	Mean weights, lb.	3·09	16·0	23·7	34·5	34·4	61·8	92·1	132·1
	S.D., lb.....	·729	3·62	4·89	9·0	7·78	20·25	31·24	44·29
	C.V., per cent....	23·23	22·7	20·65	26·1	22·63	32·76	33·91	33·53
Females.	No. of pigs.....	223	164	161	157	69	211	210	210
	Mean weights, lb.	2·85	15·2	22·8	32·0	33·5	62·1	90·3	125·3
	S.D., lb.....	·808	3·02	4·14	6·46	5·66	19·63	29·3	39·25
	C.V., per cent....	27·87	19·83	18·2	20·18	16·89	31·61	32·45	31·32

Except for the birth weights (only those born alive are included), the standard deviation and the coefficient of variability are higher for the males than for the females. Hammond (1932) found that the standard deviation of wethers was greater than that of the ewes except at 1 week of age, at which age the ewes were the heavier, whereas the wethers were the heavier at the other ages. From the results in table 5 it does not appear as if there is the very close relationship between live weight and standard deviation as was found for sheep by Hammond. As the live weight increases, however, so does the standard deviation or actual variability.

The coefficient of variability does not show the same regular tendency as the standard deviation. At birth the coefficient of variability is high and decreases up to 6 weeks of age. At 8 weeks there is quite a marked increase for the males and only a slight increase for the females. At 9 weeks it has decreased again for both sexes. From 13 weeks of age onwards the standard deviations and the coefficients of variability are high, the former continually increasing and the latter remaining about the same. Hammond (1922) found that the maximum variability in weight occurred at 7 months and this corresponds with the maximum daily gain. Our figures are rather higher than those determined by him, except his maximum (33·1) which is about the same as found from 13 to 21 weeks in table 5. Wentworth and Lush (1923) found the maximum variability to be at 5 months and which decreased after that age. From table 5 it appears that the variability will decrease rather than increase after 21 weeks, so that the maximum was reached at 17 weeks or 4 months. This is therefore at an earlier age than found by Hammond and Wentworth and Lush.

When the weekly gains are taken from birth to 21 weeks of age instead of the live weights, then the coefficients of variability closely follow the weekly rate of gain in the preceding period as shown below. The differences in the rates of gain made by the pigs would appear to be the cause of the variations in the coefficients of variability at the different ages. Only the pigs that were weighed at 9 weeks were taken to get the gain between 8 and 9 weeks and hence the difference from table 5.

	Weeks	Birth.	— 4	— 6	— 8	— 9	—13	—17	—21
Males.	Weekly gains, lb.	3·2	3·6	5·4	4·3	6·8	7·6	10·0	
	C.V., per cent.	22·7	20·6	26·1	22·6	32·7	33·9	33·5	
Females.	Weekly gains, lb.	3·1	3·8	4·6	3·2	7·1	6·9	8·7	
	C.V., per cent.	19·8	18·2	20·2	16·9	31·6	32·4	31·3	

Hammond (1932) discusses the findings of different investigators as regards the difference in the coefficient of variability of the sexes. Darwin concluded that males were more variable and Havelock Ellis (1914) and Karl Pearson had a controversy as to whether man or woman is the more variable. Pearson states that woman is slightly more variable than man, while Ellis concludes that man is the more variable. When no allowance is made for the rate of gain or the difference in live weight, then the male (barrow) is more variable than the female (gilt) as shown in the present investigation.

To see the variability of the sexes at the different ages, when the factor of difference in rate of gain had been eliminated, table 6 has been prepared. The males and females have been divided into fast (* gaining 1·5 lb. and above per pig per day), medium-fast (gaining 1·2 to 1·49 lb. per pig per day), and slow (gaining 1·19 lb. and below per pig per day) growers.

TABLE 6.—*Variability of Fast, Medium-fast, and Slow Growers.*

Average daily gain—lb...		1·5 and above.			1·2–1·49.				1·19 and below.				
Age in weeks.....		13	17	21	13	17	21	25	13	17	21	25	29
Males.	No. of pigs.....	75	75	75	98	98	98	94	97	97	97	95	93
	Mean weight—lb....	77·4	123·3	173·4	65·2	98·2	137·2	183·9	46·9	64·7	90·3	120·0	162·2
	S.D.—lb.....	17·6	24·3	28·3	18·8	26·2	26·6	24·1	10·7	15·7	19·7	26·4	31·0
	C.V.....	22·7	19·6	16·3	28·8	26·6	19·4	13·1	22·9	24·2	21·8	21·9	19·1
Females.	No. of pigs.....	40	40	40	76	76	76	64	95	94	94	94	91
	Mean weight—lb....	77·5	119·8	168·8	70·2	103·5	144·1	187·3	49·1	67·2	91·8	119·4	152·2
	S.D.—lb.....	18·6	22·1	24·6	18·7	21·7	24·9	19·0	10·8	16·3	20·8	26·0	32·6
	C.V.....	23·9	18·5	14·6	26·7	21·0	17·3	10·1	22·0	24·3	22·6	21·7	21·4

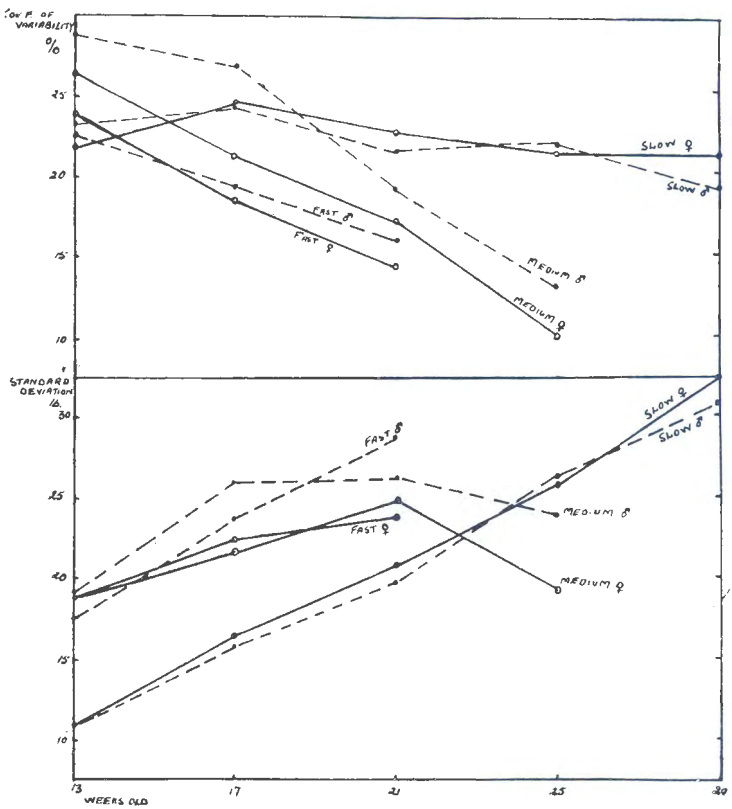
*The gains have been determined from the commencement of the trials until the pigs were slaughtered.

For the fast and medium-fast growers the standard deviations and coefficients of variability are consistently lower for the females except at 13 weeks for the fast growers, where the variability of the females is slightly higher than that of the males. As for the slow growers there is no consistent difference between the two sexes. Diagram II shows the trends of the variability for the different groups and sexes. The standard deviation of the fast growing males is still increasing at 21 weeks. The females show a smaller increase from 13 to 21 weeks. The medium fast growers show a decrease from 21 weeks to 25 weeks for both sexes and the slow growers a continual increase. Whereas the standard deviations of the fast and medium-fast groups at the different ages, do not show large or consistent differences, the coefficients of variability are decidedly lower for the fast growers. The coefficients of variability of the fast and medium-fast growers show a continual decrease from 13 weeks of age onwards, while those of both sexes of the slow growers remain fairly constant, showing little difference at 13 and 29 weeks. This, therefore, agrees with what Hammond (1932) says, that: " animals, after they have had their growth forced by high feeding, should be on the whole less variable (coefficient of variability) than those which have previously

had their growth retarded and are still actively growing ". As will be shown in another section the slow growers make much more rapid growth later on, and consequently show little change in the coefficients of variability in comparison with the fast and medium-fast growers.

DIAGRAM II.

Coefficients of Variability and Standard Deviations of Fast, Medium and Slow-growing Barrows and Gilts.



Correlation between Weights at Different Ages.—Wild (1929) and Wenck (1931) found that the pigs which were the heaviest at the young stages were also the heaviest at slaughter. The former took the earliest weights at 10 weeks and the latter at 4 weeks of age. Hammond (1932) got the same with sheep. The correlation became larger the shorter the period between the end weight and the earlier weights. Schmidt and others (1929), however, found no relation between the weights at 4 weeks and the weights at slaughter in the case of pigs. In this paper the weights at 21 weeks have not been correlated with those of the pigs before they were weaned since only recently full preweaning particulars have been kept of the pigs used in the different feeding trials. Correlation coefficients have, therefore, only been determined between the weights at 4 and 8 weeks and between the weights at 13 and 21 weeks, the number of animals

available being 338 and 479 respectively. The correlation coefficient between the 4 and 8 weeks ages is $+0\cdot76\pm\cdot02$ and between the 13 and 21 weeks ages $+0\cdot89\pm\cdot01$. Although the period is twice as long in the second case, the correlation coefficient is nevertheless significantly larger than in the first case. An important factor which probably contributed to this difference, is the milk supply of the sows. Before weaning the inherent ability of a pig for growing and the milk supply of the sow are the determining growth factors. The pigs under investigation received as much feed as they could consume when put in the trials, so that only the one factor had influence on the growth after the pigs were weaned. According to Olofsson and Larsson (1930) the sow's milk still constitutes 40 per cent. of the pig's diet at 8 weeks, so that the milk supply of the sow is still an important factor in this instance. A sow may be a heavy milker at the beginning of her lactation but the milk supply may then drop very suddenly, as is very often found with cattle. Pigs suckling such sows may start off well but lose again some of the advantage before they are weaned and in this way resulting in less strong correlations between weights at different ages before weaning than after weaning. This is another strong argument in favour of weighing pigs at 8 weeks (weaning) of age instead of at 3 or 4 weeks of age for recording purposes. One then has a measure of what a sow is capable of handing over to the farmer and at the same time has an indication of what the pigs will be able to do after weaning up to the slaughter age.

The actual weights of the pigs at 4 weeks and the weights of the same pigs at 8 weeks and weights of pigs at 13 weeks and weights at 21 weeks, are given below:—

TABLE 7.—*Relation between Weights at Different Ages.*

Relation between weights at 4 and 8 weeks.			Relation between weights at 13 and 21 weeks.		
No. of Pigs.	Weights at 4 weeks.	Weights at 8 weeks.	No. of Pigs.	Weights at 13 weeks.	Weights at 21 weeks.
	lb.	lb.		lb.	lb.
3.....	8	17·7	6.....	20	71·3
3.....	9	20·7	45.....	30	77·8
14.....	10	22·2	101.....	40	92·4
11.....	11	26·5	107.....	50	111·8
28.....	12	26·6	66.....	60	140·1
28.....	13	27·3	44.....	70	160·4
28.....	14	30·5	51.....	80	170.7
32.....	15	30·9	39.....	90	183·0
56.....	16	32·4	21.....	100	197·8
31.....	17	35·9			
29.....	18	36·8			
16.....	19	40·3			
26.....	20	38·2			
8.....	21	41·9			
5.....	22	40·2			

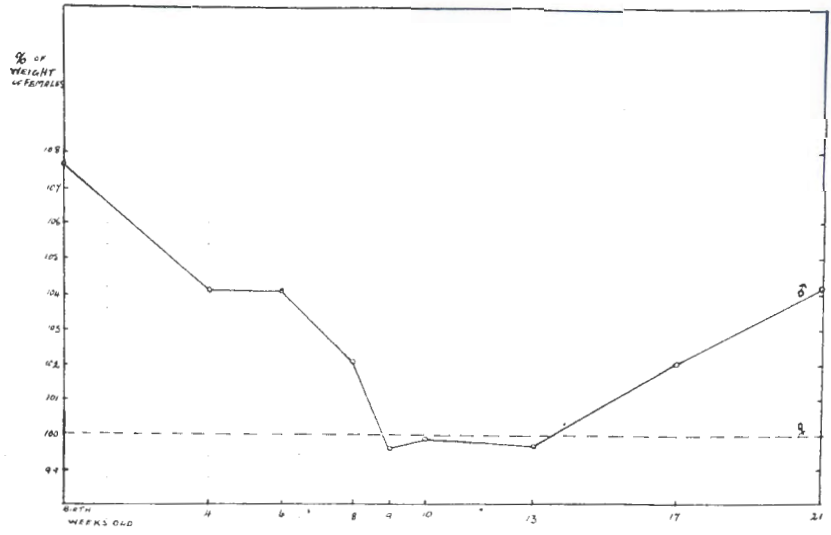
3. *Rate of Gain.*

In this section the intention is to see how the rate of gain changes for the different groups (fast, medium-fast, and slow growers), and also how the gains are influenced by the sexes. It has already been shown that the males are slightly heavier than the females, but to get a better idea of the relationship between the gains of the sexes, the weights of the females have been taken as 100 at the different ages and those of the males expressed as ratios thereof. The actual and relative weights are given in table 8, and diagram III shows how the relative weights change.

TABLE 8.—*Relative and Actual Weights of Barrows and Gilts at Different Ages.*

	Birth.	Weeks Old.							
		4.	6.	8.	9.	10.	13.	17.	21.
Relative wts. barrows	107·6	104·1	104·1	102·1	99·6	99·9	99·7	102·1	104·2
Actual weights, lb.—									
Barrows.....	2·99	15·7	23·5	32·5	33·8	46·3	61·9	92·1	130·6
Gilts.....	2·78	15·1	22·6	31·8	34·0	46·32	62·1	90·2	125·2
Average.....	2·89	15·5	23·1	32·2	33·9	46·31	62·0	91·3	128·2

DIAGRAM III.
Relative Weights of Barrows and Gilts.



The trend of the relative growth of the barrows and gilts is quite definite. At birth the males have appreciably higher weights than the females. This difference decreases until it is actually lower from the 9th to the 13th week and then the males start increasing

again in weight. The drop in the relative weights of the males is probably due to the effect of castration and weaning. Between 3 and 4 months when the females reach puberty their growth is also retarded. Wilkens (1929) also found that the difference in weight becomes greater in favour of the males with an increase in age.

The 271 males and 210 females have been divided into fast, medium-fast and slow growers to see how the gains of the three groups are affected at the different ages. The sexes are divided up as follows in the three groups:—

	Fast growers (gaining 1·5 lb. daily and over).	Medium-fast growers (gaining 1·2–1·49 lb. daily).	Slow growers (gaining 1·19 lb. and less).
Males, per cent.....	27·7	36·5	35·8
Females, per cent..	19·0	36·2	44·8

The males have only 8·1 per cent. more slow than fast growers, whereas the females have 25·8 per cent. more.

