

Genetics for the Market versus the Marketing of Genetics

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■ Introduction

How many different markets are there for Canadian pork, and how can we satisfy them? Can we rely on a limited number of breeds or genetic lines, managed differently for each market or do we need a large number of specialized lines? Are the lines from genetic suppliers today really different, or are they all moving in the same direction under the influence of the same market forces? While there is probably no definitive answer to all these questions, some elements of response are required for producers, packers and genetic suppliers to plan adequately for the future.

■ The Markets for Canadian Pork

Pork has long been a commodity product, and largely still is. Pigs produced using the available genetics and production systems, are sold to packing plants, and hopefully a buyer can be found for the meat. Another approach, which is gaining ground, consists of analysing specific market needs, and developing pigs and production systems that can match these needs as closely as possible. This approach can be used to seek premiums for specialized products that potentially are beneficial to all players in the market chain. It requires, however, knowing what markets are available, and what they need.

General Trends

Despite the trend towards specialization, there are factors that apply to most aspects of pork production. Production efficiency is one of these factors, because Canadian pork must compete against other meat and other pork-producing countries. Although premiums may permit a few products to be produced less efficiently for a time, this is rather rare. Competition usually

catches up and drives the price down. An example given by Dave Price at last year's Banff Pork Seminar is name brands. As name brands become more and more common, the rewards attached to them are likely to decrease. The way to keep prices competitive in the pork industry has been to increase sow efficiency, pig production efficiency and packing efficiency.

A heavier carcass yields more product for approximately the same slaughtering cost. However, a heavier pig tends to deposit more fat, which is undesirable for the market. The increase in slaughter weight has been possible because modern pigs are less fat at heavier weights. Another advantage of greater leanness is increased feed efficiency, therefore greater pig production efficiency. As the trend for heavier carcasses and increased leanness continues, the quality of several meat products can be affected negatively, because some genetic lines associated with extreme leanness (e.g. Pietrain, Pietrain-based lines and extreme Yorkshire lines) have low intra-muscular fat and water retention. This is a problem for fresh loins on the domestic and Japanese markets, for example.

Production efficiency does not stop at leanness. Considerable progress has been achieved over the last few years in terms of litter size and growth rate. Table 1 illustrates the economic value of some of these advances at the producer level based on genetic gains realized in the Canadian Swine Improvement Program.

Table 1. Economic gains from genetic improvement at the producer level

Traits	Current genetic rate of gain per year	\$/litter/year*
Litter size (pigs)	0.14	\$3.46
Lean yield (%)	0.20	\$2.34
Growth rate (days)	1.5	\$4.05
Feed conversion (kg/kg)	0.024	\$4.50
Total per year		\$14.35
Total over 5 years		\$71.75

* based on a production system with Duroc sires and Yorkshire x Landrace sows, litters of 10 pigs, and average hog and feed prices for the last 3 years

Genetic gains in Table 1 are based on about 100,000 records annually, and therefore are estimated with high accuracy. It is worth noting that the largest monetary gains for producers result not from the increased value of the product

they sell but from the increased efficiency with which they produce it (growth rate, litter size, feed efficiency). Therefore, even for specialized lines, part of the selection emphasis should remain on traits that increase efficiency. Selection of specialized lines for carcass and meat quality, to be worthwhile to the pork producer, must bring a sufficient premium to offset the opportunity cost of selection for production efficiency.

Different Markets

While efficiency traits are valuable in all markets, carcass and meat quality traits, on the other hand, can have different values in different markets. Table 2 summarizes the input provided by retail and export specialists at a meeting held last year in Toronto to discuss this topic.

Table 2. Market requirements for carcass and meat quality (Genetics Symposium on objectives for swine selection in Canada, Toronto, Nov. 1-2, 2000)

Market	Lean yield	Loin eye	Water retention	Marbling
Canada	+/-	+/-	+	+/-
United States	+	+/-	+	+/-
Japan	+/-	+	+	++
Others	+/-	+/-	+/-	+/-

Legend: + for increase, - for decrease, +/- for keep same

The three major markets for Canadian pork, which depend upon specific quality requirements, are the domestic, US and Japanese markets. Canadian retailers would prefer loins no bigger than currently, with more marbling, and possibly better water retention. In the US, where carcasses are slaughtered at a heavier weight, increased leanness and water retention are desirable goals. The Japanese market generally seeks bigger loins with more marbling, colour and water retention. There are further differences: for example, at the domestic level, marbling is desirable for fresh loins, but less for processed products. Size requirements for primal cuts vary according to their use. For example, heavier legs are required for prosciutto hams (10-12 kg), and lighter ones for spiral hams (6.5-7 kg) compared to fresh retail (8-9 kg). Special requirements

also exist for a variety of niche products. There are several options to satisfy these different markets:

- use specialized genetics;
- use specialized production systems; and
- use a combination of both.

