1975

Swine Selection and Breeding Programs

Cooperative Extension South Dakota State University

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Recommended Citation
South Dakota State University, Cooperative Extension, "Swine Selection and Breeding Programs" (1975). SDSU Extension Fact Sheets. 699.
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Swine Selection and Breeding Programs
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Extension Swine Specialist

Swine Selection

Crossbreeding for More and Heavier Pigs Per Litter

In attempts to make selection more effective, swine breeders have become increasingly conscious of the importance of a good swine breeding program and of the part that heredity plays in improving performance and carcass quality.

Breeder no longer select breeding stock on the basis of growth alone. Modern selection programs emphasize performance records and carcass cut-out values. This is desirable because research has indicated that visual inspection alone cannot identify animals which are genetically superior.

Good feeding and management can result in larger, faster growing litters. However, these improvements in nutrition and management do not become a part of a hog's inheritance and are not automatically transmitted to the next generation. Lasting improvement is brought about by selecting parent stock with the best inherent makeup. This type of improvement depends on the use of performance information obtained through systematic testing and record keeping.

Selecting Breeding Stock

You don't create new inheritance in animals. You devise ways of finding animals that are superior in the desired traits because of their genetic makeup, and then mate these animals to combine the best qualities of both into the offspring.

Variations in livestock occur because of heredity and environment influences. The problem is to determine which one is largely responsible. Heritability estimates for various traits give a general idea of this.

Differences in growth rate of pigs up to 5 months is about 30% heritable. This means that approximately 30% of the variation in growth rate among animals in the herd is due to differences in inheritance and approximately 70% is due to differences in environment.

Variations due to environment are not transmitted from parents to offspring, but they may conceal variations due to heredity. Therefore, you must keep environmental conditions as constant as possible when comparing prospective breeding animals.

Pay the most attention to the highly heritable traits in the breeding program. Heritability is the portion of the average superiority of selected parents that is passed on to their offspring. It estimates the proportion of the total variation in animals that is due to hereditary differences. Heritability estimates are made after removing as many causes of environmental variation as possible. When we say percent of ham is 60% heritable, we mean about 60% of the ham weight variation is due to heredity differences and 40% is due to differences in environment.

Heritabilities are usually referred to as being high, medium, or low. The key to greatest improvement for lowly heritable traits is improved management. Crossbreeding and mating less closely related parents are also likely to improve traits of low heritability.

The average estimated heritabilities for some economically important traits in hogs are shown in Table 1.

The estimates show that sow production traits are of low heritability, so improvement of these traits by selection is slow. Improvement in management will be most effective in improving sow productivity traits.

Growth rate and feed efficiency have moderate heritabilities and are easier to improve than sow production traits.

Measures of carcass merit are the most highly heritable traits in hogs. This is demonstrated by the rapid changes made by progressive breeders in developing meat-type hogs.

Table 1. Heritability Estimates

<table>
<thead>
<tr>
<th>Trait</th>
<th>Heritability Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcass length</td>
<td>60%</td>
</tr>
<tr>
<td>percent ham (based on carcass weight)</td>
<td>60%</td>
</tr>
<tr>
<td>percent fat cuts (based on carcass weight)</td>
<td>60%</td>
</tr>
<tr>
<td>backfat thickness</td>
<td>50%</td>
</tr>
<tr>
<td>loin eye area</td>
<td>50%</td>
</tr>
<tr>
<td>percent lean cuts (based on carcass weight)</td>
<td>35%</td>
</tr>
<tr>
<td>feed efficiency</td>
<td>30%</td>
</tr>
<tr>
<td>growth rate (weaning to market)</td>
<td>30%</td>
</tr>
<tr>
<td>five-month weight</td>
<td>25%</td>
</tr>
<tr>
<td>weaning weight</td>
<td>15%</td>
</tr>
<tr>
<td>number farrowed</td>
<td>10%</td>
</tr>
<tr>
<td>number weaned</td>
<td>10%</td>
</tr>
<tr>
<td>birth weight</td>
<td>5%</td>
</tr>
</tbody>
</table>

