

Genetic Sources of Variability in Pig Production

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■ Introduction

Increasing uniformity has important economic implications for pork production and rightly receives a lot of attention. On the other hand, a certain amount of variability is useful for different production environments and different market needs. Variability can also create opportunities for improvement if the reason for better performance or specific quality can be identified and repeated. Variability in pigs has both genetic and non-genetic sources. These include nutrition, disease challenges, production system, and social interactions to name a few. Genetics is certainly one important source of variability among them.

■ Breed and Line Differences

The overall differences among breeds or lines are an important source of genetic variability. Differences among the many breeds and lines available can be potentially very large. One reason for differences is that the foundation stock may have had some unique characteristics, such as maternal abilities or pork quality. However, a breed may be exceptional for one trait such as large litters, but not be able to meet the requirements for other traits such as carcass quality or feed efficiency.

Genetic selection is another, perhaps more important reason for breed and line differences. The differences will depend firstly on the selection objectives which determine the direction of genetic changes for specific traits, and secondly on the effectiveness of the selection program which determines the magnitude of the changes.

■ Differences within a Breed or Line

There is a large amount of genetic variability within each breed and line. Often the differences between sires of the same breed can be larger than differences between two different breeds. Heritability tells us how much variability is due to genetics within a breed or line. For example, if heritability for growth rate is 30%, this means that in a uniform environment, 30% of the differences among pigs for growth is because of genetic differences among the pigs. Heritability estimates for some important traits are shown in **Table 1**. Genetic evaluations done using Best Linear Unbiased Prediction (BLUP) technology allow ranking of animals for various traits. This makes the genetic variability within a breed a very useful tool for pig production.

Table 1. Proportion of variability due to genetic differences within a breed. (Source: Rothschild and Ruvinsky, 1998)

Heritability Estimates			
Backfat	49%	Meat colour	28%
Lean yield	48%	Intramuscular fat	50%
Loin eye area	47%	Ultimate pH	21%
Average daily gain	31%	Drip loss	16%
Litter size	11%	Tenderness	26%
Feed intake	29%	Firmness of backfat	43%

Advances in molecular genetics allow us to more precisely evaluate and control genetic variability. The Halothane gene and the RN gene are two examples of individual genes that have large effects on pork quality. Eliminating the adverse form of these genes enhances both the quality and uniformity of pork. A more recently available discovery is a test for the IGF2 gene. This gene has been shown to control a large amount of variability in carcass lean (**Figure 1**) and sow productivity. Sires that carry only the lean form of the gene will produce leaner and substantially more uniform market hogs. Similarly, maternal line sires that carry only the fatter form of the gene will produce gilts that are substantially more uniform for body condition.

Other genes are being discovered that could have a large influence on various traits, such as defects, intramuscular fat levels, longevity and resistance to disease. New tests for these genes will allow more precise control of genetics and production of more uniform market hogs.

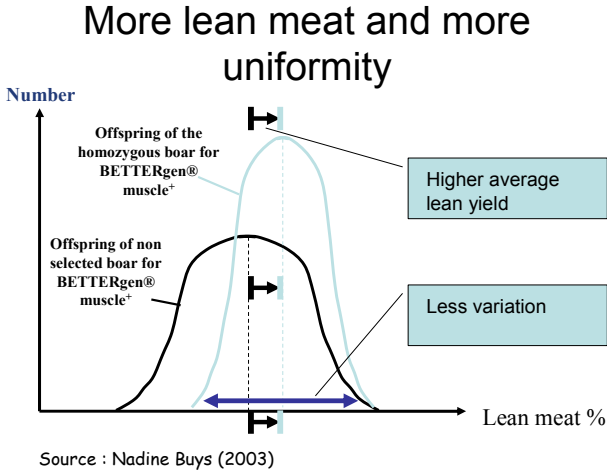


Figure 1. Example of a gene (IGF2) with large effect on carcass uniformity

■ Examples of How Genetic Selection Changes a Breed or Line

Results from the Canadian Swine Improvement Program (Mathur, 2006) are shown in **Figures 2 and 3**, and illustrate the importance of genetic selection. Each of these breeds has been selected for lean growth for several decades to improve efficiency and carcass quality of the market hog. With the implementation of genetic evaluations for litter size, Yorkshire and Landrace breeders have also been selecting effectively for this trait in recent years. With selection for litter size there has been less emphasis on lean in Yorkshire and Landrace. Meanwhile Duroc breeders have continued to focus on lean growth since Duroc is used mainly as a commercial sire line. Even in a relatively short period of time, a substantial difference has developed between the maternal breeds and the Duroc for litter size and leanness.

■ Genetic Variability due to Sires

Although genetic differences among breeds and lines can be important, there is also a large amount of genetic variability among individuals within a breed or line. Differences among individual sires within a breed, for example, can

often be much larger than differences between breeds. One way to illustrate these differences is to look at sires with a large number of progeny measured in different environments.

