Contribution of Genetics to Improved Breeding Herd Performance

Introduction:

There are three key factors where genetics has a direct influence on the performance of the sow:

1. *Genetic change* taking place in purebred breeds or lines used to produce the commercial replacements;

2. The time it takes for the genetic changes to propagate into the commercial herds, or *genetic lag*; and

3. The breed or line crossing scheme that is used, and how effective this maximizes *hybrid vigour*.

For many producers, the first factor, *genetic change*, is controllable only in the sense of the choice of breeding stock supplier. Often producers will say this is something that they leave up to their supplier. Nevertheless, some level of understanding of what genetic changes are taking place is important, firstly to be able to make informed choices among suppliers and secondly to be aware of what to expect from the genetic performance of the sows.

The second factor, *genetic lag*, is much more in the control of the producer. Partly this can be influenced by the choice of genetic supplier. For example, if replacement gilts come from more than one level of multiplication, or a backcross (often called F2s), genetic lag will be increased. Genetic lag is also influenced by how quickly the producer turns over the herd with new genetics, as opposed to keeping very old sows or selecting replacement sows within the herd.

The third factor, *hybrid vigour*, if not maximized, can quickly result in a loss of 10 to 15% in productivity of the breeding herd. It is also important to consider this factor in the choice of terminal sire line. Maximum hybrid vigour will be achieved when using a cross between two distinct maternal breeds, which produces the F1 commercial sow. It can also be maximized by crossing two synthetic lines, provided that there are no common foundation breeds in the two lines.

1. Genetic Change

Historically, there have been huge changes in the genetics that is available to commercial producers. This can be illustrated using data from the Canadian Swine Improvement Program, where measurements on growth and backfat are available for the past 25 years, and for litter size for which data is available for the past 20 years. The following charts show how dramatically each of these traits has changed in the Canadian Yorkshire and Landrace populations.

Litter size, shown in figure 1, is particularly interesting given the relatively recent changes which have occurred. For about 15 years, we observed no significant change, while in the last 5 years number born has increased genetically by about 1.5 pigs. Because of genetic lag, as discussed in the next section, these increases are just starting to reach commercial herds. Producers using replacement females from these Canadian genetic suppliers can expect to see this same trend within their herds over the next few years.

It is also important to be aware of performance traits in the maternal lines, since 50% of the genes in the market hogs come from the sow. Trends in growth rate, shown in figure 2, have been very steady for 25 years, and are continuing. On the other hand, trends in reduced backfat, shown in figure 3, have slowed in recent years. This change corresponds with the shift to emphasis on litter size, a desire to maintain a certain level of backfat in maternal lines, and with signals from the packing sector that hogs may be reaching an optimal level of leanness.

