

Selection in the US Pork Industry

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Many Types of Players in the Game

You name it and we've got it. It's impossible to characterize US selection programs in a succinct statement. We have many different types of breeders ranging from independent breeders, through those who are members of the purebred associations, to those involved in multiplying the genetic lines of the multinational companies. Within each category we have a full range of herd size and types of ownership.

Providers of Genetic Information

Just as there are many breeders in the game, there are several differing ways in which they get their genetics evaluated. The largest group is the major breed associations. The Yorkshire, Hampshire, and Duroc associations have joined together and formed the National Swine Registry. NSR and the Landrace association utilize the STAGES (Swine Testing And Genetic Evaluation System) which is technically supported by Purdue University. STAGES is a BLUP system that produces daily within herd evaluations for growth and maternal traits. In addition, Quarterly (Yorkshire), Semi-annual (Landrace) or Annual (Duroc and Hampshire) across herd evaluations are performed for each breed.

Another approach to evaluation is demonstrated by groups such as Nebraska SPF. This is a group of 10 or 12 breeders of several different breeds of pig that have formed a coalition to conduct genetic evaluation and marketing programs. They have hired a geneticist to conduct "in-house" evaluations and advise them on breeding plans. They are currently hanging to BLUP technology and perform within herd analysis.

There is one PC based software system available from a private company. Their clients are typically single farms or groups of cooperators that have formed a nucleus-multiplier organization.

The other major player in the game is the large corporate breeder. Most of these are the multinational companies you know such as PIC, and Newsham. Some estimates attribute up to 25% of the boars and 40% of the gilts coming from these companies.

The National Swine Improvement Federation (NSIF) is a quasi-governmental agency that maintains a set of Guidelines for Uniform Swine Improvement. The federation is composed of Federal and State extension geneticists, and private and corporate breeders. Recently, public and private geneticists from Canada have joined the federation as well. The guidelines cover a wide range of topics from what adjustments should be made to phenotypic measurements, what rations to feed and suggestions on methods of indexing. They provide indexes for use with phenotypic deviations but then state that a function utilizing EBVs would be preferable.

Commercial Industry Structure

Before we talk about specific selection programs, let's review the structure of the pork production industry in the US from a genetics perspective. First, virtually 100% of the commercial sows and pigs are crossbred. The industry is shifting from rotational breeding programs to terminal crossing systems. There is a high level of integration developing from the Grandparent seedstock sources through to the processing sector. The forms of integration vary from complete ownership by a single company such as Tyson's, to partnerships among "Family Farms", to contractual arrangements between a company that owns the sows and the processing plant and small growers that contract feed pigs in the nursery or grow-finish units.

The design of production units is rapidly evolving to "three site production" with "all-in/all-out" movement of pigs. This structure not only has been shown to increase growth performance of pigs through better health management, but also facilitates contracting and cooperatives being formed around a large farrowing complex producing pigs in truckload quantities for distribution to a series of nursery and grower units. The only design issue is becoming how many truckloads per week are produced. Another important change in production practice has been the utilization of A. I. with fresh semen. Recent estimates are that over 25% of all market pigs are derived from A. I. matings and the trend is still increasing.

Demographics for 1994 published by the National Pork Producers Council showed there were 149,000 pork producers in the US. Eighty Percent (120,000) of them produced fewer than 1000 pigs per year and combined to produce about 17% of the nation's pork. On the other end of the scale, there were 66 producers outputting over 50,000 pigs per year and that 1/10 % also produced about 17% of the nation's pork. The old 80-20 rule is still valid. One impact of the shift to larger production units is a much more stable production over time. We do not have the large movement of farmers in and out of pork production that was typical from the 1920s to 1970s.

The change in industry structure is having a dramatic impact on how genetic improvement is created and distributed through the industry. There are becoming fewer decision-makers in both the commercial and seedstock sectors. The Nucleus-Multiplier structure of the industry is much more defined. There is a need for fewer boars. And the focus of breeding programs is shifting strongly towards the end product and consumer acceptance.

With the consolidation of the industry, there is a more distinct use of Genetic Lines. Maternal crosses are typically Yorkshire-Landrace F₁s when total confinement production is used. York-Hampshire cross females are still popular among producers breeding in open lots, but this sector is shrinking. Sire lines are of Hampshire and Duroc origin. Crossbred boars are frequently used. Terminal sire lines carrying the Halothane gene are common. (There is considerable controversy in the industry over the use of the halothane gene.)

Traits Evaluated

By and large, the traits evaluated are the same now as 30 years ago. That because of what can be conveniently measured in production facilities; growth, backfat and litter size. Growth is most commonly expressed as days to 230 (105 kg) which is market weight. Since the industry is shifting to heavier market weights, the standard has just been shifted by NSIF to days to 250 (115 kg) and that's probably too light. The alternative measure of growth is average daily gain from 40 to 105 kg. Backfat is typically measured ultrasonically at the 10th or last rib. Feed efficiency is normally predicted from growth and fat data but with the improvement in electronic feeding systems, direct observation is becoming more frequent. A lot of research is going into prediction of lean growth rate but by and large methods are still experimental.

