

EVALUATION OF THE GROWTH PARAMETERS OF SIX COMMERCIAL CROSSBRED PIG GENOTYPES

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Pig producers have been made aware over the years that their growing pigs should be fed different feeds as they grow: for example, a weaner feed may be followed by a pig starter, then a grower and a developer. Each of these feeds will have been formulated at least cost, making use of ingredients available to the feed manufacturer, to meet certain requirements for energy and the essential nutrients such as protein, amino acids and the major and minor minerals. Because the daily feed intake of pigs increases rapidly as they grow, the protein content in the feed needs to be reduced to prevent overconsumption of protein, hence the feeding of this range of feeds during the growing period - the first feed has the highest protein content, and this is reduced in each subsequent feed. It is easy for the nutritionist to formulate these feeds to meet the various nutrient specifications, but until recently there has been no way of knowing how well the pigs will perform when supplied with these feeds, or how the feeds could be modified to make the whole process more profitable.

The difficulties faced by the nutritionist and the pig producer in formulating a feeding system for growing pigs are many: what should be the amounts of each of the essential nutrients in each of these feeds; when should the one feed be replaced by the next in the series; should males, castrates and females all be fed the same feeds and for the same length of time; what about strains differing in potential growth rate or fatness; should the feeding programme be the same irrespective of the pork price or the price of maize and soya? These and many other questions based on biology and on economics just cannot be answered with the knowledge that nutritionists or producers have in their heads. The answers can only be found with the use of simulation models, which are computer programs that are capable of predicting the voluntary food intake, growth and carcass composition of pigs, given a description of the genotype of the pig, the food that it is being fed, and the environment in which it is housed. Such a simulation model has been developed at the University of Natal, and this can be of considerable help to nutritionists and pig producers in improving the basis on which nutritional decisions are made, thereby improving the profitability of a pig enterprise.

The first prerequisite in making use of these simulation models is to be able to predict the performance of the pigs being used in the enterprise. Without knowing the potential growth rate of the genotype, and the desired amount of fat in the gain, it is impossible to know what the nutrient requirements of the pig are on each day of the growing period. And without this knowledge it is not possible to predict how much of a given food the pig would need to consume each day in order to meet its nutrient requirements. There are obvious differences in potential growth rate and carcass composition between the Meishan pig and a Cotswold pig, for example (see pictures below), and as a result their nutrient requirements would differ considerably. Most commercial strains in South Africa fall between these two extremes, but without measuring their potential to grow it is difficult to know where exactly they lie. So the work that was undertaken by Stephen Kyriazis, a postgraduate student in the Animal and Poultry Science department at the University of Natal, was designed to measure this potential in six crossbred pig genotypes/strains (**Table 1**) used in South Africa, so that more accurate estimates could be made by the simulation model of their nutrient requirements, which would then lead to the design of feeding systems that would maximise profit on the enterprise. The Protein Research Trust and the University of Natal funded the study.



Pictures of a Cotswold Terminal sire and a Meishan pig.

There are only three measurements that are needed in order to predict the potential growth of an animal. The mature size and protein content of the animal at maturity needs to be measured (known as P_m), as does its rate of maturing (B), and an estimate needs to be made of its fatness at maturity (viz. lipid: protein ratio at maturity - LPR_m). These measurements are the basis of any system that describes the genetic potential of a breed or strain of pig. Why only three, when we are interested in so many more components of the body? Fortunately, there are fixed relationships between the body components that enable us to predict the potential growth of all the important components of the animal without having to measure them all. However, in order to measure the growth rate and carcass composition, especially the protein and fat growth, it is necessary to kill some of the animals as they grow, using what is known as a serial slaughter technique. Whilst some pigs are sacrificed for this purpose at regular intervals during the growing period, the remaining pigs continue to grow in near-perfect conditions, whilst being offered two high quality feeds differing in protein content, from which they can choose the combination that meets their requirements most satisfactorily, thereby allowing them to grow as close as possible to their potential.

TABLE 1	
DESCRIPTION OF THE GENOTYPES USED, WITH LARGE WHITE (LW) AND LANDRACE (L) BREEDS DOMINATING THE CROSSES	
GENOTYPE	CROSSES
1	LW x LR
2	LW x LR x "Sireline"
3	LW x LR x Duroc
4	LW x LR
5	LW x LR x "Sireline"
6	LW x LR x Duroc x Hampshire

180 entire male pigs (30 per genotype) were slaughtered at various live weights to determine the protein, fat, water and ash content of the carcass, and the necessary growth parameters (P_m , B and LPR_m).