■ Specialized Genetics for Specialized Markets

There are a great number of genetic lines on the market, each with its own name and portrayed as superior to the others for a particular market or for all of them. The evidence to support these claims is often questionable, i.e. based on internal results or limited or selected data. Yet, marketing a product as “special” on the basis of the genetics it contains is more likely to succeed if the genetic differences are real. The industry therefore needs ways to verify marketing claims from genetic suppliers. One difficulty is that performance by itself reflects the joint effect of genetics and management. To be accurately compared, genetic lines must be compared in the same production system, with the same feeding, health and management regimes. In some instances, different genetic lines may rank differently in different environments. Therefore, it is best to compare them in the environment in which they will be used.

Breed choices

To begin with, let us examine genetic differences at the breed level. What choices are available and what do they offer? There are not many choices for maternal breeds: Yorkshire (Large White) and Landrace, with possibly some use of Chinese breeds. The latter, however, look less promising than they did years ago, because selection of European breeds for litter size has been effective and has closed part of the gap with Chinese breeds. In addition, the carcass quality of Chinese breeds is such that only a limited amount of Chinese blood can be introduced in the dams of market pigs. Synthetic or composite lines (e.g. resulting from the historically recent mixing of different breeds) are commonly used but present several limitations. First, they are generally based on small populations compared to Yorkshire and Landrace world populations. Periodic introduction of new genetics in synthetic lines is then necessary to counter the long-term effect of inbreeding, or to make changes in the direction of selection, which reduces their stability. A second limitation is the decrease in hybrid vigor when synthetic lines, which are crossed to each other to generate commercial sows or market hogs, contain the same breeds in their composition. A third limitation is the lack of product uniformity resulting from genetic recombination, as it takes many generations to stabilize a line. Therefore, it is likely that the dominant commercial sow in modern swine

production will remain a Yorkshire x Landrace sow, and that specialization will occur mostly within these breeds.

For terminal lines, the main genetic choices are Duroc, Yorkshire, Pietrain, Hampshire and Berkshire breeds. Synthetic lines, derived from combinations of these breeds, are common but suffer from the same limitations as described above. Much is already known about the relative performance of these different genetic choices. The Pietrain, for example has a high lean yield, but relatively poor growth and meat quality. The Hampshire breed, although it has been used extensively in the synthetic lines of some breeding companies, has both a limited population size and a high frequency of the RN gene, a mutation which severely affects meat quality (cost estimated at \$12 per pig).

Table 3. Some Canadian results for the RN (i.e. “Acid meat”) gene

Breed/region	% with RN gene
Yorkshire ^a	0
Landrace ^a	0
Duroc ^a	0
Hampshire ^a	63-100
Alberta meat samples ^b	25

^a Houde A. et al, 2001 - Determination of the RN gene in the breeds of pigs used in Canada.

^b Sample of pork in Alberta stores. Meadus, W.J. and MacInnis R., Meat Science 54 (2000) 231-237.

The Berkshire breed has high meat quality, but relatively small population size, and is fatter than other breeds. In last year's trials at the Deschambault test station, Duroc sires from the Canadian Swine Breeding Program were tested against sires from 5 other breeds and lines: Genex HC2000, Genex Large White, Yorkshire, Landrace and DRU (Musclor x Duroc). All sires were crossed to York x Land sows and the progeny randomized across pens in the test station. The Duroc sire line was found to exceed other lines for growth, feed efficiency, lean yield, loin depths, colour, marbling and drip loss.

Table 4. The CSIP Duroc as a terminal sire breed: deviations to the average of 696 pigs from six lines^{a,b}.

Trait	Duroc
Number of pigs tested	116
Average daily gain (g)	+26
Feed conversion (feed/gain)	-0.03
Lean yield (%)	+0.5
Lean depth (mm)	+1.03
Colour (Japanese scale)	+0.07
Marbling (AAFC scale)	+0.29
Drip loss (%)	-1.53

^a Quebec test station (CDPQ), 1999-2000.

^b CSIP Duroc, Genex HC 2000, Genex Large White, Yorkshire, Landrace, DRU (Musclor x Duroc). All sire lines randomly mated to York x Land sows.

One remarkable feature of the Duroc tested in this trial is that it produces lean fast-growing pigs, which, despite their leanness have superior intra-muscular fat and water retention. It is therefore superior for domestic fresh sales, the restaurant trade, and the Japanese market, but will do well in other markets as well (when lower intra-muscular fat is required, the Yorkshire or York x Duroc may be an alternative). The Duroc results should not be surprising. They reflect the inherent superiority of the breed for meat quality, and in the Canadian Swine Improvement Program, continuous selection for performance traits based on a large population with a common genetic evaluation system.

On the basis of independent studies, it would therefore appear that most markets could be served effectively from lines derived from a relatively small number of breeds (York and Landrace for maternal lines, Duroc and York for terminal lines).

Line differences

The above does not imply that there is no room for developing specialized lines or for applying divergent selection within breed to meet specific product requirements. There is substantial genetic variation within breed for most traits of interest. The largest AI Centre in Quebec, for example, currently markets different lines of pooled semen based on the genetic value of the boars that are

in the pool: one can order the leanness mix, the growth mix, or a mix that improves both traits. A similar approach could be used for meat quality traits as genetic evaluations are developed for these. The proportion of variation in meat quality traits, which is due to genetics, is sufficient for effective selection.

