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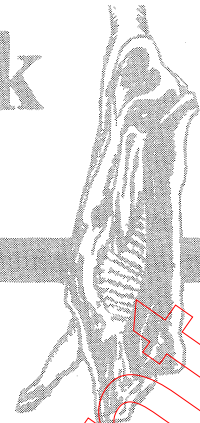
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Pigs to Pork



BREEDING

Cooperative Extension Service PURDUE UNIVERSITY Lafayette, Indiana



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Applied Swine Breeding Practices

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Most of the important economical traits in swine are affected by many pairs of genes. Since one pair of genes may result in six different genetic combinations; and since 243 possible combinations may result from five pairs of genes; the total number of possible genetic combinations becomes almost inconceivable because swine have nearly 50,000 different genes. The many possible combinations partially explain why it is so difficult to develop breeding principles for rapid improvement.

Nevertheless, basic research in genetics and animal breeding has led to great progress in livestock improvement through approved breeding practices.

Improvements in heredity are permanent--each generation builds upon the previous one. But, genes cannot express themselves to their fullest without an excellent environment. Genes establish the blueprint of maximum capabilities of the animal. The environment determines the degree of maximum capability which is realized. Neither, alone, can do the job; but, collectively, the horizons are unlimited.

The basic tools of genetic improvement are selection, crossbreeding and inbreeding. How much a swine breeder can use these tools depends upon his basic understanding of genetic principles and the factors involved in each method.

SELECTION

Major emphasis is placed on selection because the average breeder can still make

more progress through selection than with crossbreeding or inbreeding. And, when crossbreeding or inbreeding, selection must still be emphasized.

Selection is defined as causing or allowing certain animals to reproduce offspring. Two kinds of selection are often discussed--natural and artificial. Natural selection occurs in nature and has played an important role in the development of our species. Artificial selection has been practiced by man with domestic animals. Here, it must be remembered that man does not create new genes; he merely changes the frequency of certain genes and attempts to generate superior combinations of genes in one individual.

Individuality--an Aid in Selection

Artificial selection is based upon three points--individuality, pedigree and progeny tests. An animal's individuality includes type (physical characteristics) and performance. This is phenotypic selection.

One disadvantage of using individuality in selection is that environmental effects could easily be mistaken for genetic effects. For example if one beef calf is creep fed and suckles a nurse cow and another has only dry pasture and the milk supplied by its mother, creep fed calf will appear superior. But, the creep fed calf might be genetically inferior to the non-creep fed and transmit less desirable characteristics to his offspring.

A very serious disadvantage of individuality is that for most species the relationship between an animal's type and performance is often lowly correlated. In other words, just because an animal wins his class at a fair there is no guarantee that he will put more red meat on the rail. One must select for both type and performance since the two are inherited separately.

Breed type is supposed to indicate purity or homozygosity of the animal and to show the characteristics for which the breed was developed. This is all well and good. No one questions the fact that breed type influences the selling price of an animal; but often superior animals are discarded because of color or other minor defects. It seems like a terrific waste of superior germ plasm to discard a good Hampshire hog because he does not have a white belt. We would be in reality disregarding perhaps 49,998 genes because of two.

When should one use individuality as a means of selection? One should always pay some attention to the animals individuality (type), because if for no other reason this is often what is sold in the sale ring. Also, when the heritability estimates for a given trait are over 30 percent, rapid progress can be made by selection based on the animals own individuality or performance. We are indeed fortunate that many of the more important carcass traits in swine are inherited to this degree (see Table 1).

What does the term heritability estimate mean? This question can best be answered by an example. Let us use the heritability estimate for length of carcass (61 percent). This means, on the average, 61 percent of the difference found between different animals within one herd in carcass length is due to genes and 39 percent due to the environmental conditions under which the animals were raised. These environmental conditions refer to differences in

nutrition, management practices, weather conditions and others.

