pork industry handbook

AGRICULTURAL EXTENSION SERVICE • UNIVERSITY OF MINNESOTA • ST. PAUL, MINNESOTA

Selection Guidelines For The Seedstock Producer

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The seedstock industry is undergoing a revolution which emphasizes supplying genetic material to more adequately meet the needs of the commercial producer. This is the sole purpose of its existence. The dynamic nature of the commercial industry has dictated the need for this change and for reassessment of priorities by the seedstock supplier. If the progressive seedstock producer expects to continue to be a viable force in the pork industry, his goals should include the following:

- Supply the genetic material for the production of healthy, fast growing, efficient, lean and high quality pigs.
- Provide animals capable of conceiving and raising large litters of uniform, thrifty pigs.
- Produce seedstock with the structural soundness necessary to breed and perform under a wide range of environmental conditions.
- Maintain sufficient production volume to insure year-round availability of stock.
- Provide seedstock that will permit the commercial producer to maximize heterosis and utilize the superior characteristics of each breed or strain through systematic use of them in a crossing program.

Traits to Measure

Sow Productivity Traits

Litter size, number reared per litter, total litter weight at 21 days and litters per sow per year have generally been considered lowly-heritable traits. Because of their immense economic importance, these traits can be improved upon or maintained at satisfactory levels within seedstock populations by removing families extremely low in performance, keeping the rate of inbreeding low, and selecting sows with superior records. Some selection pressure on litter size is automatic since more selection choices exist in larger litters.

Attention to these traits is warranted, especially in breeds chosen by commercial producers primarily for their desirable maternal characteristics. Equalizing litters, when possible, to approximately 10 live pigs to provide every sow with the opportunity to raise a standard number and to provide subsequent measurement of 21-day litter weight (a trait largely a function of milk production) should provide an equitable method for measuring mothering ability. This also provides an opportunity for young gilts to develop unhampered by the "competitive effects" of being raised in very large litters.

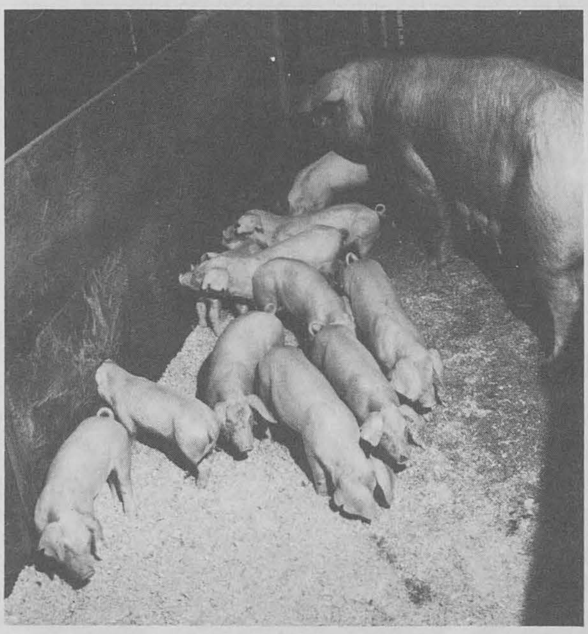

Figure 1. Number of live pigs farrowed is a measure of prolificacy.

Emphasis on number of live pigs farrowed per litter (NBA) is a measure of prolificacy. (See Figure 1). This

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should be combined with 21-day litter weight adjusted for age of dam and age at weighing (LW21) to form a sow productivity index. One such index developed by Ohio workers is I = 6.5 NBA + LW21. Prior to computing this index, litters are adjusted to weight at 21 days of age by adding 9 lb. to gilt and 10 lb. to sow litters for each pig less than 10 that the female is allowed to nurse. Adjustments for numbers in excess of 10 are not necessary.

Due to environmental differences between farrowing groups within the same farm, sow performance should be evaluated relative to the contemporary average. This is done by expressing the sows record as a ratio to the group average. Such an evaluation permits ranking of sows from various farrowing groups.