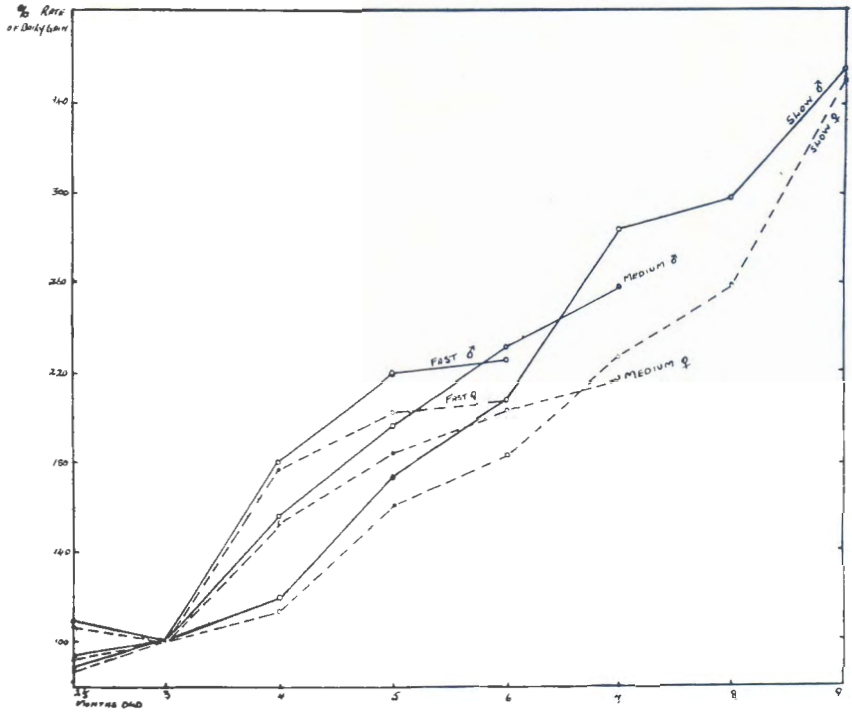
The gains made from birth up to 90 days of age have been obtained and then the gains made every 28 days for the individual pigs in the three groups. The gains made up to 90 days of age have been taken as 100 and the subsequent gains expressed as percentages of this. The results are given in table 9 and shown in diagram IV.

TABLE 9.—*Relative and Actual Gains of the Fast, Medium Fast and Slow Growers.*

	No. of Pigs	Age in Days.						
		90.	118.	146.	174.	202.	230.	258.
Males.								
Fast growers—								
Actual gains—lb..	75	·858	1·544	1·881	1·932	—	—	—
Relative gains....		100	180	219	225	—	—	—
Med-fast growers—								
Actual gains—lb..	99	·725	1·137	1·434	1·687	1·871	—	—
Relative gains....		100	157	198	233	258	—	—
Slow growers—								
Actual gains—lb..	97	·52	·624	·909	1·09	1·477	1·552	1·85
Relative gains....		100	120	175	210	284	298	356
Females.								
Fast growers—								
Actual gains—lb..	40	·861	1·525	1·75	1·804	—	—	—
Relative gains....		100	177	203	210	—	—	—
Med-fast growers—								
Actual gains—lb..	76	·776	1·199	1·436	1·588	1·685	—	—
Relative gains....		100	155	185	205	217	—	—
Slow growers—								
Actual gains—lb..	94	·546	·627	·888	1·009	1·243	1·414	1·913
Relative gains....		100	115	163	185	228	259	350

DIAGRAM IV.

Relative Gains of Fast, Medium and Slow-growing Barrows and Gilts.



The pigs came into the feeding trials at an average age of 10 weeks. The weights at 10 weeks decrease for the three groups, the females being slightly heavier. Even at 90 days the females have made better gains than the males within the different groups. At 118 days (4 months) the fast growing males are showing better gains, but in the other two groups the females are still better. It is, however, between the ages of 4 and 5 months that the males really begin to outstrip the females. The differences between the sexes in the three groups are shown better by the relative gains. The fast growing groups show a rapid rise in the relative gain during the first 28 days. The steepness of the curves decrease from the 4th to the 5th months and then the relative gains remain about the same from the 5th to the 6th months. The medium-fast growing groups have fairly high relative gains during the first 28 days and then there is also a decrease in the steepness of the curves but not so much as in the first group. In the slow growing group the increase is not much during the first 28 days and the steepness of the curves increases up to 5 months when there is a slight decrease in the steepness but an increase again from the 6th month. At the end (8 to 9 months) the females show a very sharp rise ending up near to the males.

All three groups show little differences between the sexes up to 4 months. From 4 months the differences in relative gains of the males start to show increasing gains over the relative gains of the

females and at 5 months the fast-growing group show the largest difference between the sexes. The differences of the other two groups are about the same. At 6 months the difference of the fast group has not increased much but has continued to increase in the other groups, the medium-fast group showing the largest difference between the sexes. Both the remaining groups continued to increase in the differences, but the slow group shows the largest difference in favour of the males at the age of 7 months. The curve of the slow growing males shows an irregularity between 7 and 8 months, but shows definitely that the difference in gains between the sexes is becoming less and is nearly the same at 9 months. The curves of the other two groups have shown the same tendency just before they stopped and would quite likely have approached each other if data for longer periods had been available. These differences, which first increase and afterwards decrease again at different ages for the different groups, seem to be caused by the coming on heat of the females at different ages, and that the slow growers are influenced more by these heat periods than the fast growers. As the animals become older they seem to be less affected by heat and hence the converging of the curves of the sexes after a time.

An interesting study could be made on these lines by castrating half the males and half the females and then giving all the same management and feeding until they are mature.

Part B.—Factory Results.

1. *Average Results of the two Crosses.*

Before analysing the data of the pigs of the two crosses together, it is necessary to see whether they do not show any marked differences. Hansson (1927) analysed the data of the pigs of the Swedish Landrace and Large Yorkshire coming from the testing station, but he did not find any marked breed differences. Schmidt and others (1929) again worked with the German Landrace and the Edelschwein and they did not find any marked breed differences either. In both the Swedish and German results it came out very clearly that there were much larger differences within the breeds than there were between the breeds. The individual boars and sows exerted greater influence on the progeny than the breed they belonged to. The two Swedish breeds and two German breeds mentioned are more or less of the same type. This is also the case with the three breeds used, to get the two crosses on which this work was done, so that one will not expect any marked diffrences with the data we are presenting. The average results of the two crosses are given in table 10 along with the relative weights and measurements. The length, which is an early maturing measurement, has been taken as 100 and the weights and measurements expressed as percentages thereof.

TABLE 10.—*Average and Relative Weights and Measurements of the two Crosses.*

	Actual Measurements.		Relative Measurements.	
	Tamworth X Large Black.	Large White X Large Black.	Tamworth X Large Black.	Large White X Large Black.
No. of pigs	156	295	—	—
Initial age—days	71·1	71·3	—	—
Final age—days	188·0	189·4	—	—
Initial weight—lb.	46·3	48·9	159	170
Final weight—lb.	194·8	196·2	669	682
Factory weight—lb.	178·5	180·9	—	—
Percentage of farm weight	91·6	92·2	—	—
Carcase weight—lb.	148·5	146·0	510	507
Percentage of farm weight	76·2	74·4	—	—
Weight of cured side—lb.	50·9	51·6	175	179
Percentage of farm weight (2 sides)	52·3	52·6	—	—
Weight of shoulder—lb.	15·3	15·6	53	54
Percentage of whole side	30·1	30·2	—	—
Average daily gain—lb.	1·306	1·31	—	—
Length of side—inches	29·1	28·8	100	100
Depth at shoulder—inches	16·35	16·39	56	57
Depth at flank—inches	15·85	15·69	55	55
Average—inches	16·1	16·04	55	56
Ratio— $\frac{Shoulder}{Flank} \times 100$	103·2	104·5	—	—
Circumference of ham—inches	23·34	24·06	80	84
Back fat (thickest) in inches	2·03	2·19	7·0	7·6
Back fat (thinnest) in inches	1·347	1·277	4·63	4·44
Average—inches	1·511	1·532	5·19	5·32
Evenness back fat—per cent.	66·4	58·3	—	—
Thickness of belly—per cent.	81·7	74·3	—	—
Marbling—per cent.	69·5	70·0	—	—
Refractive index at 40°C.	1·4596	1·4597	—	—
Classification: I.L.S.—per cent.	42·9	49·8	—	—
Classification: I.M.—per cent.	42·9	20·0	—	—
Classification: O.F.—per cent.	9·0	9·8	—	—
Classification: Inferior—per cent.	5·2	20·3	—	—

The gains made by the pigs of the two crosses are the same and the pigs were slaughtered at the same average live weights. The length of side, the thickness of the back fat and the thickness of the belly were somewhat better for the Tamworth cross than the Large White cross and this affected the grading to an extent, the first mentioned cross having 15 per cent. more first grade carcases than the second cross. The Large White cross had slightly better hams. The relative measurements do not show any marked differences either.

To see how different boars can influence the measurements, the average results of two Large White boars and one Tamworth boar are given in table 11. The results of the two Large White boars were obtained from the same 7 sows and 4 of these were used with the Tamworth boar. These pigs were used at the School of Agriculture, Cedara.

The average live weights of the pigs from the second and third boars are the same, but the weight of the first one is about 13.5 lb. higher. The average daily gain of the second boar is the best and the first and third are about the same. The progeny of the Tamworth

boar were much shallower than those of the Large White boars and also had poorer hams. The Tamworth boar had the thinnest back fat but the bellies were nevertheless the same as for the boar with the thickest back fat, but the marbling of the Tamworth boar was not so good. The first and third boars have the same percentage of first grade carcases (93 per cent.), but the third one has more 1 Lean Sizable carcases (53·6 per cent. in comparison with 37·5 per cent. of the first boar), but this difference was rather caused by the difference in weight than the difference between the boars. The second boar, however, has only 50 per cent. of first grade carcases and 27·8 per cent of the carcases are over fat.

TABLE 11.—*Average Results af three Boars.*

Boar.	Actual Measurements.			Relative Measurements.		
	L.W. 1.	L.W. 2.	Tam. 3.	L.W. 1.	L.W. 2.	Tam. 3.
No. of sows	7	7	4	—	—	—
No. of pigs	56	54	28	—	—	—
Initial weight—lb.	46·3	42·3	46·8	159	150	160
Final weight—lb.	208·5	195·1	194·9	718	690	666
Factory weight—lb.	196·6	183·8	180·2	—	—	—
Percentage of farm weight	94·3	94·2	92·5	—	—	—
Carcase weight—lb.	161·7	154·8	143·8	557	548	491
Percentage of farm weight	77·6	79·7	73·8	—	—	—
Age—days	175·6	155·4	165·1	—	—	—
Average daily gain—lb.	1·188	1·256	1·181	—	—	—
Length of side—inches	29·04	28·27	29·27	100	100	100
Depth at shoulder—inches	16·79	16·8	16·15	58	59	55
Depth at flank—inches	16·64	16·29	15·28	57	58	52
Average—inches	16·72	16·55	15·72	58	59	54
Ratio—per cent.	100·9	103·1	105·7	—	—	—
Circumference of ham—inches	24·23	24·23	22·83	83	86	78
Back fat (thickest)—inches	2·155	2·169	1·925	7·4	7·7	6·6
Back fat (thinnest)—inches	1·295	1·395	1·232	4·5	4·9	4·2
Evenness—per cent.	60·1	64·3	64·0	—	—	—
Thickness of belly—per cent.	81·4	77·2	76·1	—	—	—
Marbling—per cent.	69·1	78·7	66·8	—	—	—
Classification: I.L.S.—per cent.	37·5	24·1	53·6	—	—	—
Classification: I.M.—per cent.	55·4	25·9	39·3	—	—	—
Classification: O.F.—per cent.	3·6	27·8	—	—	—	—
Classification: Inferior—per cent.	3·6	22·2	7·1	—	—	—

L.W. Boar 1.—Fairholm Vanguard 7th, Reg. No. 183. Age 2 years.

L.W. Boar 2.—Grantham Tom 4th, Reg. No. 278. Age 3 years.

Tamworth Boar 3.—No particulars available.

From tables 10 and 11 it is also clear that the differences due to the different crosses are quite small when compared with the differences of the progeny of the different boars. Such marked differences were also found between different sows. These small differences between the two crosses, therefore, entitle one to treat the data of the two together. In the rest of the paper no difference will be made between the results of the two crosses.

2. *Measurements of the Different Grades.*

As the grading is done by sight and no measurements are taken to determine the grade of the carcase, it will be of interest to see in which respects the measurements of the different grades differ. The actual and relative measurements are given in table 12.

TABLE 12.—*Average Measurements of the different Carcase Grades.*

Grade.	Actual Measurements.					Relative Measurements.				
	ILS.	IM.	O.F.	2LS.	2M.	ILS.	IM.	O.F.	2LS.	2M.
No. of pigs.....	194	126	43	74	14	—	—	—	—	—
Initial age—days....	70·5	70·5	71·3	72·2	68·3	—	—	—	—	—
Final age—days.....	194·4	184·7	174·1	192·6	181·3	—	—	—	—	—
Initial weight—lb....	48·4	48·0	49·1	46·8	44·5	167	165	171	164	153
Final weight—lb....	193·2	200·8	199·2	190·5	198·9	668	690	694	666	686
Factory weight—lb..	177·0	186·4	185·1	174·1	181·6	—	—	—	—	—
Per cent. of farm wgt.	91·6	92·8	92·9	91·4	91·3	—	—	—	—	—
Carcase weight—lb..	144	150·8	151·4	139·5	145·9	498	518	527	488	503
Per cent.....	74·5	75·1	76·0	73·2	73·4	—	—	—	—	—
Weight cured side—lb.	49·7	52·7	54·8	50·5	53·0	172	181	191	177	183
Per cent. (2 sides)..	51·4	52·5	55·0	53·0	53·3	—	—	—	—	—
Weight shoulder—lb.	15·2	15·9	16·7	15·4	15·7	53	55	58	54	54
Per cent. of side....	30·6	30·2	30·5	30·5	29·6	—	—	—	—	—
Average daily gain—lb.	1·234	1·377	1·527	1·244	1·404	—	—	—	—	—
Length—inches.....	28·94	29·12	28·72	28·59	29·0	100	100	100	100	100
Depth at shoulder—inches	16·19	16·62	17·0	16·05	16·68	56	57	59	56	58
Depth at flank—ins.	15·55	16·13	16·4	15·31	15·93	54	55	57	54	55
Average—inches.....	15·87	16·38	16·7	15·68	16·31	55	56	58	55	56
Ratio.....	104·1	103·0	103·7	104·8	104·7	—	—	—	—	—
Circumference ham—inches	23·7	23·9	24·16	23·8	23·9	82	82	84	83	82
Back fat (thickest)—inch	2·03	2·222	2·502	2·157	2·342	—	—	—	—	—
Back fat (thinnest) - inch	1·17	1·39	1·642	1·225	1·386	—	—	—	—	—
Average—inch.....	1·411	1·634	1·818	1·492	1·675	4·9	5·6	6·3	5·0	5·8
Evenness—per cent..	57·6	62·6	65·6	56·8	59·2	—	—	—	—	—
Thickness of belly—per cent.	77·0	83·8	82·3	64·5	68·1	—	—	—	—	—
Marbling—per cent..	68·2	70·4	76·7	67·8	75·0	—	—	—	—	—
Refractive index.....	1·4598	1·4594	1·4593	1·4597	1·4596	—	—	—	—	—

The two grades 2 Lean Sizable and 2 Medium include pigs which may have the correct thickness of back fat to fall in one of the first grades but may be too short, or long enough but " unfinished ", or both length and the back fat may be alright but the belly may be

too thin. The average measurements of these mentioned factors are therefore not of the same value as those of the other three grades. The three grades 1 L.S., 1 M. and O.F. all have the same initial weights, but the other two grades were lighter at the commencement of the trials. The final weights are the lowest for the two L.S. grades, whereas the other three grades are about the same. The final ages show large differences, being highest for the 1 L.S. grade (194 days) and lowest for the O.F. grade (174 days), the 1 M. grade being in-between. The two inferior grades correspond to the respective first grades. The average daily gains are in the same order as the final ages of the five grades.