The values of the three parameters measured for each of the strains are given in **Table 2**. Large

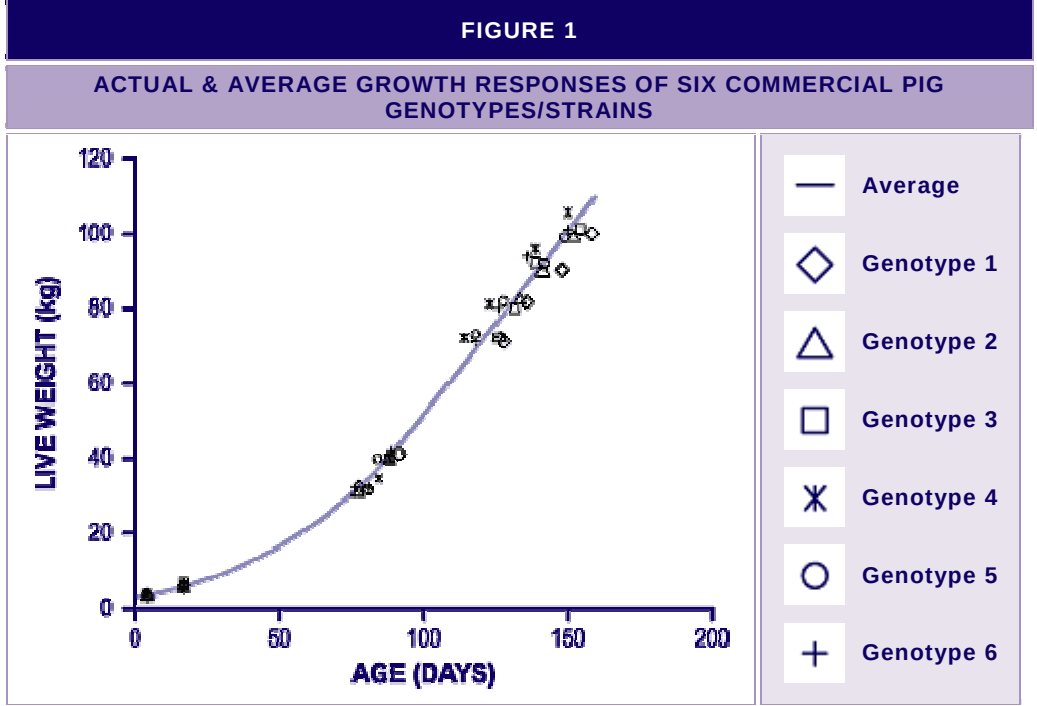
differences exist in each of these measurements between strains e.g. a difference of 12kg in the mature protein content between the smallest and the largest strain (equivalent to a difference of about 80kg in live weight), and ratios between fat and protein in the mature carcass varying from 1.5 in the leanest strain to 2.41 in the fattest. These differences are substantial, and show that, even though the six genotypes tested were composites of similar breeds, viz. Large White x Landrace, their performance varies substantially, as would their nutrient requirements, and this highlights the importance of using models to determine unique feeding systems to optimise performance in these different strains of pigs. Without a framework that considers these differences in genotype / strain, all pigs would be treated in the same way, and therefore the opportunity to develop specific feeding programmes would be lost.

TABLE 2							
ESTIMATES OF THE GROWTH PARAMETERS OF SIX COMMERCIAL PIG GENOTYPES							
GENOTYPES							
PARAMETER	1	2	3	4	5	6	AVERAGE
Pm (kg)	45.6	39.9	37.2	44.7	33.6	38.9	40.0
B (/day)	0.0107	0.0115	0.0119	0.011	0.0128	0.0115	0.0114
LPRm	1.29	2.37	1.79	1.24	2.41	1.5	1.77

Figure 1 illustrates the differences in actual growth of the six genotypes versus the average growth response for all commercial crossbred entire male pigs. Without the benefit of knowing the growth parameters of their particular strain of pig, pork producers and feed company nutritionists could, of course, use the average estimates given in Table 2 to determine nutrient requirements and feeding systems when formulating feeds for their pigs. But it is apparent from Fig. 1 that pig producers can always do better than use the average value, which will either under- or overestimate the growth and hence nutrient requirements of each specific cross. It may be argued that this is too simplistic, as it is known that there are large performance differences between farms. However, these differences between farms are, to a large extent, attributable to different management, environmental and nutritional conditions rather than differences in the potential growth rate of the animals used.