The heritability of a given trait on the same sow increases with the number of records. If the sow productivity index (SPI) is 20% heritable with a single record, the average of two records is 32% heritable; for three, the average is 40%, for four 46%, and for five 50%. Additional records improve the reliability of a sow's estimate of breeding value, but the contribution of each additional record becomes less.

Production Traits

Both growth rate and feed efficiency are economically important to most swine enterprises, and their heritabilities are of sufficient magnitude to respond to selection. Every seedstock producer should have a scale with which to measure weight for age. (See Figure 2.) It matters little

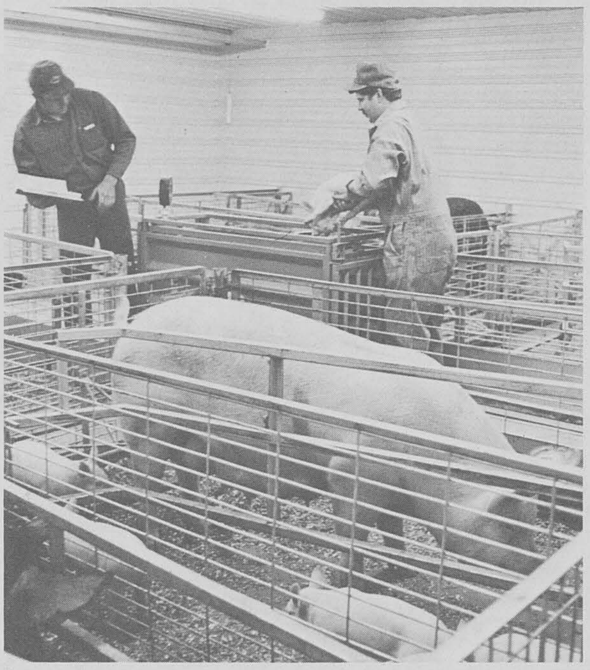

Figure 2. Weighing at 21 days. (Photo credit: National Hog Farmer magazine.)

whether growth rate is expressed as days required to reach a given weight, average daily gain, or as weight at a fixed age. What is important is that growth rate is measured in an accurate manner and carefully adjusted to some constant basis, such as days to 230 lb.

Feed costs generally account for 60-70% of the total production costs of the commercial producer. A superior boar can save a producer several tons of feed through improved efficiency of his offspring. With the long-term prospect of increased feed prices, feed efficiency is likely to receive increased attention in the future.

Two alternatives for improvement in feed conversion can be compared:

Method 1. Testing of individual pigs for gain and backfat without feed records.

Method 2. Testing of individual pigs or littermate pigs with feed efficiency records.

The simple performance test (Method 1), which can be carried out with facilities presently available on most farms, will lead to feed efficiency improvement. This improvement occurs since faster growing pigs tend to be more efficient. Also, leaner pigs tend to be more efficient. Hence, desirable genetic relationships between these traits permit progress in feed conversion without feed records.

Research data show that Method 1 would be about 70% as good as keeping feed records (Method 2) on 3 littermate boars fed together. One has to weigh the cost of littermate feed efficiency measurement against the extra improvement it permits. Clearly, it is more costly in terms of labor and facilities to test for feed efficiency. A surprising and desirable situation exists in that feed efficiency on 3 littermates is actually as good in predicting siring ability of each penmate as information provided by testing each pig singly. This is because the information provided by his littermates is almost exactly equal to the loss in accuracy of having 3 boars in a pen. A breeder needs to decide to test for feed efficiency on a litter basis or else forget it. A group of 10 boars from various litters would tell us very little other than the possible data one could get on sire groups. Absolute feed efficiency records should never be compared from one herd to another. Only comparisons among contemporary groups managed similarly and fed at a single location on the farm and/or at a central testing station provide meaningful measures of genetic differences. (See Figure 3.)