The loss in weight on the journey is lowest for the 1 M. and O.F. grades and the other three grades had larger losses which are about the same. The carcase percentage shows an increase from 74·5 per cent. for the 1 L.S. grade to 76·0 per cent. for the O.F. grade, the 1 M. grade being 75·1 per cent. It is rather striking that the carcase percentages for the two inferior grades (2 L.S. and 2 M.) are lower than those of the other three grades, although both have thicker back fat than the 1 L.S. grade and the 2 M. being fatter than the 1 M. as well. The percentage of cured sides to farm live weight increase from 51·4 per cent. for the 1 L.S. grade to 55·0 per cent. for the O.F. grade, the 1 M. and the two inferior grades being in between. The percentages of the shoulder to the whole side do not show any significant differences between the grades. All the relative weights, except the initial weight, show an increase from the 1 L.S. grade to the O.F. grade with the 1 M. grade in between and the inferior grades corresponding more or less to the two first grades except in carcase weight where they are somewhat lower.

The small difference in length between the 1 L.S. and 1 M. grades are probably only due to the difference in weight, but the O.F. grade is shorter than the previous two. The 2 L.S. is the shortest of all the grades. The actual as well as the relative depth of the side increases from 1 L.S. grade to the O.F. grade. The ham also shows improvement. The evenness of the back fat improves with fattening and so does the thickness of the belly up to a point. The thickness of belly of the two inferior grades are much lower than the other grades. The marbling improves with fattening but is not affected by the inferiority of the two grades. When the depth at the flank is taken as 100 and the depth at the shoulder expressed as a percentage thereof, the inferior grades show a larger percentage than the other grades, the 1 M. grade being the lowest. The refractive indices correspond with the thickness of back fat of the different grades, the 1 L.S. grade having the softest fat and the O.F. grade the hardest fat.

The 268 males and 183 females are distributed among the five grades as shown below:—

	Males. *Per cent.*	*Females.* *Per cent.*
1 Lean Sizable	33·6	56·8
1 Medium	27·6	28·4
Overfat	12·7	4·9
2 Lean Sizable	20·9	9·8
2 Medium	5·2	—

The males only have 61 per cent. carcases in the two first grades whereas the females have 85 per cent. The 1 M.grade does not show much difference between the sexes, but the large difference is in the 1 L.S. grade which is also the most desirable grade of carcase. This large difference in favour of the females has also been found in the Scandinavian countries as shown by the percentages in table 13.

Table 13 has been prepared to show how some of the more important measurements of the 1 L.S. grade compare with the first grades of other bacon producing countries.

TABLE 13.—*Some Average Measurements of First Grade Carcases in Different Countries.*

Country.	Live weight.	Gain per day.	Length.	Depth.	Belly.	Back fat.	*Per cent. of the sexes.	
	lb.	lb.	in.	in.	in.	in.	M.	F.
Swedish (1).....	201	1·09	29·56	—	1·311	1·44	28·3	71·7
Danish (2).....	201	1·14	—	—	1·221	1·42	37·7	62·3
English (3).....	200	·74	30·16	—	—	—	—	—
South African.....	193	·99	28·94	15·87	1·2	1·411	37·4	62·6

(1) Hansson (1927), (2) Beck (1931), (3) Davidson and Duckham (1929).
*The percentages of the male and females are those when an equal number of both sexes are slaughtered without previous grading or selection.

The average live weight of the 1 L.S. pigs is below that of the first grade pigs of the other countries. This is, however, not of such importance as the average length of the 1 L.S. grade which is much below those of the two countries given. From general observation it appeared that a large percentage of the pigs sent to the bacon factories are deficient in length. The regulations of the new classes for bacon of recorded pigs, at the London Dairy Show, stipulate that a carcase of 140 to 149 lb. should have a length of 29·25 inches to qualify. The average carcase weight of the 1 L.S. grade is 144 lb. and the length only 28·94 inches. This is, therefore, the main point where improvement is necessary, since the other measurements agree well with those of the other countries.

3. *Effect of Weight and Sex on the Measurements.*

When the type of pig is the same, then weight plays an important part in determining the grade of the carcase in bacon production, and first grade carcases will fall in fairly narrow weight limits. To see what effect weight had on our results, the data have been grouped in three weight classes in which the sexes were kept separately. The actual and relative results are given in table 14.

There is no significant difference between the initial ages of the three weight groups and the sexes within the groups, while the final ages decrease with increase in weight, the females in all the groups being older than the males. For a better comparison the ages to reach

a weight of 200 lb. for the different groups are also given. When the pigs weighed less than 200 lb., the gains made during the week before slaughter were used to determine the length of time they would have taken to reach the 200 lb. mark. The males took 7 days less to reach a live weight of 200 lb. than the females in the lightest group. The age of the males decreased about 10 days each time that the average live weight increased 11 to 12 lb., but the decrease in the case of the females is more rapid, so that in the heaviest group the ages to reach a weight of 200 lb. by the males and females, differs only by one day. Nearly the same changes are shown by the average daily gains of the pigs while in the feeding trials. This difference in gain between the light and heavy groups was also found by Hansson (1927). A factor that may have influenced this to some extent was, that the quickest growers had sometimes to be kept at the farms after they were ready for slaughter, before dispatching them to the factory so as to have large enough consignments. One would rather have expected that the lighter groups were those that had finished first, i.e. the quickest growers and not the opposite.

As regards the initial weights only the heaviest group is somewhat higher, indicating that the pigs had started to gain on the others at the commencement of the trials. The shrinkages en route, the carcase percentages, the percentage of cured sides and the weight of the shoulders do not show any significant differences between the different weight groups. In all the weight groups the females have lighter cured sides even where the average live weight was the same as for the males or slightly above, and the percentages of the cured sides show this difference. The difference in degree of fatness between the sexes may have affected this to some extent. Although only very small, the differences between the percentages of shoulder to whole side, are consistently smaller for the females than for the males in the separate groups.

The length increased ·3 to ·5 of an inch with an increase of 11 to 14 lb. in live weight. The correlation coefficient for farm live weight and length is $+0{\cdot}48 \pm {\cdot}02$. Except for the lightest group, where the lengths are the same, the females are longer than the males.

The depth of the side increases with increase in weight, and has a correlation coefficient of $+ 0{\cdot}5 \pm {\cdot}02$, which is about the same as that between weight and length. The ratio of shoulder to flank depth shows that, with increase in weight the flank depth increases more rapidly that the depth at the shoulder. In every weight group the males are deeper at the shoulder than the females, but the latter are again deeper at the flank and the average depth of side is also consistently larger for the females. This better development of flank to shoulder for the females is also clearly shown where the depth of the shoulder is expressed as a percentage of the depth at the flank. Wilkens (1929) found that the female develops strongly in all directions whereas the boar develops mostly in height and length during the first year, while breadth and depth development lags behind.

TABLE 14.—*Effect of Weight and Sex on Carcase Measurements.*

Weight Class.—lb.	Actual Measurements.						Relative Measurements.					
	189 and Below.		190–199.		200 and Above.		189&Below		190–199.		200&Above	
Sex	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
No. of pigs	77	57	95	65	94	61	—	—	—	—	—	—
Initial age—days	72·7	70·1	71·0	69·9	71·3	71·7	—	—	—	—	—	—
Final age—days	189·3	194·6	188·3	190·0	184·8	187·8	—	—	—	—	—	—
Initial weight—lb.	46·6	46·2	46·3	45·0	51·5	52·4	164	163	160	155	176	177
Final weight—lb.	183·7	183·0	194·6	194·6	206·8	209·4	647	644	673	669	708	707
Factory weight—lb.	168·7	168·1	178·4	179·6	190·0	194·4	—	—	—	—	—	—
Per cent.	91·8	91·8	91·7	92·3	91·8	92·8	—	—	—	—	—	—
Carcase weight—lb.	138·5	137·6	146·0	145·6	154·6	159·2	488	485	505	500	529	538
Per cent.	75·4	75·2	75·0	74·8	74·7	76·1	—	—	—	—	—	—
Weight cured side—lb.	49·0	47·9	51·1	50·3	54·6	54·3	173	169	177	173	187	183
Per cent. (2 sides)	53·3	52·3	52·5	51·7	52·8	51·9	—	—	—	—	—	—
Weight of shoulder—lb.	14·9	14·5	15·6	15·2	16·7	16·2	53	51	54	52	57	55
Per cent. of side	30·4	30·3	30·5	30·2	30·6	29·8	—	—	—	—	—	—
Average daily gain—lb.	1·234	1·145	1·298	1·299	1·444	1·4	—	—	—	—	—	—
Age at 200-lb. live weight—days	200·0	207·1	190·4	193·8	181·0	182·1	—	—	—	—	—	—
Length—inches	28·4	28·4	28·9	29·1	29·23	29·6	100	100	100	100	100	100
Depth at shoulder—inches	16·1	15·9	16·4	16·2	16·9	16·8	57	56	57	56	58	57
Depth at flank—inches	15·2	15·6	15·6	15·8	16·1	16·5	54	55	54	54	55	56
Average—inches	15·68	15·72	15·98	16·0	16·48	16·66	55	55	55	55	56	56
Ratio—per cent.	105·9	102·0	105·2	102·5	105·0	101·8	—	—	—	—	—	—
Circumference ham—inches	23·4	23·3	23·7	23·9	24·2	24·3	82	82	82	82	83	82
Average back fat—inches	1·505	1·423	1·571	1·461	1·628	1·541	5·3	5·0	5·4	5·0	5·6	5·2
Evenness—per cent.	58·0	59·1	59·3	56·7	60·6	60·1	—	—	—	—	—	—
Belly—per cent.	70·0	77·0	76·3	79·1	76·7	84·6	—	—	—	—	—	—
Marbling—per cent.	73·3	65·0	70·4	66·8	73·6	67·4	—	—	—	—	—	—
Refractive index	1·4599	1·4598	1·4596	1·4597	1·4594	1·4596	—	—	—	—	—	—
Classification. IL.S.—per cent.	40·3	63·2	33·7	66·2	25·5	41·0	—	—	—	—	—	—
Classification. IM.—per cent.	14·3	12·3	34·7	26·1	31·9	46·0	—	—	—	—	—	—
Classification. O.F.—per cent.	9·1	3·5	10·5	1·5	19·2	10·0	—	—	—	—	—	—
Classification. Inf.—per cent.	36·4	11·0	21·1	6·2	23·4	3·0	—	—	—	—	—	—

Although the actual circumference of ham increases with an increase in weight, the relative measurement shows no difference between the groups. Within the weight limits studied, the hams have therefore made no improvement when the plumpness is determined as above.

The average thickness of the back fat increases with an increase in weight. The relative thickness increases as well. The correlation coefficient between farm live weight and thickness of back fat is $+ 0{\cdot}26 \pm {\cdot}03$. In all the weight groups the females have thinner back fat than the males. The evenness of the back fat shows little difference between the groups. The thickness of the belly shows a definite increase and is higher for the females in the same weight group in spite of the fact that the females have the thinnest back fat. The marbling tends to remain the same, being better for the males in all the groups. Wilson and Morris (1932) made a study of the composition of rabbit carcases and found that the flesh of males and females differed markedly and that the greatest difference was in the fat content. The females had approximately 4 per cent. more fat than the males in the " young " group and approximately 6 per cent. more in the " adult " group. This seems to show the influence of the male sexual organs since the opposite happens in pigs where castrated males are compared with normal females. In humans the female also has more fat deposited than the male. Gramlich and Thalman (1930), working with steers, spayed heifers and open heifers, got results which are somewhat contradictory to those found with the pigs in so far that the open heifers were " finished " before the steers. It is possible that there may be differences with different animal species. At 5 months Hammond (1932) found that the ewe had a higher percentage of meat and a lower percentage of bone than either the wether or the ram and reckons that this may be associated with the ewe's more early maturity, for the actual growth made by the wether and ram at 5 months was greater. The wether showed greater development of fat than both the ram and the ewe and he says that the removal of either the ovary or the testes is stated to be accompanied by a deposition of fat in the body. This therefore agrees with our results where the barrows are fatter than the females.

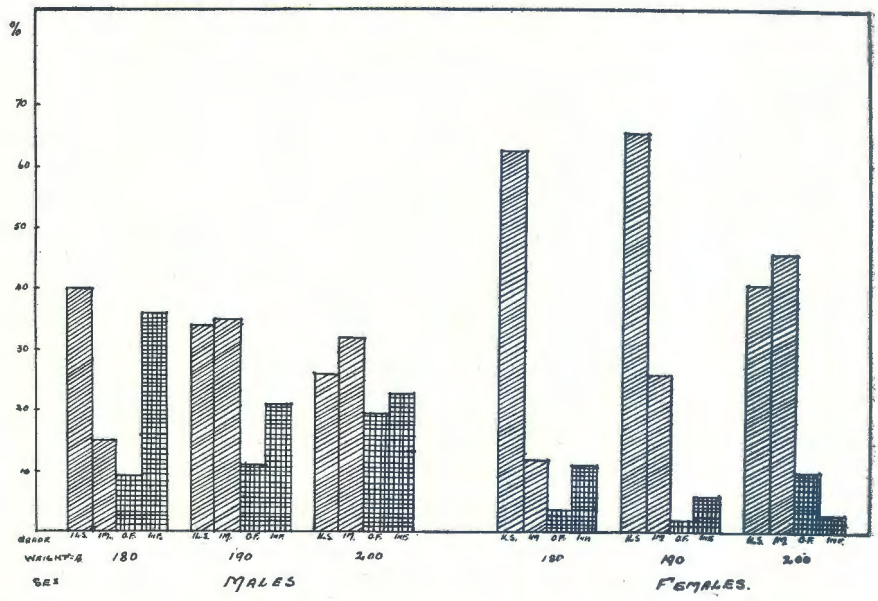
Except for the weight of the shoulder and the thickness of the back fat, the relative measurements do not show any differences between the sexes. In all cases the relative measurements increase with an increase in weight.