Using Heritability Information

To use heritability information to predict expected progress through selection, assume that the loin eye area for your present pig crop is 3.9 square inches at 200 pounds, and replacement gilts selected for your breeding herd from this group average 4.5 square inches of loin eye area. These gilts are mated to an on-the-farm tested boar from your herd raised under similar conditions. The boar measured 4.9 square inches of loin eye area. (Measurements determined by Sonoray animal tester.)

The gilts saved had 0.6 square inch more loin eye area than the herd average (4.5 - 3.9 = 0.6), and the boar had 1.0 square inch more (4.9 - 3.9 = 1.0). This difference between the selected breeding stock and the average of the herd from which they were selected is called the selection differential. Comparisons of selection differentials are valid only when pigs are from the same population and are raised under similar conditions.

By selecting breeding stock with more loin eye area, a breeder attempts to increase the loin eye area of his herd. In the case of loin eye area, only 60% of the selection differential is inheritable and could be expected to transmit to the offspring.

The predicted average loin eye area for the next pig crop resulting from these matings is calculated in this manner:

\[
\text{Predicted Av. Sq. Loin Eye Area in Next Pig Crop} = \left( \frac{0.6 + 1.0}{2} \right) \times 0.60 = 4.38
\]

Traits to Consider in Selection

Sow productivity, gain and feed efficiency carcass merit, and soundness are generally considered to have the greatest economic importance in hog production.
SOW PRODUCTIVITY

Sow productivity is a measure of reproductive ability (productivity), milking ability, and mothering ability. Number of pigs farrowed and weaned and individual pig and litter at weaning are the most common measures of sow productivity. Perhaps litter weaning weight is the best single measure.

Litter weights at 3 to 5 weeks of age are a better measure of milking ability than weights at 6 to 8 weeks. Get litter weights at an age that fits your management procedures and your breed association’s production registry programs.

RATE OF GAIN AND FEED EFFICIENCY

Faster gaining pigs reach market weight at an earlier age which should reduce production cost.

Heritability of rate of gain is moderate and permits reasonable improvement by selection. For example, if boars and gilts that weigh 30 pounds above the herd average at 5 months are selected (25% heritable), 7.5 pounds improvement can be expected in their offspring.

Rate of gain is often used as an indirect measure of efficiency of gain. Faster gaining pigs usually require less feed per pound of gain. By selecting the fastest gaining individual you indirectly select the most efficient one. This method is considered more practical than direct selection for feed efficiency.

When possible, keep the farm feed conversion records on a litter basis or on a representative sample of the herd. Entering representative samples of pigs by the same boar at the swine testing station to be fed out under uniform conditions has also provided helpful feed efficiency information.

CARCASS MERIT

Backfat thickness, loin eye area, yield of lean cuts and length are associated with carcass merit. Average heritability for these carcass traits ranges from 35 to 60% indicating that considerable progress can be made through proper selection.

Backfat thickness and loin eye area can be measured quite accurately on the live hog. Probing the pig at 200 pounds gives a good indication of backfat thickness. Recent use of ultrasonic equipment on live hogs at approximately 200 pounds indicates that there is also a good possibility of determining loin eye area to the extent that this measurement will be helpful in making selections for herd replacements.

Yield of lean cuts and carcass length can be measured and appraised only on slaughter hogs, so carcass merit measurements must be made in relatives to stock selected for breeding.

QUALITY SCORE

These scores will enable breeders to evaluate their animals as to quality. The loin will be used for scoring marbling and color and firmness as follows:

Marbling
1. Practically devoid
2. Traces to small amount
3. Moderate
4. Slightly abundant
5. Very abundant

Color and Firmness
1. Very pale, soft, watery
2. Pale, moderately soft and watery
3. Grayish pink, moderately firm and dry
4. Somewhat dark, quite firm and dry
5. Dark, very firm and dry

SOUNDNESS

Consider underlines, feet and legs, and freedom from abnormalities in selecting breeding stock.