Next, let us consider how one can use this information. If the average carcass length for the herd is 28 inches (about the Indiana average) and only animals with a 30-inch carcass were retained for breeding (approximate average of all hogs at the Swine Evaluation Station) then the difference or selection differential would be two inches. This example implies that by saving the longer hogs an attempt is being made to increase length by two inches. However, only 61 percent of this two inches is due to heredity. Two inches times 61 percent gives 1.22 inches. Adding this amount to the average carcass length of the herd gives an average of 29.22 inches. This, then, is the expected average carcass length of the next pig crop from the selected parents.

Pedigree-Another Selection Aid

What is a pedigree? For many breed associations it is only the names and registration numbers of the animal's ancestors. If one knows the breed well this is not as great a limitation as otherwise. Other limitations are as follows--offspring receive only 1/2 of their genes from each parent and one can not tell which genes were transmitted. The pedigree is limited because it has only the names of selected individuals and tells us nothing about the rest of the herd or the environment under which the animal was raised. The pedigree does not give us any information about the animals collateral relatives. One of the more serious limitations is that certain pedigrees often become popular because of fads.

With the adoption of the All-Breed Certification Program, the pedigree has taken on new importance. Currently the letters "CL" (Certified Litter) "CMS" (Certified Meat Sire) and/or "SMS" (Superior Meat Sire) are being included in the pedigree along with the name and number of the animal.

As the incidence of such ratings in the pedigree go up, the more assurance you have in the genetic worth based on ancestral background.

In spite of its limitations the pedigree could have a valuable place in selection. It could be used to correct errors due to environment. It is possible that the pedigree could be used to correct errors due to dominance, for example, selecting against the recessive genes for red coat color in Angus cattle or against dwarfism in beef cattle.

A few general conclusions can be drawn in regard to using the pedigree in selection. As a general rule the individuality of an animal is a much better choice for selection than the pedigree if a choice must be made. Use the pedigree if individuality of the animals is close. Normally little emphasis should be placed on animals over two to four generations back in the pedigree. The pedigree could also be of use when the trait in question is of low heritability, or when selecting breeding animals at an early age. However, selecting breeding stock when they are quite young is not a recommended practice.

Progeny Test--Most Recent Selection Aid

The progeny test determines the breeding worth of an animal by observing the offspring. It is the best way to determine the actual genotype of an animal. The progeny test must be used when selecting for sex limited traits, such as milk production. Carcass quality studies require the progeny test to give a true genotypic picture of breeding ability since it is necessary to slaughter animals to measure this trait.

There is no substitute for the progeny test when measuring a lowly heritable trait, that is when the heritability estimate is below 30 percent. Since the quality carcass

is one of the ultimate goals in pork production the progeny test is almost mandatory. The Swine Evaluation Station at Purdue is a form of progeny testing and the result could be of great value if the animals entered are selected properly. The following is a suggestion for setting up a progeny swine test. Let the letters A, B, and C represent three different boars. To test three boars, select 12 sows randomly. Boars should be tested in both seasons and the sows should be rotated. Below is a schematic diagram of a progeny test.

	Boars		
	A	B	C
	Spring Season		
12 sows	1	5	9
randomly	2	6	10
selected	3	7	11
	4	8	12
	Fall Season		
Same	9	1	5
12 sows	10	2	6
rotated	11	3	7
	12	4	8

Remember to make a random selection of the females, and rotate them so the best sows will not always be mated to the same boars. Choose the average pigs from each litter, this is necessary for a valid test. Use as many pigs as practical but not under two pigs from each litter, preferably four. Do not use only one sex, since gilts are known to produce better carcasses. Selecting all gilts will result in a less valid test. Select pigs from both spring and fall litters.

Although testing is a rather general word, progeny testing should be considered in specific terms. Testing results must be interpreted according to the methods used to obtain the information. Likewise it is important to consider if they passed the test and by how much the minimum standards were surpassed.