The grading of the carcases in the three groups and the sexes in the different weight groups, is interesting. A better picture of the differences is given by diagram V. than the actual figures.

Between the lightest and second lightest weight groups there is hardly any difference in the percentages of 1 Lean Sizable carcases. The percentages of Overfat carcases are also the same. There is an increase in the percentage of 1 Medium carcases and a decrease in Inferior carcases. While the 180 to 189 lb. group has 65 per cent. first grade carcases, the 190 to 199 lb. group has 80·4 per cent. The heaviest weight group has 72·2 per cent. first grade carcases. There is, however, a decided decrease in the percentage of 1 Lean Sizable

DIAGRAM V.

Grading of Barrows and Gilts at Different Live Weights.



carcases and an increase in 1 Medium and Overfat carcases, while the percentage of Inferior carcases remains constant. From this it is clear that for bacon purposes the best weight at which the pigs should be slaughtered is between 190 and 199 lb. live weight on the farm. The carcase weight obtained is on the average 146 lb. This is borne out by the results obtained in Sweden and Denmark. In Denmark, for instance, the highest price is paid for first quality carcases when they weigh from 139 to 150 lb.

The males and females in the three groups show very marked differences as far as the grading is concerned. The males show a continual decrease in the percentage of 1 Lean Sizable carcases and an increase and then a decrease in 1 Medium carcases, with an increase in live weight. For first grade carcases (1 Lean Sizable and 1 Medium) the percentage rises from 54·6 per cent. to 68·4 per cent. and then decreases to 57·4 per cent. The Overfat carcases show a continual increase from 9·1 to 19·2 per cent. The percentage of Inferior carcases decreases. The females on the other hand first show a rise in the percentage of 1 Lean Sizable carcases and then a drop, while the 1 Medium carcases increase continuously. For first grade carcases the percentages from the lightest to the heaviest groups are 75·5, 92·3 and 87·0 per cent., respectively. There is an increase in Overfat carcases and a decrease in Inferior carcases. In the different weight groups the females have much higher percentages of first grade carcases than the males. The three main factors contributing to these differences in grading are, (*a*) the thinner back fat, (*b*) the thicker bellies, and (*c*) the slightly longer sides of the females. These very marked differences between the sexes have also been found in the Scandinavian countries where pig products are produced mainly

TABLE 15.—*Influence of Rate of Gain on Carcase Measurements.*

Weight—lb.	189 and Below.					190–199.						200 and Above.					
Average gains—lb.	1·19.		1·2–1·49.		1·5.	1·19.		1·2–1·49		1·5.		1·19.		1·2–1·49.		1·5.	
Sex	M.	F.	M.	F.	M.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
No. of pigs	38	36	22	17	17	35	26	42	24	18	15	26	12	28	28	40	21
Initial age—days	75·2	71·8	72·5	67·6	67·6	74·2	69·4	69·4	69·5	68·7	71·5	73·9	72·2	70·0	68·6	74·0	75·4
Final age—days	215	213	175	167	151	213	218	180	178	160	161	218	223	187	186	162	170
Initial weight—lb.	44·7	40·0	46·8	48·3	50·6	46·1	40·7	45·5	46·0	48·6	50·8	43·5	46·2	49·9	50·3	57·9	57·8
Final weight—lb.	183	182	183	185	187	194	194	195	195	196	196	205	208	208	210	207	210
Factory weight—lb.	168	166	168	172	171	177	178	179	180	180	182	186	190	192	194	192	197
Per cent.	91·9	91·2	91·7	93·2	91·9	91·3	91·6	91·9	92·6	91·9	93·1	90·7	91·4	92·0	92·7	92·5	93·8
Carcase weight—lb.	138	137	139	141	138	144	144	147	148	147	147	152	155	156	159	156	164
Per cent.	75·7	75·2	75·8	76·2	74·0	74·3	74·0	75·5	75·9	75·1	75·0	74·2	74·7	74·8	75·6	75·4	77·8
Weight cured side—lb.	49·0	47·6	48·5	48·7	49·6	50·8	50·0	50·8	50·5	52·5	50·6	54·3	54·1	54·8	53·8	54·7	55·2
Per cent. (2 sides)	53·6	52·4	52·9	52·8	53·2	52·4	51·5	52·2	51·9	53·7	51·7	53·0	52·1	52·7	51·4	52·8	52·5
Weight shoulder—lb.	14·9	14·5	14·8	14·6	15·0	15·7	15·4	15·5	15·1	15·9	15·1	17·0	16·3	16·9	16·2	16·2	16·0
Per cent.	30·4	30·5	30·5	30·0	30·2	30·9	30·8	30·5	29·9	30·3	29·8	31·3	30·1	30·8	30·1	29·6	29·0
Average daily gain—lb.	1·0	·99	1·33	1·37	1·63	1·07	1·05	1·35	1·37	1·61	1·62	1·1	1·07	1·36	1·37	1·72	1·63
Age at 200-lb. wgt—days	226	227	186	179	159	218	222	182	182	162	164	215	219	183	180	158	164
Length—inches	28·4	28·5	28·2	28·1	28·5	28·8	29·0	28·9	29·4	28·8	29·0	29·2	29·9	29·2	29·5	29·3	29·6
Depth shoulder—inches	16·1	15·9	16·0	15·8	16·2	16·4	16·1	16·3	16·2	16·5	16·4	16·7	16·7	16·8	16·7	16·9	17·0
Depth flank—inches	15·3	15·6	15·2	15·6	15·3	15·5	15·6	15·5	15·7	15·9	16·2	15·9	16·2	16·0	16·5	16·2	16·7
Average—inches	15·7	15·8	15·6	15·7	15·8	16·0	15·8	15·9	16·0	16·2	16·4	16·4	16·5	16·4	16·6	16·6	16·9
Ratio	105	102	105	101	106	106	103	105	103	104	101	105	103	105	101	104	102
Circumference ham—ins.	23·3	23·2	23·3	23·7	23·8	23·7	23·8	23·7	23·9	23·7	24·1	24·2	24·1	24·2	24·3	24·2	24·4
*Ratio	82·0	81·4	82·6	84·3	83·5	82·3	82·1	82·0	81·3	82·3	83·2	82·9	80·6	82·9	82·4	82·6	82·4
Average back fat—inches	1·48	1·37	1·47	1·54	1·61	1·55	1·39	1·58	1·47	1·61	1·56	1·59	1·48	1·62	1·52	1·66	1·6
Evenness—per cent.	57·2	56·1	59·0	63·5	58·7	56·5	52·3	60·5	58·1	64·6	62·0	55·8	54·6	61·2	57·6	63·3	66·5
Belly—per cent.	70·8	75·6	69·1	78·8	68·8	74·0	76·5	77·4	78·8	78·3	84·0	73·5	83·3	78·6	83·9	77·5	86·2
Marbling—per cent.	76·3	64·1	70·5	68·2	72·4	70·8	64·5	67·0	65·7	77·1	72·0	74·8	68·9	71·5	66·8	74·4	67·5
Classification: 1 L.S.—per cent.	44·7	72·2	40·9	41·2	29·4	42·9	84·6	28·6	58·3	27·8	46·7	38·5	58·3	28·6	50·0	15·0	19·1
Classification: 1 M.—per cent.	13·2	8·3	18·2	23·5	11·8	22·9	3·9	45·2	37·5	33·3	46·7	15·4	33·3	42·9	46·4	35·0	52·4
Classification: O.F.—per cent.	5·3	2·8	4·6	5·9	23·5	28·6	—	9·5	4·2	22·2	- -	15·4	8·3	7·1	3·6	30·0	19·1
Classification: Inf.—per cent.	36·8	16·7	36·4	29·4	35·3	5·7	11·5	16·7	- -	16·7	6·6	30·8	—	21·4	—	20·0	9·5

* The circumference of the ham is expressed as a percentage of the length of the side.

in the form of bacon. Olson and Bull (1931) have analysed the data of ham and bacon belly yields of the carcases of 240 barrows and 205 gilts which were slaughtered at an average weight of 225 lb. They found that the average difference in dressing percentage was 0·5 per cent. in favour of the barrows, gilts averaged 0·39 per cent. more ham than the barrows; the bellies of the barrows were 0·23 per cent. heavier than those of gilts; loin yield was 0·43 per cent. in favour of gilts; barrows were 0·1 per cent. fatter, on an average, than gilts. With other comparisons they also found only very small differences and they come to the conclusion that from a commercial standpoint the differences are not significant. This is rather different to what our results and the Scandinavian results show. Whether the difference in slaughter weight and the difference in assessing the value, caused the difference in conclusions arrived at, is not clear. As far as the production of bacon is concerned, however, there can be no doubt that the gilts are superior to the barrows to a very marked degree.

4. *The Influence of the Rate of Gain.*

The idea has been commonly held that for bacon purposes pigs should not be allowed to grow too fast as they are then more liable to be too fat than when they are growing at a slower rate. In the reports of the East Anglian Pig Recording Scheme (1929) it came out clearly that the pigs in the herds making the slowest gains, gave the best results as far as grading is concerned. It is also well known that the slower the rate of gain the higher is the feed cost on account of the larger proportion of feed required for maintenance. Hansson (1927), however, on analysing the data of the Swedish testing stations concludes that, when pigs receive the proper feeding stuffs then the fast growers give better results than the slow growers as regards quality of carcases. In table 15 the average results are given after the data had been grouped according to the rate of average daily gains made by the pigs. The same groups have been used as in a previous part of the paper, and the live weights are kept constant. On account of the differences existing between the sexes, their results are given separately in the different weight and gain groups. This is also done in the subsequent groupings.

The initial ages show no consistent differences between the fast and slow growers, while the initial weights show an increase with increased rate of gain. At an age of about 10 weeks therefore, the quick growers already show a difference and this is more marked in the heavy than in the light groups.

The shrinkage on the journey shows a tendency to decrease with an increased gain, but this is rather a more indirect influence since the quick gainers are fatter and have deeper sides than the slow gainers. The same is the case with the dressing percentage and the percentage of cured sides. The small difference in the percentage of cured sides in favour of the males is again manifested. The proportion of shoulder to full side does not show much change, although the tendency is to decrease with that of the females slightly lower than that of the males.

TABLE 16.—*Effect of the Rate of Gain on the Length of the Side.*

Weight—lb.....	189.			190–199.			189.			190–199.			200.		
Ave. depth of side—ins.	15–15·9			15–15·9			16–16·9			16–16·9			16–16·9		
Average daily gain—lb.	1·19	1·2–1·49	1·5	1·19	1·2–1·49	1·5	1·19	1·2–1·49	1·5	1·19	1·2–1·49	1·5	1·19	1·2–1·49	1·5
No. of pigs.....	34	22	11	31	30	9	28	13	9	26	31	18	24	32	27
Length—inches.....	28·44	28·24	28·59	28·73	29·25	29·09	28·4	27·89	28·01	29·21	28·99	28·81	29·45	29·43	29·04

In the 180-189 lb. group there is no significant difference between the length of the males and females, but in the other two weight groups the females are throughout longer than the males. There is, however, no consistent change in length with the increase in the rate of gain. The correlation coefficient for the rate of gain and the length of the side is $+ 0{\cdot}13 \pm {\cdot}03$. The slight positive correlation coefficient is probably due to the increase in weight and not the increase in length since the weight was not kept constant in determining the correlation coefficient. The average depth of a side increases with an increase in the rate of gain. It appears that the increase in the depth at the flank is slightly more than at the shoulder. The depth of side and the rate of gain has a correlation coefficient of $+ 0{\cdot}32 \pm {\cdot}03$ when the weight is not kept constant, so that weight may have influenced this also to some extent. The grouping of the data, however, shows that there is a definite correlation between depth of side and rate of gain. When the weight is kept constant then one would expect that with an increase in the depth of the side the length would rather decrease than increase. Since the depth and the rate of gain are quite strongly correlated there may be an indirect effect on the length when the rate of gain increases. Table 16 therefore represents the results of males and females where the weight and depth has been kept constant so as to see the effect of the rate of gain on the length.

Except in the last two depth groups, there is no consistent change in the length of the sides as the rate of gain increases. Only the last two groups show a consistent decrease in length. It therefore appears that rate of gain has only a very slight effect on the length of the side and that this slight effect is rather negative, i.e. length will rather decrease with an increase in rate of gain than the opposite.

There is a decided increase in the average thickness of the back fat with an increase in the rate of gain. The correlation coefficient is $+ 0{\cdot}35 \pm {\cdot}03$. The evenness of the back fat increases as well, but there is no difference between the sexes. To eliminate any influence that may be due to the increase in the depth of the side as the rate increases, the weight and the depth have been kept constant in table 17 so as to see the effect of the rate of gain alone.

When only the rate of gain increases the thickness of the back fat still shows a definite increase.

In tables 14 and 15 it has been shown that the average thickness of the back fat of males and females increases as the weight and the average daily gain increase. To see whether the males or females fatten more quickly when the weight or rate of gain increases, the thickness of the back fat of the females have been expressed as percentages of that of the males. With an increase in weight the percentages are:—

Weight—lb.	180	190	200	210	220
Percentage	94·6	93·0	94·6	90·6	94·2

TABLE 17.—*Effect of Rate of Gain on the Thickness of the Back Fat.*

Weight—lb.....	189.			190–199.			189.			190–199.			200.		
Ave. depth of side—ins.	15–15·9			15–15·9			16–16·9			16–16·9			16–16·9		
Average daily gain—lb.	1·19	1·2–1·49	1·5	1·19	1·2–1·49	1·5	1·19	1·2–1·49	1·5	1·19	1·2–1·49	1·5	1·19	1·2–1·49	1·5
No. of pigs.....	34	22	12	30	30	10	28	13	9	26	31	18	24	32	28
Average thickness of back fat—inches.....	1·368	1·501	1·523	1·438	1·483	1·567	1·575	1·541	1·634	1·48	1·582	1·582	1·531	1·531	1·607

Weight apparently has no influence on the rate at which the back fat increases. The influence of the rate of gain seems to affect the males and females differently as shown below:—

Rate of Gain—lb.....	1·19 and below	1·2–1·49	1·5 and above.
Percentage.....	91·3	96·4	95·5

The same thing is shown in table 18 where the thickness of back fat at different rates of gain have been expressed as percentages of the back fat when the gain was the lowest.