Figure 1. Genetic Change for Litter Size
Assuming 10% heterosis in the F1

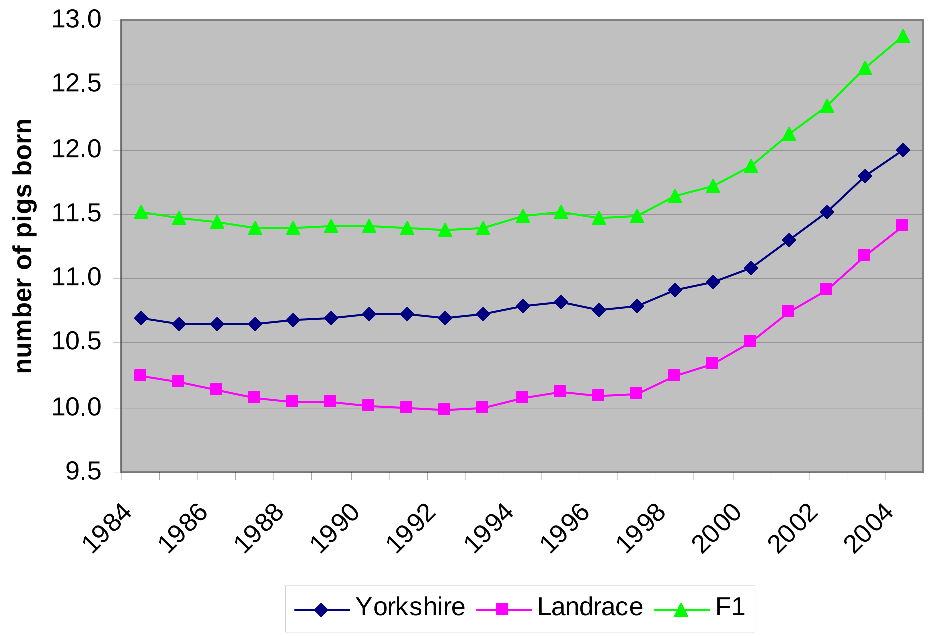


Figure 2. Genetic Change in Growth Rate
Assuming 7.5% heterosis in the F1

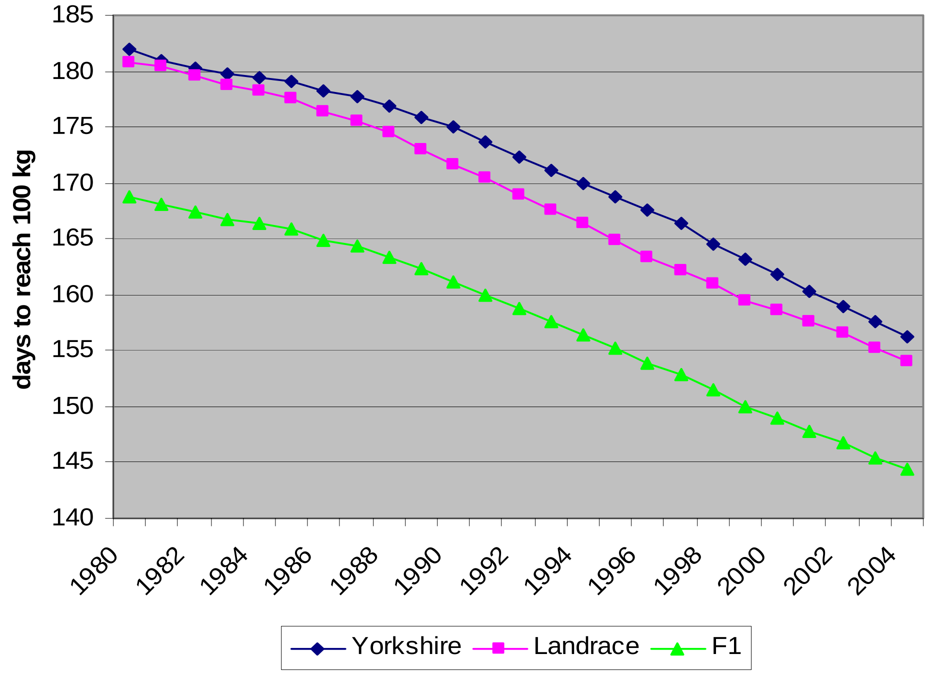
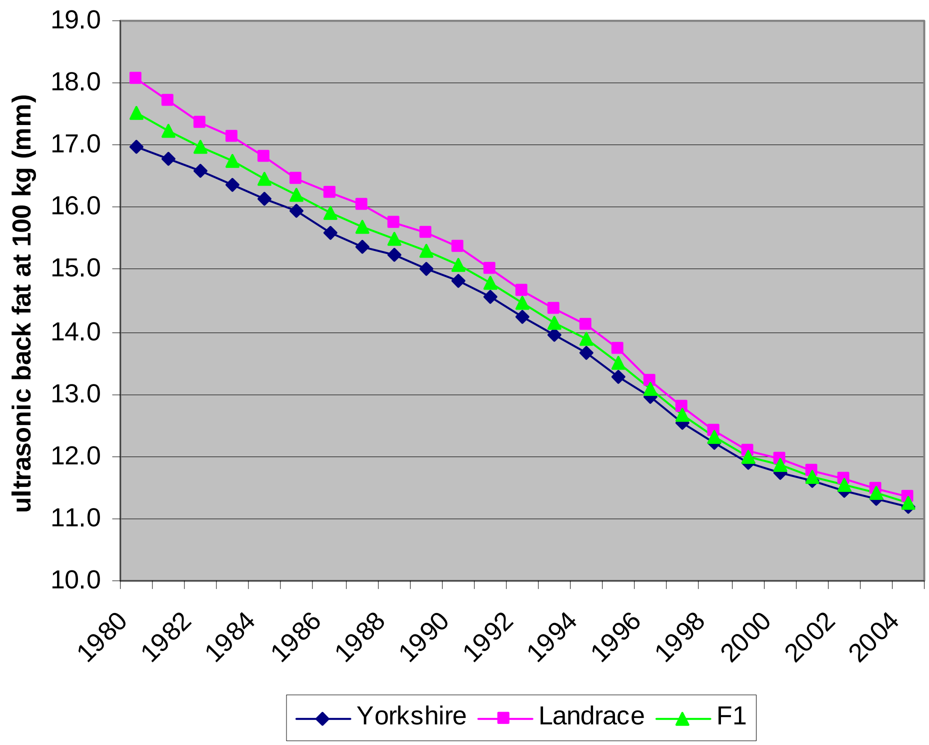


Figure 3. Genetic Change in Backfat



2. Genetic Lag

Genetic lag is the time it takes for genetic change made in the breeding stock supplier's nucleus herd to show up in the commercial herd. A common way for the genes to flow is from the nucleus herd to a multiplier herd and then to the commercial herd. How much lag there is, depends both on how quickly genes get to the multiplier herd, and on how quickly they go from the multiplier to the commercial herd.