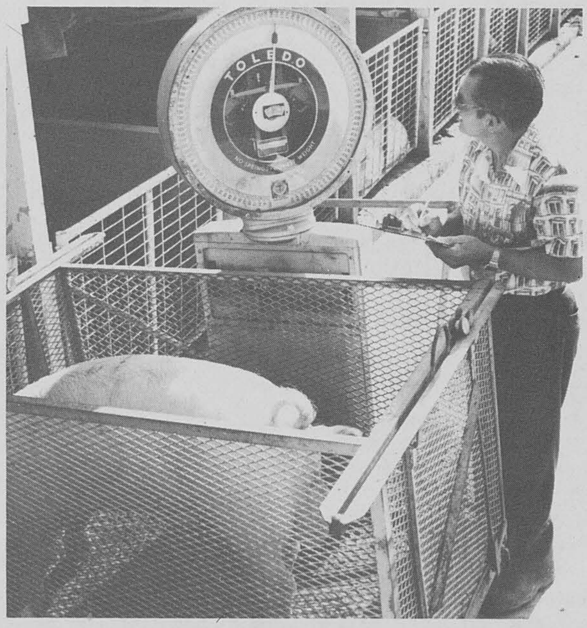

Figure 3. Weighing pigs at a central testing station.

Carcass Traits and Ultrasonic Measures

Ham-loin and lean cut percentages of pork carcasses are highly related to carcass value. Fortunately, these measures of composition can be reliably predicted by live backfat measured with either a metal ruler or ultrasonics.

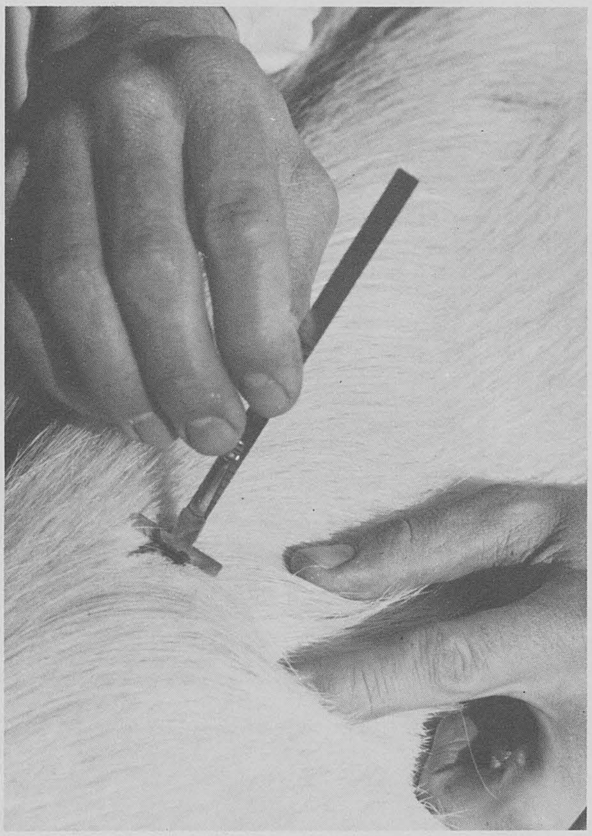

Figure 4a. Metal ruler measuring backfat thickness.

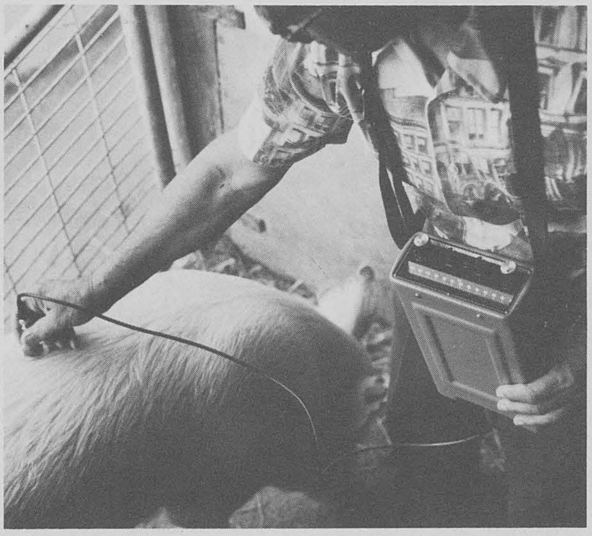

Figure 4b. Ultrasonically measuring for backfat thickness.