TABLE 18.—*Influence of Rate of Gain on the Increase in Thickness of Back Fat of Males and Females.*

Average daily gain—lb.	·8–·9	1·0–1·1	1·2–1·3	1·4–1·5	1·6–1·7	1·8–1·9
Males.						
No. of Pigs.....	28	73	60	65	28	10
Thickness of back fat—in.	1·459	1·565	1·544	1·6	1·606	1·719
Relative thickness — per cent.....	100	107	106	110	110	118
Females.						
No. of pigs.....	30	44	41	48	17	3
Thickness of back fat—in.	1·36	1·423	1·462	1·581	1·518	1·67
Relative thickness — per cent.....	100	105	108	116	112	123

Both methods of expressing the rate of increase in the thickness of back fat indicate that as the rate of gain increases the thickness of the back fat of the females increases at a more rapid rate than that of the males.

The bellies show an improvement as the rate of gain increases but the marbling shows no consistent change but tend to decrease and then increase again. Since the thickness of back fat shows an increase as the rate of gain increases one would expect the marbling to improve. It may be that age had an influence since it is reckoned that marbling improves with age. In this case the quickest growers, and also the fattest pigs, were the youngest. In table 19 the thickness of back fat is kept constant to see the effect of rate of gain on marbling.

For both males and females the group with the thinnest back fat shows a continuous increase in marbling. In the other two groups, however, the slowest growers of both sexes have the best marbling, then there is a drop to the next gain group and then there is a slight rise again. To see the effect of age the data are grouped with the back fat again remaining constant while the age increases.

TABLE 19.—*Effect of Rate of Gain on Marbling.*

Thickness of back fat—inches.....	1·49 and Below.			1·5–1·74.			1·75 and Above.		
Average daily gain—lb.....	1·19	1·2–1·49	1·5	1·19	1·2–1·49	1·5	1·19	1·2–1·49	1·5
Males—									
No. of pigs.....	23	26	19	35	43	33	14	14	22
Marbling—per cent.....	66·5	68·5	74·2	76·0	69·1	73·9	80	71·4	75·9
Females—									
No. of pigs.....	40	32	11	18	29	22	2	7	6
Marbling—per cent.....	60·8	64·4	65·5	71·7	68·6	69·5	90	70	71·7

TABLE 20.—*Effect of Age on Marbling.*

Thickness of back fat—inches.....	1·49 and Below.				1·5–1·74.				1·75 and Above.			
Age—days.....	140	160	180	200	140	160	180	200	140	160	180	200
Males—												
No. of pigs.....	15	14	18	18	21	30	27	36	16	14	6	14
Marbling—per cent.....	75·3	70·0	66·1	66·7	76·2	68·3	67·4	76·1	78·8	72·1	76·7	77·9
Females—												
No. of pigs.....	12	19	21	31	11	12	27	19	—	—	—	—
Marbling—per cent.....	66·7	63·6	60·5	62·3	70·9	70·1	67·4	71·6	—	—	—	—

This decrease and then again an increase (which is more marked than in table 19) in the marbling is also taking place when the age of the pigs increases, and this is very consistent in all the groups for males and females. We can give no explanation for this change unless there are two factors influencing the marbling; the one connected with early maturity, the effect of which decreases as the age increases, until the advanced age asserts its influence when the degree of marbling increases again.

Both males and females show rather marked decreases in the percentages of 1 Lean Sizable carcases as the rate of gain increases, while the 1 Medium carcases first increase and then decrease again. When the total percentage of first grade carcases are taken then there is first an increase from the slow growers to the medium fast growers and then a fall to the fast growers. From this it would therefore appear that there is an optimum rate of growth for baconers, viz., an average daily gain of 1·2 to 1·49 lb. This does not agree with Hansson's (1927) results where the quickest growers showed slightly better grading than the slow growers.

The results, as shown in table 15, show clearly that one cannot influence the length of the baconers to any marked extent by changing the rate of gain of the pigs. One can, however, influence the depth of the sides and the degree of fatness by changing the rate of growth. This is what one would expect knowing that length growth takes place early in the life of an individual whereas depth and width are later developing, especially in the males, as shown by Wilkens (1929). This is also the case with the amount of fat deposited. Bone and muscle development take place first and only then does a storage of fat take place [Hammond (1929)]. Length cannot therefore be influenced to a significant extent by the feed, and consequently we cannot agree with the conclusion arrived at by Schutte and Murray (1931), that barley had a favourable influence on the length of the pigs. It is only through breeding and selecting the required type of pig that one will succeed in altering the length. Slow growing pigs, being shallower than quick growing ones, may give one the impression that they are longer than the quick growers.

5. *The Influence of the Length of Side on the Carcase Measurements.*

Length in relation to the weight is one of the most important factors in judging the value of bacon sides. It is therefore important to know how the carcase measurements may be affected when we start increasing the length. For a definite weight, the ideal bacon pig should be long, deep and wide. It is, however, impossible to increase all these dimensions when the weight remains constant, consequently one or other measurement must suffer when length, for instance, is increased. The results where the carcases have been grouped according to length, are given in table 21.

TABLE 21.—*Influence of Length on Carcase Measurements.*

Weight—lb.....	189 and Below.						190–199.						200 and Above.					
Length—inches....	28·4		28·5–29·4		29·5		28·4		28·5–29·4		29·5		28·4		28·5–29·4		29·5	
Sex.....	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
No. of pigs.....	42	24	27	27	8	5	20	10	52	29	22	26	11	4	35	19	47	37
Initial age—days..	71·3	68·4	73·9	72·1	76·6	67·8	68·8	69·3	71·3	68·1	72·4	72·2	71·0	68·5	69·5	70·3	73·9	73·1
Final age—days...	191	187	184	206	199	178	184	202	194	189	180	186	176	177	187	182	186	193
Initial weight—lb.	42·7	46·7	51·7	44·8	50	52·4	45·3	41·3	44·4	44·0	51·0	47·5	54·0	54·3	49·6	52·2	52·5	52·2
Final weight—lb..	183	184	185	183	186	185	194	195	194	194	196	195	204	203	206	207	208	212
Factory weight—lb.	168	169	169	168	172	168	179	180	178	179	178	180	188	189	189	193	191	196
Per cent.....	92·0	92·2	91·4	91·7	92·3	90·8	91·9	92·5	91·7	92·3	91·2	92·3	92·1	93·0	91·9	93·4	91·8	92·5
Carcase weight—lb.	138	138	137	137	139	137	144	146	146	144	147	147	150	154	154	158	156	160
Per cent.....	75·7	75·2	74·4	75·2	74·8	73·7	74·2	74·7	75·1	74·3	75·2	75·3	73·6	75·9	74·6	76·5	75·0	75·7
Wgt. cured side—lb.	48·9	48·0	49·3	47·6	48·3	50·0	52·1	51·3	51·0	49·3	50·6	50·8	53·9	—	54·4	54·4	54·9	54·3
Per cent (2 sides)..	53·5	52·2	53·4	52·1	52·0	53·9	53·6	52·7	52·5	50·9	51·8	52·0	52·8	—	52·8	52·6	52·8	51·3
Wgt. shoulder—lb.	14·8	14·7	15·0	14·3	14·9	15·3	15·9	15·4	15·7	15·1	15·4	15·5	16·6	—	16·7	16·2	16·7	16·2
Per cent.....	30·3	30·6	30·4	30·0	30·8	30·6	30·5	30·0	30·8	30·6	30·4	30·5	30·8	—	30·7	29·8	30·4	29·8
Ave. daily gain—lb.	1·22	1·21	1·28	1·06	1·18	1·3	1·32	1·23	1·25	1·29	1·37	1·33	1·52	1·43	1·39	1·44	1·47	1·37
Age at 200 lb. weight—days....	202	198	195	219	208	187	186	205	198	194	184	189	173	175	183	179	181	185
Length—inches....	27·8	27·7	28·8	28·8	30·0	29·6	27·9	28·0	28·9	28·9	29·8	29·9	27·8	28·0	28·8	29·0	29·9	30·0
Depth shoulder—in.	16·2	15·8	16·1	16·0	15·8	15·6	16·6	16·3	16·3	16·1	16·3	16·3	16·6	17·1	16·7	16·9	17·0	16·7
Depth flank—ins..	15·4	15·6	15·1	15·5	14·9	15·4	15·9	16·0	15·5	15·8	15·5	15·7	15·8	16·6	16·1	16·6	16·1	16·4
Average—inches...	15·8	15·7	15·6	15·8	15·4	15·5	16·2	16·2	15·9	15·9	15·9	16·0	16·2	16·8	16·4	16·8	16·6	16·7
Ratio.....	105	101	107	103	106	101	105	102	105	102	105	104	105	103	104	102	105	102
Circ. ham—inches.	23·4	23·4	23·3	23·4	23·4	23·2	23·9	23·8	23·6	23·9	23·8	24	24·8	24·2	24·1	24·2	24·2	24·4
Ratio.....	84·2	84·5	80·9	81·3	78·1	78·2	85·7	85·1	81·7	82·7	79·7	80·4	88·8	86·4	83·7	83·4	80·8	81·2
Ave. back fat—in.	1·55	1·48	1·47	1·39	1·37	1·34	1·66	1·54	1·57	1·44	1·49	1·46	1·55	1·56	1·63	1·55	1·65	1·54
Evenness—per cent	59·3	60·0	56·6	57·4	55·9	62·9	59·8	56·1	58·8	57·2	59·4	56·4	59·3	61·6	60·9	63·8	60·5	57·8
Belly—per cent....	71·9	76·3	67·0	78·1	70·0	78·0	75·0	84·0	77·1	80·0	76·8	76·2	79·1	87·5	76·3	83·1	76·2	84·9
Marbling—per cent.	74·3	65·7	70·5	65·9	78·0	65·0	70·0	58·0	70·7	67·3	70·0	67·2	68·2	72·5	72·3	66·1	76·0	67·4
Classification: 1 L.S.—p.ct	31·0	54·2	40·7	70·4	88·9	60·0	10·0	70·0	38·5	58·6	45·5	73·1	45·5	50·0	22·9	31·6	21·3	43·2
Classification: 1 M.—p. ct.	19·0	20·8	11·1	7·4	—	—	25·0	20·0	34·6	31·0	40·9	23·1	9·1	50·0	31·4	42·1	38·3	48·7
Classification: O.F.—p. ct.	11·9	8·3	7·4	—	—	—	30·0	—	5·8	3·4	4·5	—	27·3	—	17·1	21·0	19·1	5·4
Classification: Inf.—p. ct..	38·1	16·7	40·7	22·2	11·1	40·0	35·0	10·0	21·2	6·9	9·1	3·8	18·2	—	28·6	5·3	21·3	2·7

The initial and final ages of the different length groups do not show any consistent tendency, neither is this the case when the ages to reach 200 lb. live weight are compared. The initial live weights vary and consequently no definite relation can be seen between length and average daily gain. As has been discussed above, length rather decreased with an increased rate of gain than the opposite. Hansson (1927), however, found that the long pigs made a larger average daily gain (0·638 Kg.) than the short pigs (0·611 Kg.). Hansson did nit keep the weights constant in comparing the long and short pigs so that the former were on an average 2 Kg. heavier than the latter. In our results, and also found by Hansson, the heavy pigs made the quickest gains and it would, therefore, appear that the difference in live weight rather caused the difference in gains between the long and short groups, than the difference in length as was found by Hansson.

Although the tendency is not definite, it still appears that there is a slight decrease in dressing percentage and percentage of bacon sides with an increase in length. Hansson (1927) found a very small decrease in the dressing percentage of the long pigs and Larsson (1928) got a positive correlation between length of side and weight of head and feet. In table 21 the thickness of the back fat decreases as the length increased which was also the case with both Hansson's and Larsson's results. This would tend to influence the dressing percentage. When length increases one would, however, expect to find the head and legs somewhat heavier as was found by Larsson. In our results this will influence the percentage of cured sides, which was, however, very slight.

With an increase in length the depth of the side decreases when weight remains constant. The males in the heaviest group shows the opposite, but in the other groups the tendency seems to be definite. The correlation coefficient for length and depth of side is $-0{\cdot}11 \pm {\cdot}05$ when the live weight is 190-199 lb. The relative depth of the side decreases to a marked extent when the length increases. The circumference of the ham shows hardly any change, but when it is expressed as a percentage of the length then there is a decided decrease. If the length of the leg increases when the length of the side increases then the ham of a long pig will be much less plump that that of a short one, when the circumference is expressed as a percentage of the length of the side. This takes place when one looks at the different types of pigs. Hansson's (1927) results show a decrease in the points awarded for the hams when the length increased.

The average thickness of the back fat decreased with an increase in length. The males in the heaviest group show the opposite. The correlation coefficient for these two factors is $-0{\cdot}03 \pm {\cdot}03$. The weight was not kept constant in determining the correlation coefficient and this resulted in no correlation since weight and thickness of back fat and weight and length are positively correlated. The effect of length is consequently neutralised when the weight increased with the length. Larsson (1928) found a negative correlation between length and the thickness of the back fat ($-0{\cdot}28 \pm {\cdot}07$) when he kept the live weight constant. The length does not affect the evenness of the back fat significantly as shown in table 22 when the thickness of the back fat remains constant.