Mammary development characteristics are heritable. Consider number and spacing of nipples in selecting both boars and gilts. Most breeders consider 12 well-spaced and well-developed nipples a minimum. Breeding stock with inverted or blind nipples should not be saved.

Straight, well-placed, sound feet and legs are a must especially where hogs are raised on concrete. Select hogs with a wide stance both fore and rear, short pasterns, and heavy bone. Much foot and leg trouble can be avoided by selecting parents sound in these respects.

Abnormalities such as shakers, hernia (either scrotal or abdominal) or cryptorchism (one or both testicles retained in abdomen) occur often enough to deserve attention. Breeders concerned with these abnormalities should cull both parents and the litter in which the condition appears.

How to Probe

Wrap your knife or scalpel blade with tape ¾ inch from the point to keep it from going too deep. Then hold the hog in a squeeze chute or with a nose holder and pierce skin at (1) mid-point of shoulder above elbow, (2) at last rib, and (3) halfway between last rib and base of tail. Make all probes 2½ inches to the side of the midline of back and crossways to the pig.

Insert steel ruler in cut (one probe should be measured before another is cut) and slant bottom end toward middle of pig’s body, forcing ruler through fat down to the muscle. Push the clip of the ruler against the skin, remove the ruler, and read the measurement.

When to Probe

Probe at weight from 175 to 225 pounds when hogs are on a standard finishing ration of grain and supplement. Probes will not be as reliable in predicting gilt and boar performance if taken when they are on a restricted ration, or if they weigh less than 175 pounds or more than 225.

Using the Information

COMMERCIAL HERDS

First sort gilts from the barrows. Identify and cull obviously poor ones. Collect the probe and weight figures on the remaining gilts and adjust, using the probe and age at 220 pounds adjustment charts. See Figure 10.

After the figures are standardized, arrange the gilts in the order of their weights with the heaviest at the top and the lightest at the bottom. Then cull the low 40% of those weighed. Keep the leanest half of the remaining 60%.

PUREBRED HERDS

Cull unsound boars, then probe and weigh all sound boars. Cull the gilt herd visually; then probe and weigh the remaining gilts. Adjust the age at 220 pounds and backfat measurements. Use the same procedure with the gilts in purebred herds as with commercial herds.

Boars are leaner than either gilts or barrows, and gilts are leaner than barrows. Therefore, in order to produce lean barrows, you must use leaner boars and gilts.

Remember, the most effective selection will be made under full-fed conditions. A limited-fed boar which measures 1.3 inches backfat is genetically a fatter boar than he measures.

Your Goal in Selection

Putting your records to use in selecting the right boars and gilts is your ultimate goal.

The above guide is the ultimate in selection possibility. It may be necessary to settle for replacement animals that have slightly lower performance standards. Set your goals in light of what you know about your herd. If you wish, use this standard for selection: select or keep no boars or gilts with 180-day weight less than 200 pounds.

BUTCHER ANIMALS

Yields of lean cuts (ham, loin, picnic, and Boston butt) determine the type of butcher hogs produced. Table 3 lists the percent required for the various types (grades) of butcher hogs on a live and carcass basis. All carcasses should measure 29 inches or more in body length.
Figure 1. Probing tools include a snare, a knife or scalpel, and a thin steel ruler graduated in tenths of an inch.

Figure 2. Probe at midpoint of shoulder above elbow, at last rib, and halfway between last rib and base of tail. Make all probes 2½ inches to the side of the midline of back and crossways to the pig.

