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Hogs Coming?

Inbreeding Experiments Indicate That This May Be a Way to Speed Swine Improvement

By JAY L. LUSH

The results look promising, but they need to be verified and other crosses tried.

Using Inbred Lines in Commercial Production

If strong and vigorous inbred boars can be produced cheaply enough, farmers who sell hogs on the market can use these boars on sows which they have produced. The boar would be from an inbred line which is unrelated to the sows. Gilts from that cross would be saved for next year's sows. An inbred boar from a still different line would be used on them. With as many as four inbred lines which nick well together, this sort of rotation crossing or top-crossing could be continued indefinitely with almost as much vigor and other good results as if it were economically possible to produce the commercial sows by crossing two inbred lines.

If the inbred boars are too deficient in vitality and sex activity to be suitable for general commercial use, the pork producer can buy a boar produced by crossing inbred lines A and B. His next boar would be a cross between inbred lines C and D. The boar after that would be a cross between lines E and F, etc. This procedure would require more inbred lines which nick well with each other than will be necessary if inbred boars good enough for successful use in commercial herds can be produced.

If commercial hog production does go in this direction, crossbreeding probably will be combined with it so that the commercial producer will get whatever extra benefit or kick there is in crossbreeding, besides what he would get from crossing inbred lines belonging to the same breed.
If the experience in corn breeding is a dependable guide, the boars in such procedure would be crosses between two inbred lines belonging to the same breed (i.e., would be purebreds), but would be used on sows with little blood of that breed.

Need Purebred Herds

The production of inbred lines is only pure breeding put into such high gear that the average individual merit (but not the average breeding merit) of the animals is likely to decline and to need restoring by an occasional cross with another line of the same breed.

It seems probable that by this process — making inbred lines, discarding those which perform most poorly in crosses, and then intercrossing the others to restore vigor — the pure breed itself can be improved more rapidly than is being done now. To test and explore this possibility is the major reason the Iowa Station is working with 12 inbred lines of one breed, rather than with a line from each breed or with some intermediate combination, such as three lines each from four breeds.

Under any plan of using inbred lines, many purebred herds would be needed to produce the inbred boars for sale to the commercial user. There will be plenty of need for registration and promotion services such as the breed registry associations provide. Indeed the associations may need to enlarge their activities enough to designate the inbred line or family to which each registered animal belongs and to verify, even more carefully than hitherto, that each pedigree actually is as represented.

The reputation of the breeder will become more important if he keeps the same or nearly the same lines year after year than it is when, as now, most breeders of purebreds use boars which are unrelated or nearly unrelated to the sows on which they are used. Under this present policy the average genetic composition of each herd can be very different today from what it was 3 years ago or will be next year or the year after.

If production and use of inbred lines become commercially profitable, there will be a continuing opportunity for profitable work in making, testing and improving inbred lines within the existing breeds. How many enterprising and venturesome breeders in Iowa can make a good living at this phase of the business when it ultimately reaches equilibrium would be only a wild speculation now.

Because one boar or one sow can produce only a few pigs (as compared with the number of kernels of corn one plant can produce), it seems impossible that public agencies like experiment stations can ever produce more than a small part of the inbred lines needed. The major usefulness of the experiment stations will be in finding and testing the methods by which such lines can best be made.

First Inbreeding Lessons

The first inbred line at the Iowa Station was started in 1930 as a four-sire herd. That is, each year we use four boars and about 40 to 50 sows, all of the replacements being selected from pigs born within this herd, just as if this herd were a small pure breed by itself. Each boar is mated to one or more of the sows most closely related to him and to some sows least closely related, in order to get every year some intensely inbred and some mildly inbred pigs by each boar.

If the pigs by one sire are distinctly superior to those by the others, the breeding stock for next year are largely saved from among the pigs by that boar. In years when there is no large difference in the average merit of the progeny from the four different boars, the breeding stock for next year are saved more or less equally from the pigs by each.

The effects of inbreeding were less extreme than was first expected. Seven years of experience with this four-sire closed herd made it seem likely that we were wasting time by inbreeding so slowly. Also it appeared that the progeny of each boar should be mated among themselves, instead of mating them to the sons and daughters of the other three boars, if we wanted to make much use of progeny tests of the boars.

Accordingly in 1937 when the United States Department of Agriculture established the Regional Swine Breeding Laboratory under the Bankhead-Jones law and made possible an expansion of the Iowa Station's experiments, four different one-sire herds and one two-sire herd were separated out of the four-sire herd. Also four more one-sire herds and two more two-sire herds were started with unrelated stock. The four-sire herd is still being continued in order to verify whether it actually is, as now seems probable, less efficient than the one-sire and two-sire methods for producing inbred lines.