TABLE 22.—*Effect of Length on the Evenness of the Back Fat.*

Thickness of back fat—inches.....	1·24 and Below.			1·25–1·49.			1·5–1·74.			1·75 and Above.		
Length—inches.....	28·4	28·5	29·5	28·4	28·5	29·5	28·4	28·5	29·5	28·4	28·5	29·5
No. of pigs.....	3	14	6	38	67	55	57	82	57	15	25	27
Evenness—per cent.....	56·4	52·4	53·5	56·9	56·3	56·8	60·0	61·1	59·5	64·1	62·5	62·3

TABLE 23.—*Influence of Degree of Fatness on Carcase Measurements.*

Weight—lb.	189 and Below.						190–199.						200 and Above.					
Back fat—inches	1·24	1·25–1·49		1·5–1·74		1·75	1·25–1·49		1·5–1·74		1·75		1·25–1·49		1·5–1·74		1·75	
Sex	F.	M.	F.	M.	F.	M.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
No. of pigs	8	29	25	33	21	9	30	35	47	23	17	4	21	19	46	27	25	9
Initial age—days	75·8	74·4	69·8	72·0	68·9	67·4	72·3	70·9	71·9	71·5	66·2	60·3	72·1	71·1	72·3	71·4	70·7	71·2
Final age—days	206	191	194	188	191	183	192	193	188	185	182	170	188	193	188	185	176	181
Initial weight—lb.	50·8	50·2	47·8	44·5	42·3	39·3	46·7	48·3	46·9	42·5	42·4	38·0	49·6	53·4	51·7	49·9	51·7	53·4
Final weight—lb.	181	184	184	184	185	186	195	195	195	195	193	195	206	209	207	208	206	212
Factory weight—lb.	164	169	169	169	170	170	178	180	178	180	179	179	188	192	190	193	192	200
Per cent.	90·6	91·7	91·8	91·8	92·1	91·5	91·4	92·4	91·5	92·4	92·3	91·6	91·2	92·0	91·5	93·0	93·1	94·6
Carcase weight—lb.	130	139	137	139	142	141	145	145	146	148	147	148	154	156	154	158	155	167
Per cent.	72·1	75·6	74·5	75·5	76·8	75·7	74·6	74·3	74·8	75·7	76·0	76·1	74·8	74·9	74·5	76·2	75·2	78·6
Wgt. cured side—lb	47·4	47·5	47·1	49·3	49·5	51·6	49·3	49·9	51·5	50·6	54	54·1	53·0	52·7	54·2	53·5	56·8	58·6
Per cent (2 sides)	52·5	51·7	51·3	53·6	53·5	55·5	50·6	51·3	52·8	51·9	55·8	55·5	51·6	50·5	52·4	51·5	55·1	55·4
Wgt. shoulder—lb.	15·1	14·5	14·4	14·8	14·7	15·9	15·0	15·4	15·8	14·9	16·3	16·1	16·2	15·7	16·7	15·5	17·1	17·5
Per cent.	31·9	30·5	30·6	30·0	29·7	30·8	30·4	30·9	30·7	29·4	30·2	29·8	30·6	29·8	30·8	29·0	30·2	29·9
Ave. daily gain—lb.	1·02	1·19	1·14	1·27	1·21	1·3	1·27	1·23	1·31	1·38	1·34	1·48	1·39	1·31	1·41	1·45	1·55	1·48
Age at 200 lb. weight—days	219	202	207	199	202	192	195	197	191	189	186	173	186	188	184	181	173	173
Length—inches	28·8	28·5	28·4	28·3	28·3	27·9	29·2	29·2	28·7	29·1	28·8	29·2	29·1	29·6	29·1	29·5	29·4	29·3
Depth shoulder—in.	15·4	16·0	15·8	16·3	16·2	16·6	16·2	16·1	16·3	16·4	16·8	16·4	16·5	16·6	16·9	16·9	17·1	17·1
Depth flank—ins.	14·7	15·1	15·5	15·4	16·0	15·9	15·3	15·7	15·5	15·9	16·1	16·1	15·8	16·2	16·1	16·6	16·3	17·2
Average—inches	15·1	15·6	15·7	15·8	16·1	16·3	15·8	15·9	15·9	16·1	16·5	16·3	16·2	16·4	16·5	16·8	16·7	17·2
Ratio—per cent.	105	106	102	106	101	104	106	102	105	103	104	102	104	103	105	102	105	99
Circ. ham—inches	23·4	23·4	23·3	23·5	23·4	23·3	23·6	24·0	23·7	23·8	23·8	24·1	24·1	24·0	24·2	24·3	24·3	24·4
Ratio—per cent.	81·3	81·9	82·0	83·0	82·6	83·6	80·8	82·2	82·7	81·7	82·6	82·5	82·7	81·2	83·1	82·4	82·7	83·2
Back fat—inches	1·13	1·36	1·37	1·59	1·59	1·85	1·38	1·38	1·6	1·57	1·84	1·81	1·4	1·38	1·61	1·59	1·86	1·87
Evenness—per cent	49·7	56·9	57·5	58·4	64·3	62·1	56·4	54·8	60·1	59·3	62·8	64·5	59·1	57·7	59·8	62·9	63·7	59·4
Belly—per cent.	58·8	69·7	76·8	69·7	85·7	82·2	73·3	78·0	76·6	81·3	81·2	87·5	77·6	86·3	75·4	85·2	78·0	84·4
Marbling—per cent.	50·3	68·3	62·6	76·9	72·0	75·6	69·6	62·8	67·0	71·0	80·7	80·0	70·5	65·0	75·0	66·7	73·6	72·2
Classification: 1 L.S.—p. ct.	37·5	69·0	92·0	24·2	38·1	11·1	50·0	85·7	34·0	47·8	—	25·0	57·1	84·2	26·1	22·2	—	—
Classification: 1 M.—p. ct.	—	3·4	4·0	24·2	28·6	22·2	23·3	14·3	38·3	43·5	47·1	50·0	38·1	15·8	23·9	66·7	40·0	44·4
Classification: O.F.—p. ct.	—	—	—	3·0	4·8	66·7	—	—	6·4	4·3	41·2	—	—	—	10·9	3·7	48·0	55·6
Classification: Inf.—p. ct.	62·5	27·6	4·0	48·5	28·6	—	26·7	—	21·3	4·3	11·8	25·0	4·8	—	39·1	7·4	12·0	—

The thickness of the belly decreases with an increase in the length. The marbling shows no definite trend.

The percentages of 1 Lean Sizable carcases in the first two weight groups increase with an increase in length when the males and females are taken together. This is not so with the heaviest group where the shortest pigs have the highest percentage of 1 Lean Sizable sides. In all the groups there is a larger percentage of 1 Lean Sizable female carcases except in the longest group of the 180-189 lb. weight group where a large percentage (40 per cent.) of the female carcases were " unfinished ".

6. *The Influence of the Degree of Fatness on the Carcase Measurements.*

To see how fattening influences the carcase measurements the data have been grouped according to the thickness of the back fat. According to Larsson (1928) the thickness of the back fat is the best indication of the degree of fatness of a pig. The results are shown in table 23.

The initial and final ages decrease with an increase in the degree of fatness within the different weight groups. The initial weights also tend to decrease. The average daily gains increase as the thickness of the back fat increases and the correlation coefficient is $+ 0{\cdot}35 \pm {\cdot}03$. The ages to reach a live weight of 200 lb. decrease markedly, there being a difference of about 14 days between the fattest and leanest pigs in the three weight groups. The actual age and the thickness of the back fat is negatively correlated ($- 0{\cdot}24 \pm {\cdot}03$). To see at what ages the rate of gain for the different fat groups show the largest gains, the average daily gains at different periods have been determined and expressed as percentages of the gains made from birth up to 90 days of age. Table 24 and diagram 6 show the trends of the different groups.

TABLE 24.—*Actual and Relative Gains made by Pigs of Different Degrees of Fatness.*

	No. of pigs.	Age in Weeks.						
		13	17	21	25	29	33	37
Males.								
Back fat, 1·24 and below—inches.....	5	·824	1·15	1·394	1·398	—	—	—
Relative—per cent....		100	140	169	170	—	—	—
1·25–1·49—inch.....	66	·702	1·122	1·4	1·589	1·573	—	—
Relative—per cent....		100	160	199	226	224	—	—
1·5–1·74—inches.....	124	·686	1·048	1·395	1·439	1·67	1·395	1·843
Relative—per cent....		100	153	203	210	243	203	269
1·75 and above—inch	68	·665	1·073	1·314	1·417	1·494	1·8	1·893
Relative—per cent....		100	161	198	213	225	271	285
Females.								
1·24 and below—inch	12	·667	·854	1·181	1·243	—	—	—
Relative—per cent....		100	128	177	186	—	—	—
1·25–1·49—inches....	74	·746	1·001	1·311	1·355	1·495	1·267	1·531
Relative—per cent....		100	134	176	187	200	170	205
1·5–1·74—inches.....	92	·654	1·029	1·231	1·32	1·325	1·501	2·276
Relative—per cent....		100	157	188	202	203	230	348
1·75 and above—inch	22	·663	1·037	1·269	1·293	1·158	1·479	2·028
Relative—per cent....		100	156	191	195	175	223	306

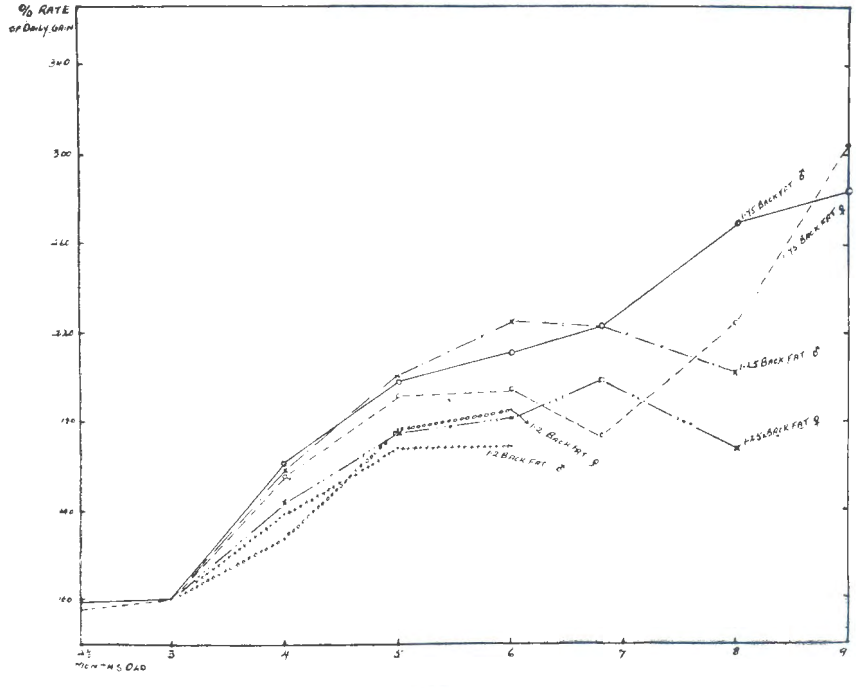
The proportion of males (263) and females (200) in the four groups are as follows:—

Thickness of back fat-inches	1·24	1·25–1·49	1·5–174	1·75
Males—per cent.....	1·9	25·1	47·1	25·9
Females ,, ,, ...	6·0	37·0	46·0	11·0

The females have a larger percentage of carcases falling in the classes with thin fat than the males. The two fattest male groups do not show much difference in relative gains, except for the irregularity at 8 months in the 1·5 – 1·74 inches group. The increase in gains are maintained up to 9 months although the steepness varies. The third group (1·25 – 1·49 inches) shows a drop from 6 months while the leanest group already remains constant from 5 months, and they also make lower relative gains than the other three groups. In the case of the females the two fattest groups are about the same and the two leanest ones slightly lower and also about the same. Up to about 2 months the difference in relative gains are not very pronounced. The males and females in the two leanest groups tend to remain constant or start decreasing in relative gains from 5 to 6 months, whereas those in the fatter groups continue to increase. The females show a depression from 5 to 7 months and then make more rapid gains than the males. Except for the male group 1·5—1·74 in., the males make more regular gains than the females.

DIAGRAM VI.

Relative Gains of Barrows and Gilts of Different Degrees of Fatness.



The shrinkage on the journey tends to decrease with increased fatness. The dressing percentage increased, so also the percentage of cured sides. The males do not show so consistently a higher percentage of cured sides over the females as in table 15 since the degree of fatness is the same in table 23. The proportion of shoulder to the whole side shows very little change but tends to decrease.

The length decreases with increased fatness. This has been fully discussed in a previous section. There is a marked increase in the depth of the side as the pig fattens. The flank measurement increased at a quicker rate than the shoulder measurement as shown by the shoulder/flank ratio. The females show quite a large difference from the males as regards this ratio and in the 200 lb. and heavier group the fattest females have a deeper flank than shoulder measurement. Not a single male carcase had a greater depth at the flank than at the shoulder. The correlation coefficient of depth of side and thickness of back fat is $+ 0{\cdot}47 \pm {\cdot}03$. There is a slight increase in the circumference of the hams with an increase in fatness and when it is expressed as a percentage of the length of the side it shows a small improvement. The males and females do not show any consistent difference.

The evenness of the back fat improves as the thickness increases. The average measurements of the back fat expressed as percentages of the thickness at the shoulder for the three main grades are as follows: —

	Place Measured.			
	Shoulder.	Back.	Loin.	Ham.
1 Lean Sizable—per cent.....	100	68·2	57·6	64·7
1 Medium—per cent.....	100	69·9	62·6	76·5
Overfat—per cent.....	100	73·5	65·6	70·5

As the pigs fatten all the back fat measurements approach that of the shoulder measurement, i.e. the back fat becomes more even. When carcases are therefore judged one should first make sure that the thickness of the back fat is the same before taking evenness into consideration. The thickness of the back fat and its evenness has a correlation coefficient of $+ 0{\cdot}31 \pm {\cdot}03$. The bellies show marked improvement as the pig fattens and the correlation coefficient is $+ 0{\cdot}35 \pm {\cdot}03$. Davidson (1927), discussing the Swedish testing station results, concludes that the lesser evil is to have thin back fat and a thin belly rather than thick back fat and a thick belly. Although the thickness of the bellies are also considered in the Scandinavian countries, much more attention is paid to the thickness of the back fat in grading carcases. In England rather more attention is given to the bellies in laying down standards for bacon classes at shows. The marbling of the lean meat also improves with fattening, the males being the better in practically all the groups.

When the weight groups are not taken into consideration but only the degree of fatness of the pigs then the average percentages for marbling are as follows:—

Thickness of back fat—inches...	1·24	1·25–1·49	1·5–1·74	1·75
Males.....	66·0 (5)	70·0 (69)	72·5 (116)	76·0 (50)
Females.....	56·0 (11)	64·0 (72)	69·7 (69)	73·3 (15)

In brackets the number of carcases are given from which the averages are obtained. The correlation coefficient for the thickness of the back fat and marbling is + 0·29 ± ·03. As shown above the marbling of the female carcases improve at a quicker rate, than those of the males, with fattening.

The very marked effect of the thickness of the back fat on the grading is shown by the decrease of first grade carcases as the thickness of the back fat increases. Below the percentages of carcases in the different grades are given when the weight and sex are not considered but only the thickness of the back fat. The actual numbers are given in brackets.

Thickness of back fat—inches.....	1·25–1·49	1·5–1·74	1·75
1 Lean Sizable—per cent.....	73·0 (116)	32·6 (61)	3·1 (2)
1 Medium—per cent.....	15·7 (25)	38·0 (71)	40·6 (26)
Overfat—per cent.....	—	6·4 (12)	47·0 (30)
Inferior—per cent.....	11·3 (18)	23·0 (43)	9·4 (6)

First grade carcases (1 Lean Sizable and 1 Medium) show a decrease from 88·7 per cent. in the leanest group to 70·6 per cent. in the second leanest and only 43·7 per cent. in the fattest group. The 1 Lean Sizable carcases show a very rapid decline when the back fat is thicker than 1·5 inches on an average. As was shown in table 12 the average thickness of 1 Lean Sizable carcases is 1·4 inches, the thickest average measurement being 2·0 inches and the thinnest 1·2 inches.

Larsson (1928) made a study of the influence of the degree of fatness on the amount of feed consumed per unit of gain. He also compared the Swedish results with the Danish results which agree well as shown in table 25.