Table 5. Impact of genetics on various meat quality traits^a

Trait	% variation due to genetics
Ultimate pH	21
Meat colour	28
Drip loss	16
Marbling	50
Tenderness	26
Structure score	30

^a The Genetics of the Pig, 1998, edited by M. F. Rothschild and A. Ruvinsky

Different Duroc or Yorkshire lines may already provide different characteristics which can be explored to market specialized products. Using such lines, which have a narrower genetic base than their breed of origin, increases uniformity in the final product. At the extreme, if it ever becomes commercially feasible and acceptable at the consumer level, cloning of outstanding individuals would be the best way to ensure product uniformity from a genetics standpoint. However, large breed populations and lots of genetic variation would still be required for selection, to develop the next “batch” of clones.

Another area where further development is likely to occur is the selection of specific lines for their ability to combine with each other. This specific combining ability, often called “nicking” in poultry breeding, must be measured by relating the performance and the quality of the market hogs to the parent or grand-parent lines under selection. It requires the periodic testing of the “genetic package”. If systems are devised to track performance, carcass and meat quality data on market pigs back to their parents and grand-parents (e.g. through electronic identification as in the “Closing the Loop” project in Ontario), it will then be possible to use this data for the continuous selection of parent and grand-parent breeds or lines.

■ Specialized management for specialized products

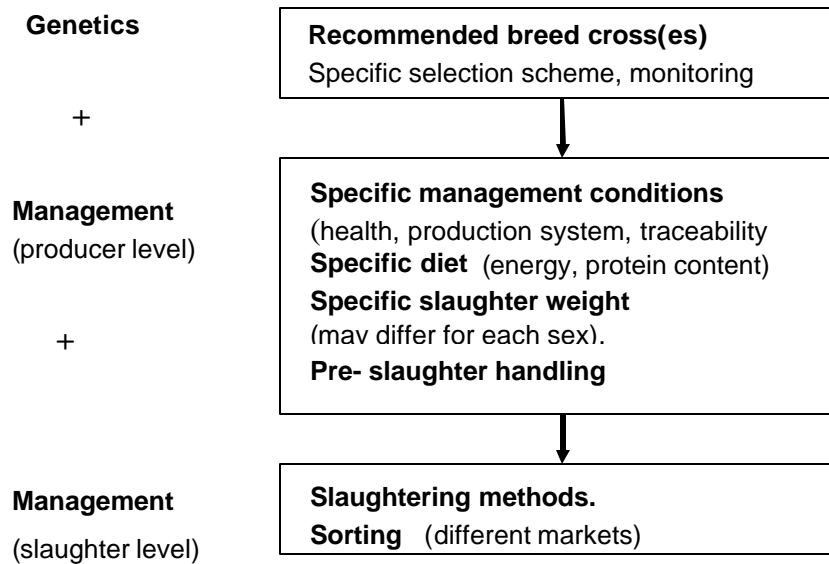
The value of specialized lines will depend, to a large extent, upon the conditions in which they are used. Many factors influence the quality of the final product besides genetics, such as feeding, health, slaughter weight, sex, pre-slaughter handling, slaughtering and processing methods. The same genetic line can be used to yield somewhat different products in terms of lean yield, loin size and marbling just by varying the slaughter weight, sorting the sexes (gilts are leaner and have bigger loins with less marbling than barrows) or feeding different regimes (e.g. higher vs lower protein content). In this regard, we are probably quite far from making the maximum use of the genetics we already have.

Product differentiation can also be based upon such things as absence of pathogens or residues, perception of wholesomeness, methods of production and slaughter (animal welfare), name branding, etc... Some specific genes and markers in the pig might sometime be used to make products “special”, although much caution would have to be exercised to ensure this does not create a “biotech backlash” from the consumer.

■ Serving specialized markets

Therefore, the most effective way to meet diverse market needs will likely entail combining specialized genetics with specialized production and processing systems as shown in Figure 1.

Such systems require the establishment of a market value chain where the players, i.e. genetic suppliers, producers, feed companies, veterinarians, packers and retailers work towards a common goal. Market value chains, which were discussed in last year's Banff Pork Seminar, are easier to implement in a vertically integrated system. However, vertical integration is not necessary. The different links in the chain can remain independent, and generate “virtual” integration through mutual cooperation. One advantage of this is that each link still has to compete with similar businesses in the industry, and therefore must remain efficient on its own. Another requirement in such value chains is the development of systems to continually verify the quality of products at different stages in the chain. The slaughter trials conducted by some packers, those undertaken at Deschambault in Quebec, or the “Closing the Loop” project in Ontario are all examples of initiatives in support of this approach, which will hopefully become more and more commonplace.

Figure 1. Producing pork for specific markets

■ Conclusions

The creation of value chains where specialized genetics are used jointly with pre-determined production and processing systems will likely be the method of choice to meet diverse market needs in the future. The inherent advantages of some swine breeds, and the genetic variation in them, can be exploited to obtain the specialized genetics for these value chains. The monitoring of differences among genetic lines by objective methods will become more commonplace as end users develop systems for quality control.

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