Table 2. Suggested Guide to Use for Selecting Breeding Stock

<table>
<thead>
<tr>
<th>Boars</th>
<th>Gilts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Litter size</td>
<td></td>
</tr>
<tr>
<td>8 or more</td>
<td>8 or more</td>
</tr>
<tr>
<td>Age at 200 pounds</td>
<td>150 days or less</td>
</tr>
<tr>
<td>Teats on underline</td>
<td>12 or more</td>
</tr>
<tr>
<td>Feet and legs</td>
<td>Wide stance, both fore and rear, short patterns and adequate bone</td>
</tr>
<tr>
<td>Pounds of feed required per cwt. gain</td>
<td>Less than 320</td>
</tr>
<tr>
<td>Probed backfat thickness at 200 pounds</td>
<td>Less than 1.2 in.</td>
</tr>
<tr>
<td>Carcass length 29 in. or more</td>
<td>29 in. or more</td>
</tr>
<tr>
<td>Backfat thickness 1.3 in. or less</td>
<td>1.3 in. or less</td>
</tr>
<tr>
<td>Loin eye area At least 4.5 sq. in.</td>
<td>At least 4.5 sq. in.</td>
</tr>
</tbody>
</table>

Table 3. Determining Butcher Hog Grades by Percentage of Four Lean Cuts in Live and Carcass Weights

<table>
<thead>
<tr>
<th>Types (grades)</th>
<th>% of 4 Lean Cuts Based on Live</th>
<th>% of 4 Lean Cuts Based on Carcass Wt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat-type</td>
<td>36 and up</td>
<td>52 or more</td>
</tr>
<tr>
<td>Good or average</td>
<td>34-35</td>
<td>48-52</td>
</tr>
<tr>
<td>Fat hogs</td>
<td>Less than 34</td>
<td>Less than 48</td>
</tr>
<tr>
<td>Medium and culls</td>
<td>Lean but lack muscling and quality</td>
<td></td>
</tr>
</tbody>
</table>

LOIN EYE

Loin eye area, measured between the 10 and 11 ribs, is a common measure of carcass meatiness. Figure 5 shows how loin eye is measured and Figures 6 and 7 are actual size loin eyes ranging from approximately 2.80 square inches to 6.08 square inches.

The aim is to get the highest proportion of the carcass in the higher priced cuts—the ham and loin. Yield is often expressed as percentage of four lean cuts (ham, loin, shoulder, and Boston butt). However, percent ham and loin is more easily obtained and is presently the preferred measure for meatiness.

Carcass length also is normally included as a desirable carcass trait, but has little relation to muscling in the carcass. A medium to long carcass may be desired for other reasons, but length should not be overemphasized to the detriment of other traits.

Sex of the pig also affects muscling. On the average, gilts are longer, have less backfat, larger loin eye area, and a higher percentage of ham and loin than their litter mate barrows.

On-the-Farm Testing

On-the-farm testing is designed to help swine producers select from their herds breeding stock with the ability to produce large, fast growing litters which are superior meat hogs. These testing programs are not hit and miss tangents that have little practical or profit making value. They are sound, proven plans that provide tools to help each producer make continued progress and earn extra dollars. The plans outlined below may not fit all needs, but the producer who follows as many phases as are possible will be providing the means for today's most modern and useful swine selection program.
Carcass length and backfat thickness measurements. Length is measured from the lower point of the aitch bone to the forward edge of the first rib next to the backbone. Backfat is measured opposite the first rib, last rib, and last lumbar vertebrae. The average of the three backfat measurements is used.

A band saw is the ideal implement with which to cut the loin between the tenth and eleventh ribs. Start cut at the end of the tenth rib. Cut the loin at a right angle—straight across. Do not follow rib. The tenth rib should always be marked before the loin is removed as usually three ribs are left in the shoulder when it is severed.

Figure 3. Carcass length and backfat thickness measurements. Length is measured from the lower point of the aitch bone to the forward edge of the first rib next to the backbone. Backfat is measured opposite the first rib, last rib, and last lumbar vertebrae. The average of the three backfat measurements is used.