(See Figure 4.) The accuracy of fat measurement in the live hog is generally accepted by the industry. Recent reports reveal that the backfat probe, even in meatier herds where variation in backfat cover has been drastically reduced, accounts for approximately 50% of the differences in ham-loin percentages. In fact, numerous reports have demonstrated the probe to be a better predictor of carcass merit than corresponding measurements taken on the midline of the carcass. In extremely meaty animals, backfat is considerably thinner at the probe site than over the midline, whereas this difference in backfat is not as pronounced in less meaty hogs.

The measured value of the backfat probe is commonly 0.1-0.2 in. less than that of the carcass. This should not be alarming for they are measurements taken at different points. The shoulder probe is normally taken at a point 2 in. off the midline at a position directly above the point of the elbow or front flank. This corresponds to approximately the 5th or 6th rib and not the first rib where shoulder backfat is measured in the carcass. A second difference stems from probe measurements being taken 1.5-2 in. off the midline, whereas the carcass measurement is taken on the midline. This variation in procedure between the two methods in meaty hogs can account for a difference of a least 0.1 in. at the last rib probe site. When adjusting backfat probe of boars to a barrow equivalent, about 0.4 in. should be added. About one-half of this adjustment is for sex influence and the remaining half is the probe vs. carcass difference. In spite of the errors in measurement that may sometimes occur, the effectiveness of this tool for swine improvement has been limited more by its lack of use than by its application.

Fat measures taken by ultrasonics have proved to be of value, but extreme care should be taken in putting too much emphasis on loin eye measurements so obtained. The industry has been "oversold" on the value of loin eye area in the past. Even in one of the most accurate studies reported, loin eye area estimated by ultrasonics accounted for only 25% of the variation in ham-loin percentage. Also, live animal ultrasonic estimates have produced poor agreement when compared with carcass data. Part of this difference is due to errors in measuring carcass loins in the same manner as live estimates were obtained. Ultrasonic instruments have been developed which estimate loin area with slightly greater precision. However, these have proved to be more costly and to require more time in obtaining the estimates. Hence, these instruments have been largely abandoned in the U.S. Today, less sophisticated ultrasonic machines have seen wide-spread use. These give loin readings based on easily read loin depths. Deep loins on a weight-constant basis tend to have larger areas, so an experienced operator can separate animals with larger loin areas from those with smaller areas within a herd. Depth of the loin eye in inches, measured at approximately the 10th rib, 1.5 in. off the midline and perpendicular to the curvature of the back, is multiplied by approximately 2.5 to produce an estimate of square inches of eye muscle. For example, a loin 2 in. in depth could be expected to measure approximately 5 sq. in. in area. Selection of potential breeding animals with the largest loins should be considered within test groups in the same herds. Comparing loin areas between herds is not recommended unless measured at comparable weights by the same operator using the same instrument.

Quantitative Carcass Traits and the Porcine Stress Syndrome

Field reports suggest the frequencies of pale, soft and exudative (PSE) pork carcasses and of death due to the porcine stress syndrome (PSS) are lower today than 10 years ago. However, these problems still persist and can be severe in herds selected for extremes in muscling and/or those not utilizing objective tests to select against the malady.

Recent reports substantiate the single recessive gene theory earlier proposed for the inheritance of PSS.

Furthermore, it has been verified that most PSS pigs produce carcasses that are PSE, although other causes of poor quality muscle are known.

Ridding the swine population of the stress gene would appear nearly impossible since our present state of knowledge will not permit identification of the normal carrier individual. However, preventing PSS pigs from becoming herd replacements will lower the occurrence of affected offspring. Creatine phosphokinase (CPK) testing has proved to have the best applicability in the field for this purpose, especially if the animals are severely stressed prior to blood sampling. Visual appraisal can be quite accurate when used by trained personnel, but the risk of discarding heavy muscled but nonstress susceptible animals is high. Halothane testing is the accepted test in most European countries and, although it is the most accurate test known, it is considered too expensive and time-consuming for general use in the U.S.