The differences in potential growth rate between strains shown in this study (Table 2), and the difference between genotypes in South Africa and those in the rest of the world, as published in the literature (Table 3), are not only of interest to nutritionists but also to pig breeders. Firstly, they indicate that there is scope for genetic improvement within commercial crossbred pigs in South Africa, and secondly, with the information now available it is possible to predict in what direction improvements to the genotypes will be made, as well as the consequences for nutritional and environmental management of these pigs in the future. Selecting for higher lean growth rate will, over time, increase both the mature protein weight, Pm, and the rate of maturing, B, while LPRm, the inherent fatness of the animal, is expected to decrease with selection. The age, or stage of growth, at which selection takes place will affect these parameters differently: selection at lower live weights will affect the rate of maturing, while later selection will affect the mature protein weight. Selection against fatness, at any weight, will decrease LPRm. There is no direct relationship between Pm and LPRm, as genotypes are either fat or lean, but there is a

relationship between LPRm and B, as animals are lean at birth and get fatter as they mature. Therefore, selection against fatter animals, at a given age, will decrease LPRm rather than increase the Pm.



From Table 2 it can be seen that higher Pm values are associated with lower B values. Although pig genotypes in general have become leaner, the mature body weight, and thus Pm, have remained "practically unchanged" for commercial pig genotypes. This is most likely because selection has been applied mainly against fatness, rather than for a higher protein weight at slaughter. What is particularly encouraging is that the results of the current study indicate that there has been a significant genetic improvement in South Africa over the last nine years (see measurements given by Ferguson and Gous, 1993, in Table 3), with current commercial male pigs having a higher mature protein weight and rate of maturing, with a lower level of fatness.

The economic benefits to both the pork producer and the feed manufacturer, of being able to describe the potential growth rates of pig genotypes, are enormous. With this information it is now possible to make more efficient use of the growth models that are becoming more abundant in the Industry, which in turn enables the nutritionist or producer to predict the performance of the animals when subjected to any feeds or feeding programmes. Not only is the biological performance of the pigs accurately predicted, but the yield of parts, the carcass grade, the cost of production and the expected revenue can all be calculated once the feed intake of the animal has been accurately predicted. The nutritionist then has two options: conduct 'experiments' using the model to quantify in economic terms the effects of feeding higher or lower amounts of protein or amino acids, the effects of changing feeds at different times for males and females, the effect on profitability of different slaughter weights, etc. which can then be put into practice, or let the computer find the optimum feed composition and feeding programme that will maximise profitability for each enterprise, based on the genotype, the environment and the feedstuffs available to that producer, including the method of selling the pigs and the revenue to be derived from the sale of these animals. Now that pig producers and nutritionists have a tool that enables them to predict the performance of their animals, a whole

new and exciting world has been opened up to them: for the first time it is possible to determine with some certainty the profitability of an enterprise before the animals even get to the farm. But it is essential to be able to describe the animals before any of this is possible.

T A B L E 3				
COMPARISON OF THE RATE OF MATURING (B), MATURE PROTEIN WEIGHT (Pm) AND THE LIPID: PROTEIN RATIO (LPRm) AT MATURITY, BETWEEN PUBLISHED AND MEASURED VALUES				
Source of Estimates	Country	B (/day)	Pm (kg)	LPRm (kg)
Current Study	South Africa	0.0114	39.6	1.77
Ferguson & Gous (1993)	South Africa	0.0107	38.7	2.6
Emmans & Kyriazakis (1999)	UK	0.010-0.125	40.0-45.0	2.8-3.6
Knap (2000) ¹	Europe	0.019	33.0	1.0

¹ Prediction for 2005

Note

The Animal and Poultry Science department at the University of Natal have excellent facilities for research on pigs, and publish these results extensively in both local and international journals. If you wish to know more about the work being done there, contact Rob Gous (gous@nu.ac.za) or visit their website (www.ansi.unp.ac.za).