Feeding the modern lean genotype

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Over the course of the last 40 years, the commercial hybrid companies world-wide have generated consistent and very high selection responses in their pig populations. The rate of genetic progress in pigs has been truly phenomenal and this has been achieved by the utilisation of the rapid generation turnover and high reproductive rate of pigs coupled with the fast evolving computer systems including software applications such as BLUP (Best Linear Unbiased Prediction).

This has produced novel breeding lines that grow faster, convert their food much more efficiently and also have superior carcases compared to the pigs of the past.

This rate of genetic improvement has been exceptionally fruitful for the commercial pig industry and significant economies of production have accrued. In addition, the reduction in carcase fat levels and the increased lean tissue accretion has gone a long way to providing consumers with meat products that are both healthy products and what is required.

Through the 1970s and 1980s genetic change moved further and further into private hands from the public sector as the large scale commercial genetics companies successfully entered this arena. From the basic original European White breed lines (Yorkshire, Large White, Landrace) that were the foundation of most breeding programmes, inevitably the specialised sire and dam lines have been derived.

This has also led to a different level of nutritional requirements for each of these different lines and hence nutritionists and geneticists have had to work closer together. The purpose of this article is to focus on these changes and to review knowledge in this area.

Genetic change

A major physical factor determining the profitability of a pig enterprise is lean tissue growth and this is genetically correlated to lean tissue food conversion efficiency.

In practice the selection criteria that are principally used are daily liveweight gain, food conversion ratios, ultrasound backfat and probably various slaughter pig traits such as killing out (dressing) percentage, lean depth at the eye muscle, length, and perhaps some meat quality parameters.

All of these traits are easily and cheaply measured and also carry medium to high heritabilities. The pig also has a high rate of reproduction (litter size = 10-12, 2.4 litters per sow per year) and hence very high selection differentials are possible. Together with low generation intervals (12 months) this means that the rate of genetic progress has been very high indeed.

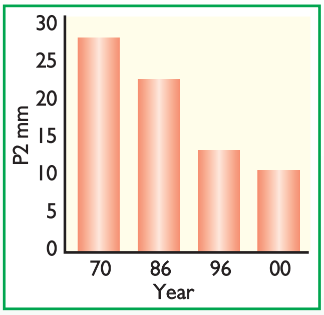

Fig. 2. Carcase changes in hybrid pigs.

The Meat and Livestock Commission (MLC) in the United Kingdom have estimated in the past from control herd population data that the annual genetic progress in selected populations was about 30 points change from a moving average base of 100 points.

As a consequence, modern hybrid pigs are totally different to the pigs of 40 years ago and the phenotypic differences reflect this.

Figs. 1 and 2 illustrate from MLC yearbook data, how pigs have changed over the years 1970-99.

Clearly the production efficiency and carcase traits continue to improve.

Over long time spans using very short generation intervals, it has been inevitable that the various hybrid products have also diverged in characteristics.

Genetic technologies

Genetic selection programmes have been based on large nucleus populations and structured breeding pyramids with male and female lines to produce a first cross crossbred female and a 'purebred' sire line; each with different qualities.

The nucleus level populations are often 10-20,000 females and the use of embryo transfer and artificial insemination has enabled these nucleus herds to exist as breeding entities but actually to be physically located in many different parts of the world. Multiple trait selection indices have been used to facilitate overall economic merit selection and more recently BLUP technologies have taken this a step further allowing varying environments and varying locations for nucleus level selection.

Massive computer power is utilised for this process and most companies have their own in-house geneticists and statisticians to both design the programs and to develop the breeding lines.

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Fig. 1. Phenotypic changes in hybrid pigs 1970-99.