TABLE 25.—*Influence of Fatness on Feed Requirements.*

Material from.	No. of Groups.	Live Weight of Group at Slaughter Kg.	Correlation between Back Fat and Feed Units per Kg. Gain.	Increase in Feed Units per Kg. Gain, when Thickness of Back Fat Increases 1 cm.
Sweden.....	178	89·0–95·9	+ 0·22 ± ·07	0·10
Denmark.....	861	89·0–95·9	+ 0·19 ± ·03	0·12
Denmark.....	181	90 –90·9	+ 0·20 ± ·07	0·12
Denmark.....	182	91·0–91·9	+ 0·21 ± ·07	0·15

The above is more or less what one would expect since a fattening animal requires more energy above the maintenance requirements than one that is still putting on flesh. No mention is made whether the factor of the rate of gain was taken into consideration. As our results show, the fat pigs are the quickest growers and it is a well known fact that quick growers need less feed per unit of gain than slow growers. If this factor had been taken into consideration the difference in feed requirements per unit of gain would have been less than the results obtained in the above table between pigs of different degrees of fatness.

7. *Influence of Depth of Side on Carcase Measurements.*

The results, after the data had been grouped according to the depth of the sides, are given in table 26.

As in the case with the degree of fatness (table 23) the initial and final ages decrease with an increase in the depth of the sides, while the initial weights are somewhat variable. The average daily gain increased and the correlation with depth of side is + 0·32 ± ·03. The loss of weight on the journey decreases as the depth of side increases and the dressing percentage shows quite a marked improvement and the improvement appears to be more pronounced than in table 23 where the degree of fatness increased. As the depth increased the thickness of the back fat also increased and may have influenced the shrinkage en route and the dressing percentages. To eliminate the influence of the degree of fatness on these factors, the depth is changed in the different fat classes as shown in table 27. In table 14 it was shown that the different weight groups had no significant influence on the loss of weight en route and the dressing percentage, so that weight is not taken into consideration in table 27. The data of the males and females have been taken together.

TABLE 26.—*Influence of Depth of Side on Carcase Measurements.*

Weight—lb.....	189 and Below.						190–199.						200 and Above.					
Depth—inches.....	14·9		15–15·9		16–16·9		15–15·9		16–16·9		17		15–15·9		16·16·9		17	
Sex.....	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
No. of pigs.....	12	4	30	37	34	16	43	28	44	31	8	6	19	8	57	27	16	24
Initial age—days..	78·3	84·0	73·2	70·3	70·9	66·4	70·7	71·9	71·4	68·4	69·0	69·0	72·0	76·1	70·3	73·2	71·6	68·9
Final age—days...	203	227	187	190	190	197	189	203	188	180	185	180	188	198	188	191	168	182
Initial weight—lb..	50·0	54·5	49·1	46·9	43·7	42·8	44·5	42·0	48·1	47·7	45·9	44·7	49·0	45·6	49·6	53·1	53·3	53·1
Final weight—lb..	182	179	183	182	186	185	195	194	194	195	195	195	206	203	206	209	211	212
Factory weight—lb.	166	162	168	168	171	171	177	178	179	180	182	183	187	181	189	194	196	199
Per cent.....	91·2	90·5	91·9	91·9	91·9	92·2	90·7	91·8	92·3	92·5	93·5	93·8	90·8	89·2	91·9	92·8	92·9	94·1
Carcase weight—lb.	135	139	138	136	142	143	144	144	148	147	150	152	151	149	155	158	160	164
Per cent.....	74·1	77·4	75·2	74·5	76·3	77·0	73·8	74·2	75·9	75·3	77·3	77·8	73·3	73·4	75·2	76·0	76·0	77·5
Wgt. cured side—lb	45·9	—	48·7	47·4	50·6	50·0	50·5	50·0	51·3	50·5	53·1	52·5	53·5	50·6	54·8	55·3	56·7	56·2
Per cent. (2 sides)..	50·3	—	53·3	52·0	54·5	54·0	51·9	51·5	52·8	51·8	54·6	53·8	52·0	49·9	53·3	53·0	53·9	53·0
Wgt. shoulder—lb.	14·0	—	14·8	14·5	15·3	14·7	15·5	15·3	15·7	15·1	16·3	15·4	16·5	15·0	16·7	16·6	16·9	16·6
Per cent.....	30·5	—	30·4	30·6	30·2	29·5	30·7	30·6	30·6	29·9	30·7	29·3	30·8	29·6	30·5	30	29·8	29·5
Ave. daily gain—lb.	1·1	·87	1·27	1·18	1·25	1·13	1·3	1·2	1·29	1·37	1·33	1·39	1·4	1·31	1·4	1·37	1·68	1·46
Age at 200 lb. weight—days....	215	242	196	204	199	207	192	208	192	184	188	182	184	196	184	187	162	174
Length—inches....	28·7	29·2	28·6	28·3	28·1	28·5	28·9	29·1	28·8	29·2	28·6	28·9	29·1	29·6	29·1	29·7	29·7	29·4
Depth shoulder—in.	15·2	14·6	15·9	15·7	16·7	16·7	15·8	15·6	16·7	16·5	17·4	17·4	16·0	15·8	16·8	16·6	18·0	17·4
Depth flank—ins..	14·3	14·0	15·0	15·3	15·9	16·5	15·0	15·1	15·9	16·2	16·9	16·9	15·2	15·2	16·1	16·2	17·1	17·2
Average—inches...	14·7	14·3	15·4	15·5	16·3	16·6	15·4	15·4	16·3	16·4	17·1	17·1	15·6	15·5	16·5	16·4	17·5	17·3
Ratio—per cent...	106	104	107	102	105	101	106	103	105	102	103	103	105	104	104	103	105	101
Circ. ham—inches.	23·3	22·9	23·4	23·4	23·6	23·4	23·8	24·0	23·7	23·9	23·4	23·8	24·0	23·8	24·1	24·2	24·6	24·5
Ratio—per cent...	81·2	78·4	81·9	82·8	83·5	82·2	82·4	82·2	82·3	81·8	81·8	82·4	82·6	80·4	82·9	81·6	82·9	83·5
Back fat—inches...	1·33	1·16	1·48	1·4	1·59	1·54	1·55	1·42	1·59	1·48	1·73	1·59	1·6	1·35	1·61	1·49	1·72	1·64
Evenness—per cent	58·7	46·2	55·2	57·8	60·3	65·3	58·0	53·5	60·1	58·9	62·0	80·3	57·7	60·1	60·0	58·7	67·5	61·5
Belly—per cent....	60·0	57·5	66·7	76·0	77·1	84·4	72·1	71·8	79·3	81·3	82·5	86·7	73·2	77·5	77·0	85·6	80·0	85·4
Marbling—per cent.	62·9	—	70·0	62·7	79·0	71·9	66·5	60·0	71·1	69·7	83·8	81·7	68·4	57·1	72·9	68·8	82·7	69·6
Classification: I L.S.—p. ct.	41·7	25·0	46·7	70·3	35·3	56·3	34·9	85·7	38·6	54·8	—	33·3	26·3	87·5	28·1	48·1	12·5	20·8
Classification: I M.—p. ct..	8·3	—	6·7	8·1	23·5	25·0	30·2	7·1	34·1	38·7	62·5	50·0	26·3	12·5	35·1	48·1	31·3	50·0
Classification: O.F.—p. ct..	—	—	6·7	2·7	14·7	6·3	4·7	—	15·9	—	12·5	16·7	—	—	21·1	3·7	31·3	20·8
Classification: Inf.—p. ct..	50·0	75·0	40·0	18·9	26·5	12·5	30·2	7·1	11·4	6·5	25·0	—	47·4	—	15·8	—	25·0	8·3

TABLE 27.—*Influence of Depth of Side on Shrinkage and Dressing Percentages.*

Thickness of back fat—in.	1·25–1·49.								
Depth of side—in.....	15–15·9.			16–16·9.			17.		
	Live wgt.	Fact. wgt.	Car-case wgt.	Live wgt.	Fact. wgt.	Car-case wgt.	Live wgt.	Fact. wgt.	Car-case wgt.
No. of pigs.....	88	88	88	60	60	60	7	7	7
Average weight—lb.....	189	173	140	199	182	150	204	188	154
Per cent. of farm wgt...	—	91·3	74·1	—	91·8	75·3	—	92·0	75·1
Thickness of back fat—in.	1·5–1·74.								
Depth of side—in.....	15–15·9.			16–16·9.			17.		
	Live wgt.	Fact. wgt.	Car-case wgt.	Live wgt.	Facr. wgt.	Car-case wgt.	Live wgt.	Fact wgt.	Car-case wgt.
No. of pigs.....	68	68	68	81	81	81	20	20	20
Average weight—lb.....	193	176	144	197	180	149	207	192	159
Per cent. of farm wgt...	—	91·0	74·4	—	91·7	75·6	—	92·8	76·7
Thickness of back fat—in.	1·75 and above.								
Depth of side—in.....	15–15·9.			16–16·9.			17.		
	Live wgt.	Fact. wgt.	Car-case wgt.	Live wgt.	Fact. wgt.	Car-case wgt.	Live wgt.	Fact. wgt.	Car-case wgt.
No. of pigs.....	9	9	9	32	32	32	16	16	16
Average weight—lb.....	195	177	144	198	184	151	203	190	157
Per cent. of farm wgt...	—	91·1	74·2	—	92·8	76·2	—	93·3	77·1

It is shown quite definitely that the depth of side has an influence on the shrinkage and dressing percentages quite apart from the fatness of the pigs. Hansson (1927), however, found that the deep pigs had a larger loss at slaughter than the shallow ones and he thought that the difference might be partly due to a larger stomach content of the deep pigs. His depth measurements were taken on the inside of the carcases and not on the outside where our measurements were taken. Whether this difference in taking the depth measurements of the sides caused these opposite results is not clear. The length shows a slight decrease with an increase in the depth. Hansson's deep pigs were longer than the shallow ones, but he did not keep the weight constant so that the former were 2·2 Kg. heavier than the latter and this may account to some extent for the difference of 1·6 cm. in length. The percentage of shoulder decreases slightly so also the ratio of the shoulder and flank measurement, the decrease in the shoulder/flank ratio appearing to be more marked in the females than in the males. The circumference of the ham increases and the ratio has a slight tendency to increase, but this is not quite consistent.

The thickness of the back fat increases as the depth of side increases the correlation coefficient being + 0·47 ± ·03. In table 15 it was shown that rate of gain had a strong influence on the thickness of the back fat so that the influence will exert itself here since rate of gain increases with an increase the depth of the side. In table 28 the effect of the depth of the side on the thickness of the back fat is shown when the rate of gain and the live weight are constant.

TABLE 28.—*Effect of Depth of Side on Thickness of Back Fat.*

Live weight—lb.	189.			190–199.			189.			190–199.			200.		
Average daily gain—lb.	1·19.			1·19.			1·2–1·49			1·2–1·49			1·2–1·49		
Depth of side—inches	14·9	15	16	15·9	16	17	14·9	15	16	15·9	16	17	15·9	16	17
Thickness of back fat—inches	1·27	1·37	1·58	1·44	1·48	1·8	1·33	1·5	1·54	1·49	1·58	1·59	1·54	1·58	1·56
No. of pig	12	34	28	31	26	4	4	22	13	29	31	5	11	32	13

When the effects of weight and rate of gain are eliminated, as shown in Table 28, the thickness of the back fat still increases when the depth increases. Here again our results do not agree with Hansson's, who found that the deep pigs had less back fat than the shallow ones. The actual measurements of the back fat are not given but only the points awarded which were 13·3 for the deep carcases and 12·5 for the shallow carcases. It is only in one respect that our results agree with Hansson's in connection with the depth of the sides, and that is the average gains made by the pigs. He also found that the deep pigs made the quickest gains (633 gm. per day as compared with 601 gm. made by the shallow pigs) and required 180 days to reach a live weight of 90 Kg. while the shallow pigs took 185 days to reach the same weight. Table 29 shows that the depth of side has an increasing effect on the evenness of the back fat when the average thickness of the fat is constant.

The actual thickness of the fat over the shoulder decreases slightly and the thickness at the loin again increases slightly as the depth of the side increases.

On account of the influence of the thickness of the back fat on the grading of the carcases, the results as shown in table 26 cannot be taken as showing the effect of the depth of the sides. Table 30 has been prepared where the weight and the thickness of the back fat are kept constant so as to see whether depth of side had any marked effect on the grading.

From the results of table 30 one can see that the depth of side has a certain amount of influence on the grading. There appears to be an optimum depth round 15-16·9 inches and that the depth expressed as a ratio of the weight remains more or less constant, since the optimum actual depth shifts as the weight increases.

8. *Factors affecting the Firmness of the Back Fat.*

One of the most unsatisfactory conditions in bacon production is soft carcases since this condition causes a depreciation in the value of bacon to a very large extent. In a study made of this subject in the United States of America [Hankins and Ellis (1928)], it was indicated that the softness of the fat is responsible for the softness in the pig carcases and the products. Conversely, when the fat of a carcase is firm the carcase and the products are firm. Different methods of determining the firmness of the fat were used, and it was found that the refractive index of the fat was the best single method to use, and was consequently also used in determining the firmness of the fat of the pigs used in this analysis. Ellis and Isbell (1926) found that the refractive indices of the fats of the meat and the back fat are almost identical. Ranges from hard to oily fat caused no variation between the two. Leaf fat values on the other hand were considerably below those of the other samples, i.e. they were much firmer, and the difference between the leaf fat and the meat or back fat was not always a uniform one. Therefore, by taking samples of the back fat and determining the firmness thereof, one can see what the firmness of the carcase is like.

TABLE 29.—*Effect of Depth of Side on the Evenness of the Back Fat.*

Back fat—inches..	1·49 and Below.						1·5–1·74.						1·75 and Above.					
Depth—inches.....	15–15·9		16–16·9		17–17·9		15–15·9		16–16·9		17–17·9		15–15·9		16–16·9		17–17·9	
Place measured*...	S.	L.	S.	L.	S.	L.	S.	L.	S.	L.	S.	L.	S.	L.	S.	L.	S.	L.
Males.																		
No. of pigs.....	36	36	36	36	3	3	49	49	62	62	9	9	9	9	30	30	12	12
Average- inch.....	1·92	1·07	2·04	1·17	1·96	1·34	2·25	1·28	2·24	1·34	2·18	1·41	2·54	1·52	2·51	1·55	2·49	1·54
Evenness—per cent	55·4		57·0		68·2		56·8		59·7		64·6		59·6		61·7		62·0	
Females.																		
No. of pigs.....	48	48	36	36	6	6	19	19	31	31	20	20	—	—	—	—	—	—
Average--inch.....	1·94	1·06	1·95	1·1	1·88	1·13	2·24	1·3	2·2	1·38	2·2	1·38	—	—	—	—	—	—
Evenness—per cent.	54·7		56·3		60·1		58·0		62·5		62·5		—	—	—	—	—	—

* S. Shoulder—thickest place, L. Loin—thinnest place.