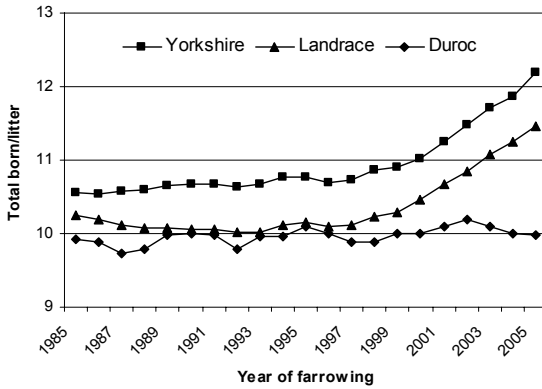


Figure 2. Divergence of genetic trends in different breeds for litter size

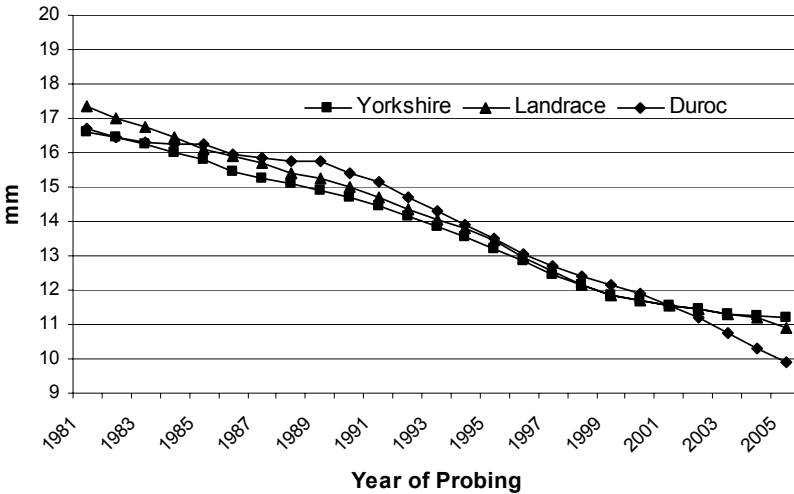


Figure 3. Divergence of genetic trends in different breeds for backfat

Differences in Performance

Average backfat depth, lean depth and days to market, are shown in **Table 2** for progeny of four popular AI sires. The sires each had hundreds of progeny evaluated in several dozen herds across Canada in 2005. Although the progeny are influenced by other non-genetic effects, these other effects will tend to average out over the various herds and large number of progeny. BLUP genetic evaluations on these specific sires show that a large portion of the observed differences in progeny is in fact due to genetic differences among the sires.

Table 2. Differences in progeny performance of popular AI sires on the Canadian Swine Improvement Program.

Sire	Herds	Progeny	Back fat (mm)	Lean depth (mm)	Age at 100 kg (days)
A	28	623	11.0 ±1.9	59.0 ±5.1	154 ±14
B	21	586	10.5 ±1.7	65.9 ±5.8	152 ±15
C	34	1,209	10.0 ±1.7	60.4 ±4.7	154 ±15
D	38	1,170	10.3 ±1.6	63.4 ±5.2	152 ±16
Overall	95	93,052	11.0 ±2.1	61.9 ±5.8	154 ±13

Differences in Sow Productivity

Table 3 shows average total number born from daughters of four popular AI sires in 2005. Daughters of these sires averaged as high as 14.2 born, which was 2.2 pigs more than the average of 61,304 litters recorded across Canada in 2005. BLUP genetic evaluations on these specific sires provided an early indication of the larger litter size, which has been the reason for their popularity.

Table 3. Differences in daughter productivity of popular AI sires on the Canadian Swine Improvement Program.

Sire	Herds	Daughters	Litters	Average Litter Size
A	44	582	1069	14.2 ±3.9
D	43	306	411	13.3 ±2.8
E	37	207	371	13.1 ±3.8
F	35	288	447	12.9 ±3.3
Overall	102	35,700	61,304	12.0 ±3.5

■ Managing Variability through Genetics

Genetic evaluations based on genetic differences between individuals provide a tool for producers to gain control over genetic choices. These choices can enhance herd performance levels and also move performance in a direction that matches the needs of each producer. We can use results from the Canadian Swine Improvement Program to illustrate. Consider for example the average genetic evaluation of AI boars that have been active in 2006 versus AI boars that were active in 2005. In the last year, Duroc AI sires are genetically 3.1 days faster to market, 0.27% higher for lean yield and have 0.6mm more lean depth. In the same time, Yorkshire and Landrace AI sires have increased litter size by 0.4 pigs and 0.2 pigs, respectively. Tapping into the latest boars will transfer this annual improvement to commercial herds. Producers could go further by working with their genetic suppliers to select specific boars for the combination of traits most important to the producer.

■ Conclusions

Genetics is a very important source of variability in pigs, and genetic variability is an important tool for genetic improvement. The genetic choices made by producers can and do have a large impact on both herd performance and variability. Unique attributes of the foundation stock of a breed or line may be an important consideration. However, it is also important to consider the selection objectives that have been followed and the total amount of genetic change that has been made for traits of interest. Further, there are very large genetic differences among individuals within the same breed or line. These differences can be larger than differences between breeds and lines. Genetic evaluations of individual pigs, especially AI sires, offer new opportunities for producers to fine tune the use of genetics for their own needs. These opportunities are increasing with the recent discoveries of tests for important genes, and will become even larger as more gene tests are available.

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