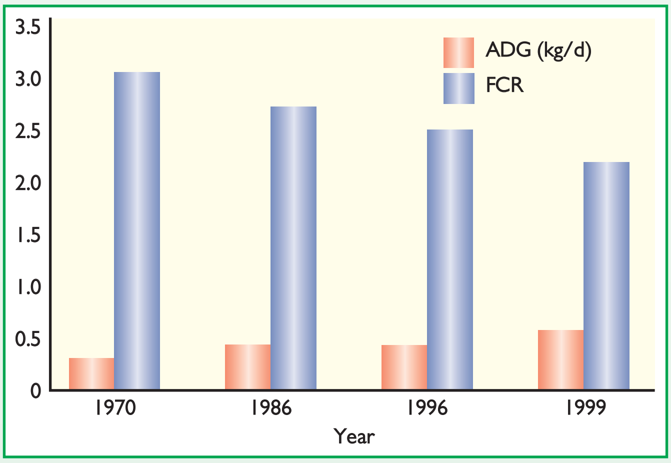
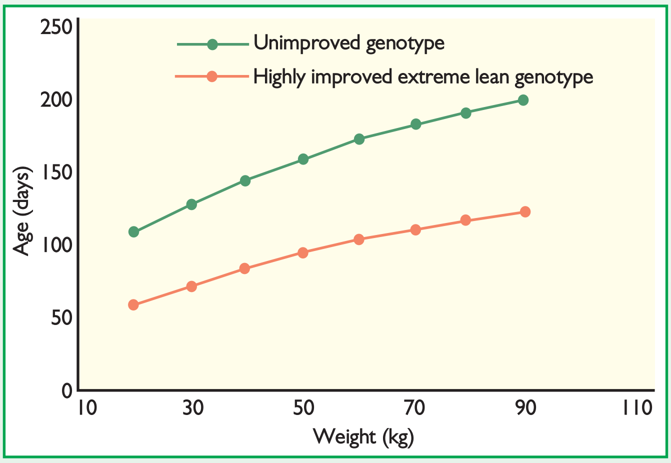


Fig. 3. The range in growth for modern genotypes.



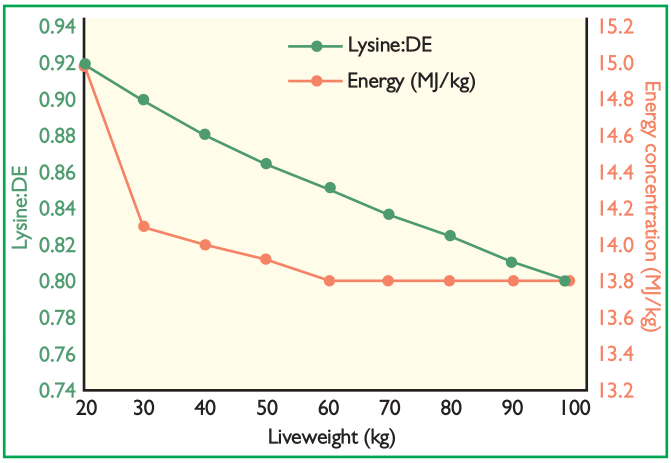


Fig. 4. Nutritional requirements for improved pigs.

Taking into account that the various companies started off with different foundation stock and applied different selection objectives and weighting factors in their indices, it seems inevitable that after 25-30 years of selection there will be significant differences in the basic phenotypic expression for these commercial products.

The hybrid companies for commercial reasons do not divulge the details of their selection indices and each will place a different level of emphasis on different selection objectives using various weighting factors. The outcome of this has been that lean growth traits are very different in commercial hybrid products and, therefore, nutritional requirements are also very different.

Feed intake characteristics also vary significantly between different hybrid products and again there is very limited data associated with the various products. The nutritionist usually works from his own practical experience with specific products and needs to make some predictions in this regard.

Nutritional requirements

The need for lean growth data and other information on specific hybrids stems from the complexities that nutritionists are faced with in practice in formulating diets for different growing and finishing pigs. This process is nowadays carried out with great precision to utilise expensive feed ingredients.

Feed programmes are designed using knowledge of the growth potential (PDmax – protein deposition when at maximum lean growth rate) and the derived lysine-calorie ratios and available nutrient requirements. These nutritional specification parameters in some feeding systems are altered on a weekly basis. It is, however, necessary to know the lean growth characteristics for the specific genotype to achieve the required accuracy. Fig. 3 illustrates the likely range in growth characteristics between unimproved genotypes and highly selected lines.