It appears certain that direct selection against this problem is warranted since comparative tests of normal and PSS positive littermates show the positive animal to be both leaner and more efficient than his normal mates. Although the normal pigs are faster in rate of growth, indexes of merit, such as that recommended by the National Swine Improvement Federation (NSIF), slightly favor the stress animals.

Structural Soundness

One of the great needs of the swine industry is for more sound, durable breeding animals capable of withstanding the rigors of confinement rearing and breeding. Breeders commonly consider unsoundness as one of the results of confinement, but in truth, confinement rearing only makes this trait noticeable. A sound pig reared on pasture or dry lot may be an unsound pig in confinement. Some seedstock producers raise them in confinement, similar to the manner in which most commercialmen will produce their offspring, and then cull the unsound ones.

One of the overlooked advantages of test stations may be the attention they place on leg soundness. This may be the severe test needed to identify the genetically sound animals. When some pigs in a test group stay sound and others, handled and fed similarly, are unsound, visual selection for soundness is possible. Recent studies report soundness to be medium in heritability and hence amenable to improvement through selection. Soundness should be an easy trait to improve through visual selection if breeders decide to cull restricted, peggy, unsound boars lacking the proper flex at the hock, set of the shoulder, even toe size, or proper curvature and cushion to the forearm and pastern.

Visual Traits

Caution should be exercised to insure that breeders do not place too much emphasis on "indicators of performance" instead of measuring performance itself. Some traits, such as structural soundness, length of body, underlines, general conformation and presence of physical defects, can only be evaluated visually on the live animal. Appraisal of animals with outstanding performance will train the keen observer to make selections among animals lacking performance figures or to make meaningful selection among animals from different herds. Biased or erroneous measurements can sometimes be uncovered by a watchful eye. Performance records, in addition to "eyeball appraisal," should be better than either method by itself.

The Basis for Selection

The seedstock producer must have clear goals and a definite plan for his breeding program. His main objective must revolve around producing what the commercialman needs. The average seedstock producer must have this goal foremost in mind and that of selling to other breeders a distant second. If the first objective is met, the second should follow automatically.

Selection represents the only directional force available for creating genetic change. No shortcut exists. With perhaps at least 50,000 pairs of genes, one can appreciate the complex genetic composition of an animal. Selection can be simply thought of as increasing the number of good genes and decreasing the bad genes. Most economic traits are controlled by hundreds of gene pairs. Therefore, the odds of getting all gene pairs in any perfect combination by chance is virtually impossible. Only purposeful selection will permit an increased frequency of desirable genes. This process is impaired because both genetics and environment make pigs different. The latter includes all aspects of health, nutrition and management and masks the accurate evaluation of the genetic potential of an animal.

Breeding Program Essentials

Performance Records Under a Standard Environment

Records are valuable when used in the breeding program, while those obtained only for promotion are eventually self-defeating. The primary reason for obtaining records should be to improve accuracy of selection. To be of value, records must be obtained under a comparable environment. The breeder who gives a small group of pigs preferential treatment is deceiving only himself. If this procedure is used, the breeder can no longer compare accurately even the individuals in his own herd, and records thus obtained will yield false conclusions.

The ultimate objective in an improvement program is to predict an animal's breeding value. Breeding value is a measure of the animal's ability to transmit desired genetic traits to the resulting offspring. Proper records on the individual and on his/her relatives can help a great deal in predicting breeding value.

Heritability estimates are medium and high for performance and carcass traits, respectively. Genetic principles indicate that the most rapid rate of improvement for these traits is through measurement and subsequent selection based on the performance of the individuals being considered for selection. Thus, the breeding value of an animal for most traits can be predicted at the young age of 5-6 months and will generally result in more rapid genetic progress than a selection scheme based on sib or progeny tests or on pedigree information. Regardless of types of facilities available, individual performance tests can be conducted on the farm if all animals are handled similarly. On-the-farm testing is essential to a program of rapid genetic improvement since it permits testing of a larger sample of the potential breeding population than is possible in central testing stations.

