

Crossbreeding and Hybrid Vigor

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How pigs perform is the result of two influences: genetics and environment. The genetics or heredity of a pig sets the upper limit or potential of its performance. The environment of a pig sets the actual level of performance. Environment includes the pigs' surroundings, the feed, and the diseases it encounters. The genetics of a pig are passed from the boar and sow that produce the pig. The pig producer has two primary tools to influence the genetics of a pig: selection and hybrid vigor.

Selection is the process of picking which breeds or lines of pigs to use and which individuals within the breed to mate.

Breeds

There are eight major U.S. swine breeds plus several minor breeds. There are also many lines that have been developed by commercial swine companies. The three white breeds, Yorkshire, Landrace and Chester White are known for maternal traits, i.e., they excel as sows with large litters. The five dark breeds, Duroc, Hampshire, Poland China, Spotted and Berkshire, are known for carcass or terminal traits, i.e., they excel as boars to produce market pigs. In niche markets, Berkshire and Duroc breeds are often used because they excel in meat quality traits.

Breed Attributes¹

There is considerable variation within a breed, however there are some differences between breeds.

- ◆ **Berkshire** Better in conception rate, intramuscular fat, and pork quality. More backfat.
- ◆ **Chester White** Better in conception rate, litter size weaned, and growth rate.
- ◆ **Duroc** Better in growth rate, intramuscular fat, and pork quality. More backfat.
- ◆ **Hampshire** Less backfat and lean pork.
- ◆ **Landrace** Better in litter size weaned, litter weight. More backfat.
- ◆ **Poland** More backfat.
- ◆ **Spotted** Better in growth rate.
- ◆ **Yorkshire** Better in litter size weaned, litter weight, and growth rate.

¹Based on NC-103 and NPPC NGEF, 1995.

Heritability of traits

Individual boars and sows pass on traits to their offspring based on the heritability of the traits (Table 1). The maternal/reproductive traits have low heritability about (5 to 30%). The growth traits are moderately heritable (24 to 30%), and the carcass traits have high heritability (40 to 60%). Pork quality traits are moderately heritable (15 to 30%). Traits with a low heritability change more slowly due to selection than traits with a high heritability.

Heterosis

Hybrid Vigor (or heterosis) is the improved performance of offspring compared to the average of their parents. Hybrid vigor is maximized by crossing different breeds or lines. This is known as crossbreeding. Hybrid vigor is greatest for reproductive and early pig survival/growth traits. Most sows and market pigs in the U.S. are crossbred pigs.

Table 1. Estimates of heritability of traits¹

Reproductive traits	
Conception rate	30%
Pigs born alive	10%
Litter birth weight	30%
Prewean survival	5%
Pigs weaned	7%
Weaning weight	17%
Rebreed Interval	23%
Growth traits	
Average daily gain	30%
Feed/Gain	30%
Average daily feed intake	24%
Carcass traits	
Backfat	50%
Loin muscle area	45%
Lean percent	48%
Pork quality traits	
Pork color	28%
Muscle pH	21%
Drip loss	16%
Tenderness	26%

¹Adapted from PIH 06-01-05.

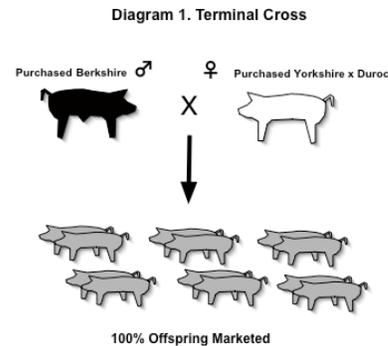
Crossbreeding Strategies

Crossbreeding systems are designed to maximize hybrid vigor. Crossbred sows are especially advantageous with better conception rates, more pigs born and weaned, and heavier litters than purebred sows. For extensive niche pork production settings (outdoor or in hoop barns), a crossbred sow with some dark breed ancestry may be more rugged and durable than an all-white sow. There are three basic crossbreeding systems.

1) Terminal System

Terminal cross systems usually use a boar (purebred or crossbred) on crossbred sows of different breeds. All the pigs are marketed. Replacement gilts are purchased.

For example a Berkshire boar mated to a Yorkshire x Duroc sow would produce pigs that are ½ Berk, ¼ York, ¼ Duroc (Diagram 1).



Advantages

- Simple to manage
- 100% hybrid vigor
- Genetically uniform pigs from year to year
- Crossbred sows
- Uses breeds where their strengths exist (terminal or maternal)
- Works well for small herds

Disadvantages

- Replacement gilts must be introduced to the herd (usually purchased)
- Gilt availability
- Gilts may introduce disease
- Gilt cost

2) Rotation System

Rotation cross systems involve rotating breeds of boars each generation. Usually two, three, or four breeds are used in rotation. When the rotation is complete, the first breed in the rotation is used again and the sequence repeats. Replacement gilts are saved from the pigs and bred to the breed of boar next in the sequence. A typical 3-breed rotation used by niche pork producers is a Berkshire/Yorkshire/Duroc sequence (Diagram 2).

Advantages

Simple to manage
Replacement gilts are produced in herd
Crossbred sows
Boars or semen are only addition to the herd
Less risk of bringing disease into herd
Works well for small herds

Disadvantages

Less than 100% hybrid vigor
 2-breed has 67% PHV
 3-breed has 86% PHV
 4-breed has 92% PHV
 (PHV = possible hybrid vigor)
Less genetically uniform pigs from year to year
Breeds must be dual-purpose (both terminal and maternal)

3) Combination or Rotaterminal System

By combining the terminal and rotational systems, the advantages of both can be achieved. A few of the sows are bred rotationally to maternal boars to produce replacement gilts, and the rest of the sows are bred to terminal boars to produce market pigs.

Advantages

Replacement gilts are produced within the herd
Crossbred sows
Boars or semen are only addition to herd
Less risk of bringing disease into herd
100% hybrid vigor in market pigs
Uses breeds where their strengths exist
 (terminal or maternal)

Disadvantages

Somewhat complicated to manage
Requires about 200 litters per year to work
Less than 100% hybrid vigor in sows
Less genetically uniform pigs from year to year and within a year
Maternal white barrows and cull gilts may require a separate market

Each system has its own advantages and disadvantages. Beginning niche pork producers should use either the terminal or rotation approach, based on whether they plan to raise or purchase replacement gilts. Remember to always isolate incoming breeding stock for 30-60 days and consult with your veterinarian about tests and vaccinations before mixing the new stock with your herd.

Additional Resources

Iowa Pork Industry Center. 109 Kildee Hall.
Iowa State University, Ames, IA, 50011.
515-294-4103.
in Iowa: 1-800-808-7675
<http://www.ipic.iastate.edu/about.html>

U.S. Pork Information Gateway
<http://pork.porkgateway.org/web/guest/home>

Diagram 2. Rotation System