Some other points to consider are 1.) Where the tests were made, 2.) the ration fed, 3.) sex of the test pigs, and 4.) the age of the pigs on test. Interpret the progeny test data with common sense and use them as selection guides.

CROSSBREEDING

Various Agricultural Experiment Stations estimate that the commercial swine producer can expect a 10 to 20 percent increase in overall performance as a result of systematic crossbreeding over the production of straight bred pigs under the same conditions. Crossbred pigs are usually more vigorous and growthy than their purebred parents. This advantage in performance is referred to as hybrid vigor or heterosis and may be the result of increased heterozygosity or the pairing of unlike genes. The weak genes are strengthened--the favorable effects of the good genes mask the unfavorable effects of the poorer ones.

The crossbred sow seems to provide the largest benefits. In addition to increased overall performance, livability and growth rate, the crossbred sow usually has more pigs and is a better mother. The greatest benefit from crossbreeding seems to result from crisscrossing two breeds--using crossbred sows mated by a boar of one of the breeds involved in the sow's ancestry. Some have estimated that as high as 78 percent of the increased performance comes from such a system.

More than three breeds in the crossbreeding program is apparently of little advantage.

If crossbreeding is practiced, a systematic program must be followed. The three most common systems are:

1. Single cross--mating a sow of one breed to a boar of another. The pigs would

show the result of hybrid vigor but the great benefit derived from the crossbred sow would be lost. Also, the breeding stock would all need to be purchased or two breeds maintained in addition to the commercial hogs.

2. Crisscrossing--rotating boars of two breeds on crossbred sows of the same two breeds. One receives the benefit of the crossbred sow and needs only to purchase male breeding stock. Some feel this plan is the most practical from the record keeping standpoint, and also feel that it is easier to obtain good boars from two breeds than from more.

3. Rotation crossing--crisscrossing three or more breeds. The system results in the breeder rotating the boars of three or more breeds on cross bred sows of the preceding generation. This should give one the maximum benefit from heterosis. One disadvantage would be in obtaining superior boars when needed from several breeds.

INBREEDING

Inbreeding may be defined as the mating of animals more closely related than the average of the population. From the genetic standpoint inbreeding causes the animal to be more homozygous. One can expect the following consequences from inbreeding:

(a) An increase in prepotency--the ability of an animal to stamp his characteristics on his offspring.

(b) A revelation of recessive genes.

(c) Fixation of characteristics in a population.

(d) A separation of the population into distinct families.

(e) An expectation of a phenotypic decrease in vigor.

(f) A possible increase in phenotypic uniformity, if not too many genes are involved.

The following are sometimes listed as practical uses of inbreeding:

1. To keep the relationship high to some desired individual (unless one inbreeds, 50 percent is the highest possible).
2. To select against a recessive gene; inbreeding allows recessive genes to express themselves.
3. To check the actual genetic worth of an individual.
4. To economize, for example, when you own animals that are better than you can buy.
5. To increase the purity of your herd.
6. To form families within a breed.

However, if one decides to inbreed he should know why and what to expect. The following are possible dangers of inbreeding.

1. A decline in vigor usually occurs.
2. One might fix recessive genes, which could be undesirable.
3. One should know how fast to inbreed, and how intensely. As a rule about 6 percent per generation, in a good sized herd, will not result in a decline in vigor.

SUGGESTIONS FOR THE PORK PRODUCER

Set up goals. Goals will depend, to some extent on whether commercial or purebred hogs are produced. Try to follow the same goals over a period of years--don't keep changing objectives.

Keep good records. The main purpose of records is to identify individuals which are superior on the basis of their own type, performance and quality as well as on

the basis of that of their ancestors, their progeny and sibs. Use these records in selection.

Select for as few traits as possible. The more traits the breeder selects for, the less improvement he can expect to make in any one of the traits. The purebred breeder is forced to emphasize some selection on breed type, while the commercial breeder can pay more attention to economic traits.