Maternal traits currently measured are litter sizes at birth and 21-days, and litter weight at 21-days. Litters are standardized within 24 to 36 hours of birth so the 21-day measures reflect pig survival and sow lactation yield. With the shift to early weaning, many breeders are shifting their attention to birth litter size and pig survival. There is also work exploring ways to evaluation reproduction but as with lean growth rate, little measurement is occurring on farms today.

Carcase quality, palatability rather than lean content, is a major topic of discussion in the US pork industry. Considerable research is going on to develop measures of quality but little is happening at the farm level to day to alter quality. We are still focused on carcase quantity, both weight and percent lean.

Methods of Selection Practiced

I know of one commercial producer that is so concerned about importing animals onto their farm (disease control) that they use the boars that were missed at castration as replacement sires. That's about as random as it gets. But that's not typical. Some breeders still utilize single trait selection, usually for growth or litter size. More common is use of Independent Culling levels with two-stage selection at weaning and 105 kg. The selection criteria used as the culling levels have shifted from single traits of litter size and growth to use of either maternal or terminal indexes. A major reason that two-stage selection is use in the US is that we castrate our market males. Any intact males sold for slaughter attract a major discount in the market, as much as 50% or more. Therefore, breeders attempt to reduce the number of surplus boars by using some criteria to castrate boars by 30 kg.

The indexes used fall into three general categories. Terminal Sire indices will include growth, backfat and feed efficiency. Maternal Line indices include the three growth traits plus numbers of pigs at birth and weaning and litter 21-day weight. Some breeders do not measure growth on a large number of pigs so use a sow productivity index that only includes the three maternal traits. The majority of the groups providing genetic evaluations use a profit function approach. The general approach is quite similar to PIGBLUP but there are two distinct differences. First, PIGBLUP combines the growth and maternal components based on the percent marketings of pigs for breeding and market. In the US system, seedstock and commercial production separate tiers in the

production system. So the maternal and terminal indexes are calculated separately. The other difference is the inclusion of pig survival and sow lactation in the indexes.

NSIF Phenotypic Indexes

NSIF currently recommends 6 indexes for use with phenotypic deviations.

- Sow Productivity Index, $SPI = 100 + 6.5(L) + W$
- Early Weaning SPI, $EWSPI = 100 + 10(L)$
- Maternal Index, $MI = 100 + 6(L) + .4(W) - 1.6(D) - 81(B)$
- Terminal Index (A-mode Ultrasound), $TIA = 100 - 1.7(D) - 168(B)$
- Terminal Index (B-mode Ultrasound), $TIB = 100 - 1.4(D) - 106(B)$
- Terminal Index (% lean), $TIM = 100 - 1.4(D) + 12(M)$

L = Number born alive, W = 21-day litter weight, D = Days to 250, B = Backfat depth, M = Percent Lean

The indexes are formulated so that they average 100 and have a Standard Deviation of approximately 25 units. The coefficients are based on the heritabilities, correlations and economic value of the traits. They would not account for any performance information available on relatives. That's why NSIF states that an EBV system of indexing is preferred.

STAGES Indexes

Examples of an EBV based index are the STAGES indexes. In general, the approach is similar to that of PIGBLUP. Since EBVs are available for 21-day information, pig survival, sow lactation and pig pre-weaning growth are included in the formulation of the profit function. This leads to a somewhat more complex function when the costs associated with farrowing and lactation are included as well. For comparison in the slides, I have converted the economic values to Australian dollars and metric measurement as well as included the equivalent values from the PIGBLUP \$index.

Another difference between the STAGES and PIGBLUP indexes has been mentioned. That is the use of separate indexes for Terminal and Maternal Lines in STAGES while PIGBLUP combines these into a single index. Since commercial production in the US is a separate sector from seedstock production and extensive crossbreeding is used, genetic lines are more specialized. Therefore, specialized indexes are used for maternal and terminal lines.

Response to Selection

Genetic trends for the Yorkshire and Landrace breeds are presented in the figures. One issue to point out is that in the US, EPDs are used rather than EBVs. It is just a scale difference that $EPD = \frac{1}{2} EBV$. So in looking at the genetic trends, you will need to double the value to compare the results to Australian EBVs. All traits have shown desirable

change. In general, the Yorkshire breed has made more progress than the Landrace breed. Some reasons for this include: Yorkshire breeders had a large set of data accumulated from a 10 year sow productivity program which could be loaded into their BLUP system. This gave them a running start. Yorkshire is a larger breed with a higher percentage of the pigs involved in whole-herd performance testing. Yorkshire breeders have generated larger selection differentials.

Since these two breeds are maternally oriented, lets look at the combined impact of their improvement in maternal performance. The combined increase in MLI is \$28 per litter. This translates into about a 92 million-dollar increase in the maternal performance of commercial sows as a direct result of the genetic improvement of these two breeds. Registered Yorkshire and Landrace stock produce about 1/3 of the replacement gilts used in the US every year.