The principle of using on-the-farm records to identify the genetically superior animals is quite simple. It is a matter of standardizing environment and then measuring the traits to provide an estimate of the animals' potential breeding value. If an animal is better because of environment, he will breed worse than he himself appeared. If he received a poorer than average environment, he will probably breed better than he appeared. Therefore, it is important to determine if an animal is better because of environment or genetics. In comparing animals in different herds, this presents a problem.

Table 1. Ratio Concept to Evaluate Different Environments.

Herd Information	Animal	Days to 230 lb.	Ratio to herd avg.	Rank
Herd A	1	170	88	6
(Avg. 150 days/230)	2	150	100	4
	3	139	108	2
Herd B	4	150	113	1
(Avg. 170 days/230	5	168	101	3
	6	187	91	5

Table 1 illustrates an important concept for ranking animals in different herds or environments through use of the ratio concept. For instance, one can answer the question of which is the genetically superior boar for days to 230 lb. Is it boar 3 who reached 230 in 139 days or is it boar 4 who reached 230 in 150 days? By knowing the average performance of the herd, one can use the following formula for calculating a ratio:

$$\text{Ratio (superiority)} = \frac{\text{Herd Average}}{\text{Individual's record}} \times 100$$

Example

Boar 3 $\quad \text{Ratio} = \frac{150}{139} = 108$

Boar 4 $\quad \text{Ratio} = \frac{170}{150} = 113$

Because boar 4 scores 113 or 13% better than the average, he would be expected to be superior to boar 3 who scored 108 or 8% above average. One could conceivably use this concept to rank all 6 boars. It may surprise you to note that boar 6 who reached 230 lb. in 187 days is predicted to be superior to boar 1 who required only 170 days to 230 lb. Other traits can be evaluated in the same way. This method is valid because the greatest part of differences between herd performance are environmental rather than genetic.

To compare animals within a group more objectively, indexes have been developed by the NSIF for use in testing stations and farm programs. The index $I = 100 + 60$ (avg. daily gain - $\overline{ADG}$) - 75 (feed efficiency-$\overline{F/G}$) - 70 (backfat - $\overline{BF}$) allows comparison of boars tested at the same location as part of a similar test group. The Index $I = 100 + 110$ (ADG - $\overline{ADG}$) - 105 (BF - $\overline{BF}$) is recommended for on-the-farm testing where feed efficiency records are not obtained. Observe that each trait is deviated from the test group average for that trait and multiplied by a weighing factor. The average boar indexes 100. About 20% of the boars would exceed 120 index points, and 20% fall below the recommended minimum culling level of 80.

Exerting Selection Pressure

Only boars in the upper 10% of a herd in performance can be expected to be real improvers. Considerable variation exists within any herd. Many animals are average, a few are superior, and there will always be a few of which the breeder is not too proud. Selection differential or selection pressure is largely a function of percent kept. Identify those superior animals through use of records, and keep only the smallest possible fraction for maximum progress.

Rapid Generation Interval

If the same boars and sows are used in a herd without replacement, we will make no genetic improvement. The herd can go neither backward or forward, genetically. Replacing poor-producing sows with the most promising young gilts will speed genetic change, particularly if the sows are re-evaluated on the basis of their progeny and performance records to insure that the poorest are culled.

How fast you improve is determined by the formula:

$$\text{Improvement per Year} = \frac{\text{Heritability} \times \text{Selection Differential}}{\text{Generation Interval}}$$

The selection differential represents the superiority of the animals kept above the average of their contemporary test group. The generation interval is the average age of the breeding herd. Hence, turning over the herd as rapidly as possible while keeping the very best animals for replacement should constitute an optimal program for the seedstock producer.

The same rules apply to the herd boars that will provide 50% of the germ plasm for the next generation. Of course, not all young boars will be better than their sires. However, even superior sires, if kept too long, may hold back potential progress since their best performing sons, if from genetically superior sows, should have higher breeding values than themselves.

References

Additional references are available from National Swine Improvement Federation by writing 101 Peters Hall, Institute of Agriculture, St. Paul, Minnesota 55101. Publications include "Guidelines For Uniform Swine Improvement Programs," "Why Test?" and "Selection Indexes and Ratios."