TABLE 30.—*Effect of Depth of Side on Grading.*

Weight—lb.....	189.			190–199.			189.		190–199.			200.		
Back fat—inches	1·25–1·49			1·25–1·49			1·5–1·74		1·5–1·74			1·5–1·74		
Depth—inches...	14	15	16	15	16	17	15	16	15	16	17	15	16	17
No. of pigs.....	9	33	15	33	26	4	24	28	29	38	4	15	33	23
1L.S.—per cent.	55·6	81·8	93·3	87·9	57·7	25·0	41·7	21·4	27·6	50·0	—	33·3	30·3	8·7
1M.—per cent....	—	6·1	—	6·1	26·9	50·0	12·5	35·7	37·9	39·5	75·0	13·3	39·4	60·9
O.F.—per cent..	—	—	—	—	—	—	—	7·1	—	7·9	25·0	—	12·1	8·7
Inf.—per cent...	44·4	12·1	6·7	6·1	15·4	25·0	45·8	35·7	34·5	2·6	—	53·3	18·2	21·7

Hammond (1932) discussed the question of the firmness of the body fat and refers to the different investigators who have worked on this subject and showed how fat that is first deposited is the firmest. In the pig we therefore get that the leaf fat is the firmest, then the back fat below the streak, the outer back fat layer being the softest. The percentage of unsaturated fatty acids causes the fat to be firm or soft. Bhattacharya and Hilditch (1931) found that the variation in the amount of unsaturated acids was mainly compensated by corresponding changes in the stearic acid content. The proportion of linoleic acid (1) clearly increased with an increase of unsaturation in the fatty oil forming part of the diet and (2) also increased from the leaf fat to the outer layer of the back fat. They further showed that when different rations were fed this order was still maintained and that an alteration in the diet had relatively less effect on the composition of the outer layer of back fat than on that of the inner layer or of the leaf fat. The outer layer of fat was the most unsaturated and contained a higher proportion of linoleic to oleic acid than the inner layer of back fat which was approximately more nearly in composition to the leaf fat than to the outer back fat, but being less saturated than leaf fat. They reckoned that the relative constancy of the outer back fat in composition may be determined by the adjustment of the fat nearest the skin to a more or less constant consistency adapted to the average temperature conditions of the external atmosphere. Moulton (1929) has suggested that the temperature at which fat is deposited may affect the composition of the fat, and then mentions the difference in melting point of the fat of seals and bears living in Arctic regions, which is softer than the fat of animals living in temperate climates. Animals having different body temperatures show differences in the firmness of their fats. The sheep with a body temperature of 104° F. has a firmer fat than the pig or dog with a body temperature of 101° F.

In the United States extensive co-operative investigations have been done on the influence of different feeds on the firmness of the fat and reports were issued by the Bureau of Animal Industry (1926, 1928). In Canada experiments have also been conducted in connection with the causes of soft bacon and the results were summarised by Day (1922):—

(i) Lack of maturity. Generally speaking, the more immature the pig, the greater is the tendency to soft fat. Almost invariably the largest percentage of softness occurs among the light sides of bacon.

(ii) Lack of finish. Thin animals have a marked tendency to produce soft bacon. Marketing pigs before they are finished is, no doubt, responsible for a great deal of softness.

(iii) Unthriftiness, no matter what the cause may be, at most invariably produces soft bacon.

(iv) Lack of exercise has a tendency to produce softness, but this tendency can be largely overcome by judicious feeding.

(v) Exclusive grain feeding is, perhaps, one of the most common causes of softness.

(vi) Maize. Of the grains in common use, maize has the greatest tendency to produce softness.

(vii) Beans seem to have a more marked effect than maize in producing softness.

Breed differences in firmness of the fat have been determined at the Purdue University (Kelly, 1932). The fat of pigs of the Berkshire, Large White, Tamworth, and other British breeds became hard at about 80 to 100 lb. live weights while the American breeds—Poland China and others—particularly when of the "large type", were soft, in some cases up to 250 lb. live weight.

The effects of the different feeds on the hardness of the fat of the carcases dealt with in this paper, have been reported on elsewhere [Romyn and others (1930), Schutte and Murray (1931)], so that in the present paper the effect of feed will not be considered but the other factors which may influence the firmness of the fat as determined by the refractive indices.

Except in the case of a limited number of carcases, the outer and inner layers of the back fat samples were not rendered separately. In the few cases that this was done separately, the outer layer was softer than the inner layer as shown by the average refractive indices of 13 samples. When the two layers were not separated, the refractive index was 1·4597, the outer layer alone 1·4601 and the inner layer alone 1·4596. All the refractive indices values are at a temperature of 40° C.

In this paper the data have been grouped so as to see the influence of (1) the degree of fatness, (2) the rate of gain, (3) live weight, and (4) age. The correlation coefficients of these different factors and the refractive indices have been determined and are given below:—

(1) Thickness of back fat and refractive index..	— 0·48	·03
(2) Rate of gain and refractive index.....	— 0·30	·03
(3) Live weight and refractive index.....	— 0·23	·03
(4) Age and refractive index.....	— 0·19	·02
(5) Thickness of back fat and rate of gain.....	— 0·35	·03
(6) Thickness of back fat and live weight.....	— 0·26	·03
(7) Thickness of back fat and age.....	— 0·24	·03
(8) Rate of gain and live weight.....	— 0·32	·03
(9) Live weight and age.....	— 0·09	·03

In determining the correlation coefficient of two factors no other factor was kept constant. They, however, give a good indication of the many factors which may influence the firmness of the fat and also how one factor may indirectly influence the firmness by influencing another factor.

(1) The thickness of the fat shows the strongest correlation with the firmness of the back fat and by grouping we get the following averages:—

Thickness of back fat—inches...	1·24	1·25–1·49	1·5–1·74	1·75
No. of pigs.....	12	119	151	52
Average refractive index.....	1·4602	1·4598	1·4595	1·4593

There is a progressive decrease in the refractive index of the back fat with increased thickness, i.e., there is a progressive hardening of the fat. On account of this strong influence and also the correlation of the thickness of back fat with the other factors, the thickness of the back fat will be kept constant in determining the effect of the other factors on the firmness of the fat.

(2) Rate of gain.—In table 31 the influence of the rate of gain on the refractive index is shown.

The results in table 31 show quite clearly that when the thickness of the back fat is kept constant then the rate of gain has no influence on the firmness of the fat. Helmreich (1929) reckoned that when other conditions are equal then the quick growers have the firmest fat, but he did not say whether the thickness of the back fat was one of the conditions that remained constant. The correlation coefficient of the rate of gain and the refractive index ($-0{\cdot}30 \pm {\cdot}03$) was only caused by the positive correlation ($+0{\cdot}35 \pm {\cdot}03$) between the rate of gain and the thickness of the back fat.

(3) Live weight.—Table 32 shows the influence of farm live weight on the firmness of the fat.

Although the average refractive indices do not show quite the same consistency as in table 31, one can nevertheless conclude that the live weight has no effect on the firmness of the fat when the thickness of the back fat is kept constant. The same has happened with the correlation shown between the live weight and the refractive index ($-0{\cdot}23 \pm {\cdot}03$) as the rate of gain and refractive index. The live weight is also positively correlated ($+0{\cdot}26 \pm {\cdot}03$) with the thickness of the back fat and hence the correlation it shows with the firmness of the fat.

(4) Age.—This is the only factor of the four which shows a positive correlation with the refractive index, i.e. the older pigs have the softer fat. Table 33 shows its influence when the thickness of back fat is constant.

TABLE 31.—*Influence of Rate of Gain on Firmness of the Fat.*

Thickness of back fat—inches.....	1·24 and Below.			1·25–1·49.			1·5–1·74.			1·75 and Above.		
Average daily gain—lb.....	1·19	1·2	1·5	1·19	1·2	1·5	1·19	1·2	1·5	1·19	1·2	1·5
No. of pigs.....	12	2	—	72	31	17	57	49	36	20	15	24
Refractive index.....	1·4603	1·4604	—	1·4599	1·4599	1·4594	1·4595	1·4595	1·4595	1·4593	1·4593	1·4594

TABLE 32.—*Influence of Live Weight on the Firmness of the Fat.*

Back fat—inches.....	1·24 and Below.			1·25–1·49.			1·5–1·74.			1·75 and Above.		
Live weight—lb.....	180	190	200	180	190	200	180	190	200	180	190	200
No. of pigs.....	10	6	—	49	43	22	52	52	49	9	16	26
Refractive index.....	1·4603	1·4601	—	1·4598	1·4598	1·4596	1·4596	1·4595	1·4595	1·4592	1·4594	1·4594

TABLE 33.—*Influence of Age on the Firmness of the Fat.*

Back fat—inches	1·24 and Below.		1·25–1·49.				1·5–1·74.				1·75 and Above.			
Age—days.....	180	200	140	160	180	200	140	160	180	200	140	160	180	200
No. of pigs.....	3	9	11	13	32	60	22	25	48	56	12	13	6	21
Refractive index	1·4605	1·4601	1·4596	1·4601	1·4593	1·4598	1·4595	1·4597	1·4595	1·4595	1·4593	1·4592	1·4593	1·4594

In the first two groups the average refractive indices are somewhat variable but remain constant in the last two. From these results it therefore appears that age has no effect on the firmness of the back fat when the thickness of the latter is kept constant. There is a negative correlation between the age of the pigs and the thickness of the back fat ($- 0{\cdot}24 \pm {\cdot}03$) which resulted in a small positive correlation ($+ 0{\cdot}19 \pm {\cdot}02$) between the age and the refractive index.

From the evidence as given and discussed, one cannot come to another conclusion than that apart from such factors as feed, breed and climate, the thickness of the back fat, or the degree of fatness of the pig, is the only factor which affects the firmness of the back fat. The different factors influencing the firmness of carcases as given by Day (1922), such as lack of maturity, lack of finish and unthriftiness, are true in so far as these conditions affect the thickness of the back fat and so indirectly affect the firmness of the fat. Directly these factors have no effect on the firmness of the fat. The fact has been mentioned above that the outer layer of the back fat is much less affected by feed than the inner layer and if it is true that the composition of the outer layer remains practically constant under the same environmental conditions, then one would not expect that it would either change to an appreciable extent as the back fat thickens. The firming up will then be more due to the change taking place in the inner layer and the outer layer making out less and less of the total fat on the back. The average refractive indices given of the outer and inner layers separately and the two together, show that the average of the back fat (1·4597) is much nearer to that of the inner layer (1·4596) than to that of the outer layer (1·4601). These results also indicate on which lines some future investigations on the firmness of the fat could be carried out.

IV. SUMMARY.

The paper comprises an analysis of growth and carcase measurements of 450 to 550 baconers of the Large White × Large Black (sow) and Tamworth × Large Black (sow) crosses.

Growth.

1. *Preweaning.*—The average gestation period for 39 farrowings was 113·7 days, the average birth weight of the pigs being 2·89 lb. The males averaged 2·99 lb. and the females 2·78 lb. at birth and 8·6 per cent. of the males and 8·3 per cent. of the females were born dead. The average weight per pig decreased from 3·5 lb. and 3·17 lb. for males and females respectively, when the litter size was 6 to 8 pigs per litter, to 2·34 lb. and 2·21 lb. respectively, when the litter size was 15 to 17 pigs per litter. The data indicate that litters of more than 12 pigs per litter are not desirable. 81 per cent. males and 76 per cent. females of those born alive respectively, were weaned, and the difference is probably due to the difference in live weight between the sexes.

2. *Weights at Different Ages.*—The average live weight at 8 weeks (weaning) is 30 lb. The maximum variability of weight appears to be between 4 and 5 months. The barrows are more

variable than the gilts. Fast and medium fast growing males are also higher than the females but the slow growers show no difference in variability between the sexes. The correlation coefficients between weights at 4 and 8 weeks are + 0·76 ± ·02 and 13 and 21 weeks + 0·89 ± ·01.

3. *Rate of Gain.*—The relative weights of males decrease from birth and from 9 to 13 weeks are below the females and then show a definite rise and they outstrip the females from round 4 months. The relative gains are given for fast, medium-fast and slow growers of the two sexes, females being lower throughout. The differences increase and afterwards decrease again.

Factory Results.

1. The average results of the two crosses do not show marked differences; there are, however, large differences between the average results of the progeny of different boars of the same breed.

2. *Average Measurements of the Grades.*—There are 24 per cent. more females in the best grade than males. The best grade, 1 Lean Sizable, is deficient in length when compared with the requirements of the English market.

3. *Influence of Weight and Sex.*—The heaviest pigs made the quickest gains and have longer and deeper sides, and the correlation coefficients between weight and length and weight and depth are respectively + 0·48 ± ·02 and + 0·5 ± ·02. Barrows are deeper than gilts at the shoulder but the latter are deeper at the flank and also have a larger average. The barrows are fatter and have better marbling than the gilts, but the latter nevertheless have better bellies. The most suitable live weight at which to kill baconers lies between 190 and 199 lb.

4. *Influence of Rate of Gain.*—Depth of side increases with rate of gain, the correlation being + 0·32 ± ·03. It has hardly any effect on length of side. Back fat increases with increase in rate of gain, the correlation being + 0·35 ± ·03. The females have thinner back fat than the males, but fatten at a more rapid rate with increased gain and so tend to approach that of the males. Bellies improve and marbling decreases and increases again. This also takes place when age increases. For baconers the optimum gain per day appears to be between 1·2 to 1·49 lb. The results show that length cannot be significantly influenced by rate of gain since it is early maturing. Later maturing parts as depth and thickness of back fat can be influenced significantly.

5. *Influence of Length.*—The actual depth of side appears to decrease slightly when length increases whereas the relative depth decreases markedly. The thickness of back fat decreases.

6. *Influence of Degree of Fatness.*—The relative gains made by pigs of different degrees of fatness are shown. The shrinkage en route decreases and the dressing percentage and percentage of cured sides increase with increased fatness. Length decreases and there is a marked increase in the depth of the side (correlation + 0·47 ± ·03), the flank measurements increasing at a quicker rate than the shoulder

measurements. Females have a smaller proportion of shoulder than males. Hams show a slight improvement. Evenness of back fat improves (correlation + 0·31 ± ·03) and also the bellies (correlation + 0·35 ± ·03), and the marbling (correlation + 0·29 ± ·03), the males having better marbling than the females.

7. *Influence of Depth of Side.*—The shrinkage en route decreases and the dressing percentage increases more markedly with increase in depth than with increase in fatness and it is still the case when thickness of back fat is kept constant. The proportion of shoulder decreases so also the relative depth at the shoulder. The thickness of back fat still increases with depth of side when gain is constant, and the evenness of the back fat increases with depth when thickness remains constant. Depth of side appears to have an influence on the grading, the optimum being 15 to 16·9 inches, and that depth/weight ratio remains about the same.

8. *Factors affecting the Firmness of the Fat.*—The refractive indices were determined to get a measure of the firmness of the fat. The correlation between refractive index and thickness of back fat is − 0·48 ± ·03, rate of gain − 0·3 ± ·03, live weight − 0·23 ± ·03 and age + 0·19 ± ·02. There are also correlations between these different factors and thickness of back fat. When the thickness of back fat is kept constant then live weight and the rate of gain have no influence on the firmness of the fat and the data also indicate that age has no influence either. These factors only affect the firmness of the fat, since they are correlated with the thickness of the back fat.

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