These growth curves are modelled on Gompertz equations to give slaughter ages that are significantly different. If these genetic lines were given exactly the same diet programmes, there would be gross inefficiency and waste of nutrients for some of the lines.

Company	J	K	L	M	Control
Daily gain	841	772	834	804	811
FCR	2.53	2.84	2.68	2.67	2.69
P_2	11.2	16.2	12.8	11.9	13.1
Lean (%)	58	53	56	57	55
Lean growth	401	318	369	363	348

Table 1. Growth characteristics for four different hybrid products (MLC Stotfold Data).

As pigs grow they also change their body composition and lean tissue growth remains relatively constant through a large portion of the growth curve to slaughter. Basically as they get older and gain body weight, lipid deposition gains increasing momentum. Lean tissue deposition requires 14MJ gross energy for 1kg tissue accretion, whereas fat deposition requires 49MJ per kg of gain.

As the animals grow and the rate of fat deposition accelerates, then inevitably this changes dietary energy and protein requirements.

Similarly, modern lean genotypes also have far less subcutaneous, inter-muscular and intra-muscular fat and this has significant impact on the required nutrient density in the feeds.

Fig. 4 presents data to illustrate for an improved pig growing at about 850g/d day from 25-90kg showing how energy and lysine/energy ratios may change. These relationships will change gradually as the animals get leaner genetically and hence express higher lean gains.

Commercial evaluations

In the UK, the Meat and Livestock Commission have published limited data to allow comparisons between commercial genetic products but there is still a dearth of hard facts.

Close (1994) provided some analysis in relation to unimproved versus improved pigs using commercial data and this provides some insight into the likely variation that exists in commercial practice. The MLC in the UK in the mid 1990s, however, embarked on an exercise using their own Stotfold Farm unit to evaluate the growth characteristics of four hybrid products against a genetic control.

This has produced some valuable information for the industry although the published report does not label the specific companies. Table 1 presents a sample of these data to illustrate the observed range.

Swine industries in some parts of the world have moved towards large corporate farming, particularly in North America and this has brought putative economies of scale. Some of these companies run many hundreds of thousands of breeding females and finish millions of pigs per year.

They demand a high level of efficiency and accordingly carry out their own assessments on lean growth characteristics to help them make selection decisions on the various hybrids available.

At this level of production it is economically justified for them to commission their own growth evaluations on various hybrids to facilitate the selection of the appropriate product coupled with the matched nutrition programme for their own production conditions.

Fig. 5 presents the results of one such evaluation that was carried out in the USA using many thousands of growing pigs with a serial growth programme to generate very accurate lean growth characteristics.

The comparable growth curve data from a published university study carried out in the public domain at the same time is also presented. This latter study was implemented with less animals and also used ultrasound back fat levels to estimate lean gain.

The contrast presented in Fig. 5 illustrates how much error can be built into nutritional programmes without precise knowledge on lean growth parameters.

If the commercial diet programme was based on the university data or the wrong hybrid data then there would be significant waste of nutrients in either case.

Conclusions

It is self evident from the foregone discussion that hybrid pig products over recent years have changed in a manner driven by the selection index parameters and there will have been divergence in lean growth characteristics.

Nutrition technology has also moved on at a pace and with phase feeding systems and sophisticated simulation software systems in use. The level of nutritional accuracy required has also increased accordingly.

It is imperative if accuracy and efficiency is to be sustained to understand the genetic product that is being fed and its growth characteristics. The only way that this can be done is for geneticists and nutritionists to work much more closely together than they have in the past.

The North American experience is pointing to the fact that unless the genetic parameters are provided then the production companies will set up their own evaluations to produce their own comparative data. ■

Fig. 5. Commercial evaluation of two hybrid lines for optimum lean gain and nutrient requirements. Genetic line 2 vs 3 gilts – lysine:calorie to optimise ADG.