Cull vigorously. Vigorous culling is of great importance to both the commercial breeder and the purebred breeder. Vigorous culling will improve the overall performance and quality of the herd at the present, as well as in the next generation.

Use the right mating system. The kind of mating system to use will depend upon what one considers the important economic traits and their degree of heritability.

SUGGESTIONS FOR THE BREEDER

- (1) First step is to set up a system of record keeping for each pig and sow in the herd.
- (2) Identify each pig.
- (3) Breed associations have excellent recommended forms for record keeping.
- (4) Record litter size and weight at 21 and 56 days.
- (5) Keep records on the daily rate of gain from weaning to 200 pounds. (170-175 for breeding animals).
- (6) Calculate efficiency of gains when possible.

First choice is: (a) Individual - usually different (b) Litters (c) Two to four pigs per litter or by one sire.

- (7) Types scores, if desired, on all pigs at near 200 pounds.
- (8) Backfat probes at about 200 pounds at three sites--both sides are better.

Heritability of different traits

Characteristics	Heritability range	Approximate average	Heritability
Length of body	40 - 81	61	
Length of carcass	40 - 81	61	
Belly thickness	49 - 72	61	High
Percent ham (based on carcass weight)	51 - 65	58	
Percent fat cuts (based on carcass weight)	52 - 69	60	
Percent shoulder (based on carcass weight)	38 - 56	47	
Back fat thickness	38 - 80	46	Medium
Loin eye area	16 - 79	48	
Economy of gain	26 - 57	38	
Percent lean cuts (based on carcass weight)	15 - 76	34	
Growth rate to 200 pounds	22 - 46	30	
Pigs farrowed	3 - 24	15	Low
Pigs weaned	3 - 32	19	
Litter weaning weight	7 - 37	17	
Five month weight	18 - 36	21	

(a) behind shoulder (b) middle of back (c) mid-way between hip bone and tail.

(9) Obtain carcass data on at least two pigs per litter and from different sexes where possible. (a) length of body, (b) back-fat, (c) loin eye area, (d) percent of ham and loin - if possible.

(10) Make up an index depending upon the amount of selection pressure desired.

These suggestions are generally easy for the breeder to adopt through their national breed association activities, the Indiana Swine Evaluation Project and the Hoosier On-the-Farm Testing Project. The latter two, projects of the Indiana Livestock Breeders Association, evaluate blood lines and litters on the basis of 1.) brood sow productivity, 2.) gainability, 3.) feed efficiency, 4.) carcass quality, and 5.) health--all are factors of economic importance.

GENETIC ASPECTS OF SELECTED TRAITS

"The progress that can be made in improving our hogs," states Dr. W.A. Craft

of the swine Breeding Laboratory, Ames, Iowa, "depends on the selection pressure that can be applied, the heritability of the variations of various trends, the interplay between the genetic nature of the traits, and the interplay between the heredity of the animals and the environment under which they are produced."

Fortunately, some of the important traits needing improvement are sufficiently heritable to permit improvement if diligent and consistent effort is applied to that end.

SUMMARY

This series of publications--Reproductive Tract of the Boar and Sow, Swine Reproductive Endocrinology, Types of Gene Action in Swine and Applied Swine Breeding Practices--have been presented with the central theme of WHY. Why does the animal body react as it does? Why do the various organs respond to various stimuli? Why is the reproductive efficiency affected? Why do the

rigorous culling, proper selection, timed mating, balanced feeding, good sanitation and sound management practices mean more dollars to you? Why? Why?

With the understanding of the "whys" of swine breeding and with the adoption of as many new technologies and practices as

fit your farm, you and your hogs, then you will be in a position to reap many rewards.

Reference material from: John F. Lasley, 1963. Genetics Improvement of Livestock, Prentice Hall, Inc., Englewood Cliffs, New Jersey.

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