In a multiplier herd, the average age of sows at farrowing may be about two years. The boars used to produce the commercial F1 females could be one year old on average. In this case, the lag would be 2 years on the multiplier sow breed and 1 year on the multiplier boar breed. This means the F1s being produced for the commercial herd would lag 1.5 years on average behind the nucleus.

The sows in a commercial herd will be on average two or three years old at farrowing. This will add 2.5 years to the lag. Realistically, the commercial sow will lag 4 years or more behind the nucleus.

To achieve minimum lag in the above example, key points to note:

1. The multiplier replaces 50% of the herd with replacement gilts from the nucleus each year;

2. The multiplier replaces boars every year with new boars from the nucleus; and

3. The commercial producer replaces 40% of the herd with F1 gilts from the multiplier every year.

Genetic lag can increase significantly if the multiplier doesn't turn the herd over quickly, breeds their own replacements rather than getting them from the nucleus or doesn't turn the boars over quickly. Other systems, such as F2s, require an extra generation of multiplication and can add further to the genetic lag.

3. Hybrid Vigour

When two breeds or lines are crossed, the performance of the offspring is often superior to the average performance of the parents. This is caused by heterosis or hybrid vigour. The effect tends to be large in many reproductive and fitness traits.

Average levels of heterosis found in research trials are shown in table 1. The top part shows the effect on traits of the sow, and the bottom on traits of the market hog. As mentioned earlier, a cross between two distinct breeds (F1) or lines will give maximum hybrid vigour in the sow. It results in better fertility, larger litters, better survival to weaning, and better pre-weaning growth. Added up, this is a boost of 20 to 30% in productivity of the sow.

For the market hog, use of a 3rd distinct breed or line will give maximum hybrid vigour. This will result in more vigorous embryos and piglets, with larger litters, better pre-weaning survival and better growth both pre and post-weaning.

Table 1. The effect of hybrid vigour on performance of sows (dam heterosis) and hogs (litter heterosis).

Trait	Heterosis level
Dam heterosis (crossbred sow)	
Conception rate	+3%
Litter size at birth	+0.66 pig
Litter size at weaning	+0.84 pig
Litter weight at 42 days	+15.0 kg
Litter heterosis (crossbred piglet)	
Litter size at birth	+0.24 pig
Litter size at weaning	+0.49 pig
Litter weight at 42 days	+13.35 kg
Post-weaning growth	7.5%

Source: Genetics of the Pig, 1998

A Yorkshire x Landrace F1 is the most common to achieve maximum hybrid vigour in the sow. Use of Duroc on the F1 sow would maximize hybrid vigour in the market hog. Other crosses will also work, but maximum hybrid vigour will only be reached if the parents being crossed have no breeds in common.

Losses in hybrid vigour occur in backcross systems, such as selecting replacements from F1 X Yorkshire. This is often referred to as an F2, and results in a loss of 50% of maximum heterosis in the commercial sow.

In-house replacement systems are more and more common due to biosecurity concerns, and biosecurity factors may be more important that achieving 100% of maximum hybrid vigour. In-herd rotational crossing systems can still result in reasonable levels of hybrid vigour. A properly managed two breed rotation results in 67% of maximum heterosis. Use of more than two breeds can increase this, but it becomes more difficult to manage and it may be difficult to find three distinct maternal breeds or lines with acceptable genetic qualities.

Conclusions

To make the most of genetics in commercial hog production, it is important to be aware of three key factors: *genetic change, genetic lag* and *hybrid vigour*. Each factor is very important on its own, but they also interact and depend on each other. All the genetic improvement in the world does very little good if genetic lag prevents it from getting to the producer. Multiplication systems that produce cross-bred gilts create some genetic lag, but can result in maximum hybrid vigour. Other gilt producing systems can increase genetic lag and at the same time create loss of hybrid vigour, a double whammy against the producer.

Understanding these factors also enables the producers to know what to expect in terms of genetic performance. This is particularly important when something new has happened, such as genetic increases in litter size in recent years. Producers should expect and be prepared for large increases in litter size over the next few years. Similarly, if a producer determines that they currently have excessive genetic lag, information on genetic changes from their genetic supplier can be used to predict and prepare for a higher level of genetic performance. The same would be true for optimizing the level of hybrid vigour.

Producers should be confident that their genetic suppliers are making competitive genetic changes in the traits that matter most to the producer. From there, be sure that genetic lag is not excessive either at the multiplication level or because of slow replacement rates within the commercial herd. Breeding of replacements should be done to maximize hybrid vigour in the sows, taking into account the practical needs such as closing a herd for biosecurity reasons. Consideration of hybrid vigour should also be taken into account when choosing terminal sire lines, and where possible avoid use of terminal breeds that were also used in the sow.