Figure 4. A band saw is the ideal implement with which to cut the loin between the tenth and eleventh ribs. Start cut at the end of the tenth rib. Cut the loin at a right angle—straight across. Do not follow rib. The tenth rib should always be marked before the loin is removed as usually three ribs are left in the shoulder when it is severed.

Figure 5. A planimeter is used to measure loin eye area. Loin eye area is measured between the 10 and 11 ribs after the carcass has chilled correctly for 24 hours. The loin is cut at an exact right angle and the short end of the loin is set on a table with the newly exposed loin eye at the top. A piece of acetate paper is then placed over the exposed loin eye and the main muscle is traced. Only the loin muscle and not the adjacent lean area is included in this measurement.
PLAN 2: PROCEDURE FOR COMMERCIAL PRODUCERS

The modern day, progressive commercial producer insists on obtaining a boar from a purebred herd that has performance records available on those traits that are most important for continued improvement in his herd. This information determines whether or not the boar he selects is superior to the average of his present herd. By selecting a boar that is superior to the average of his herd and by selecting replacement gilts in the same manner, the producer can then expect continued progress. He is combining those improved traits of both animals selected into the offspring that are produced. To assist in evaluating his herd and to aid in selecting the most productive gilts, a commercial producer might consider the following plan:

At Farrowing—
1. Identify pigs in outstanding litters and record litter birth date.

At Weaning—
1. Keep feed requirement information on representative group or groups of hogs on the farm (follow the “keeping feed record plan” listed under Plan 1 for purebred herds). All gilts being considered for replacements should be handled under the same environment so that selection can be made on existing genetic differences.

At 175 to 200 Pound Weight Range—
1. Sort ear-notched gilts from market herd. Cull all off-type and unsound gilts.
2. Weigh prospective herd replacement gilts. Figure weight for age (200 pounds at 165 days or less).
3. Probe herd replacements.
4. Obtain carcass cut-out information on at least 10 head. Pairs of littermates sired by the same sire would make a good representative sample of the herd.
5. Determine final selection on basis of available records and soundness.

Next farrowing continue to follow the above recommended selection and testing program.

CROSSBREEDING FOR MORE AND HEAVIER PIGS PER LITTER

The majority of all hogs produced in South Dakota are crossbred. The three-breed rotational cross is perhaps the most widely used crossbreeding system. In this system boars of three different breeds are continually rotated in succession on each generation of crossbred sows produced in the program. This system is diagrammed.

It is a continuous rotation of boars from three breeds, mating the gilts and sows in each generation to boars of the breed farthest removed in their pedigree. It is rather simple to follow and since all sows and pigs are crossbred it should yield heterosis in litter size, livability, and growth rate.

Base the choice of breeds to include in rotational breeding on availability of tested boars and knowledge of how the various crosses perform. If you have no experience involving various crosses, remember that breeds that perform best as purebreds will generally produce the highest performing crossbreds.

BOARS USED

REPLACEMENT GILTS

Repeat cycle using boars of breeds B, C, and A in rotation.

Figure 6. An approximately 2.80 square inch loin eye area, actual size.

Figure 7. An approximately 6.08 square inch loin eye area actual size. The actual size of the muscle can be altered by careless handling. Extra care is necessary for accurate measurement.

Figure 8. Three-breed rotational crossbreeding system.
Figure 9. Chart for measuring age at 220 pounds. Lay a ruler or any straightedge from a point on the left scale, which represents the age of the pig, to a point on the right scale, which represents the pig's weight. The intersection of this line and the center scale shows the estimated age of the pig when his weight is 220 pounds.

Figure 10. Backfat probe adjustment chart, 220 pounds live weight. Lay a rule or any straightedge from a point on the left scale, which represents the weight of the pig when probed, to a point on the right scale, which represents the total of the three probes. The intersection of this line and the center scale shows the estimated average backfat thickness at 220 pounds.

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