A two-sire herd of Danish Landrace has been maintained since the spring of 1934. It gives a chance to measure the effects of inbreeding on another
breed, to get more information on crossbreeding and to see how performance of this breed under American conditions is different from its performance in Denmark.

**Measures of Practical Merit**

In the swine breeding work at the Iowa Station the ideal pig is considered to be the one which makes the most profit for its owner. Profit depends of course both on the price the pig brings on the market and on the cost of producing it.

The selection index now used at the Iowa Station for deciding which gilts and young boars are to be saved for breeding is about half determined by the pig's weight-for-age and about half by the productivity of its dam. Weight at 154 days is being used to measure weight-for-age. Productivity of the sow is measured mostly by the number and weight of the pigs she weans. A gilt gets one point for each pig she farrows, plus two points for each pig she weans, plus one point for each 15 pounds the litter weighs at weaning time.

Because the number of pigs a sow farrows and raises varies widely from one litter to another and is much influenced by other things than the sow's own ability, her real productivity is usually much closer to the herd average than her own record is. The more litters she farrows, the more we trust her average record. The most practical general rule is to cull all gilts which perform very badly in their first litter but to hold the mediocre or doubtful cases for a second litter, especially if their dam or full sisters performed well.

We save about half of the gilts for a second litter and about one-fifth of them for three or more.

For several years we tried scoring the pigs at market weight for their visible conformity to the market ideal. It turned out that these scores ranked the pigs in so nearly the same order as their weight-for-age that selecting them on either basis would have given us nearly the same pigs. There were a few exceptions. For example, occasionally a pig with very crooked legs or some other serious defect would nevertheless have a heavy weight-for-age.

A pig is given some credit or penalty when the average merit of its "sibs" (its brothers or sisters) is high or low. These "sib credits" play a big part in deciding between pigs when individually they are close to each other. The sib credits are the chief way in which we have been able to make real use of progeny tests.

**Definite Findings Made**

1. **Sow Productivity.** Our present method of measuring productivity of sows is based on findings published in detail in Technical Bulletin No. 836 of the U.S.D.A., October, 1942. About one-sixth of the differences in size or weight of single litters produced by different sows of the same herd and breed are caused by permanent differences between the individual sows themselves.

   The rest of the differences are caused by temporary circumstances which change from litter to litter even for the same sow. Mature sows will farrow nearly two more pigs than gilts and about one more than sows 18 months old. Mature sows will wean about one more pig than gilts and the total weaning weight of the mature sow's litter will be about 50 pounds heavier.

2. **Differences in Growth Rate** can be measured fairly well by weight at 4 to 6 months. We found some practical advantages in using 154 days instead of 180 days (as was tried first) for the standard age. The pig's weight from birth to weaning is much affected by the nursing ability of its dam. After weaning it is more on its own, and the inheritance it received from its sire and from its dam then becomes more decisive. Individual differences in weight at 4 to 6 months of age have been about 20 to 40 percent hereditary. This means that we get in the average weight of the offspring about 20 to 40 percent as much improvement as we reached for when we selected as parents those which were heaviest in the preceding generation.

3. **Effects of Inbreeding on Individual Merit.** The average merit of the pigs has declined at least a little as the inbreeding proceeded. This decline was irregular and there were many individual exceptions to it. Our pigs at 180 days of age averaged 3/4 pound less in weight for each percent more they were inbred. This amounts to a loss of about 15 or 20 pounds at 6 months of age as the average result of one generation of full brother and sister inbreeding, and half that much for one generation of half brother-sister mating.

Vitality, as measured by percentage which survive to weaning, seems to have fallen even more. The number farrowed per litter has not yet been affected much, but doubtless this depends more on the inbreeding of the dam than of the pig. Defects such as hernia or bad eyesight have occurred in somewhat larger numbers than in outbred stock, but this increase has been large in some lines and has not happened in others.

All the individual selection we can practice during inbreeding can only partially prevent decline in characteristics which are strongly influenced by environment or accidents, or which are
Carass characteristics of sisters and brothers.

5. Differences Between Lines have become larger and more impressive as the inbreeding has proceeded. Many of the lines have drifted apart in characteristics which earlier had appeared to be largely individual irregularities or accidents. To some of these, such as shape of ear or face, we had given no attention in our selections. Against others, such as white or reddish spotting, swirls, or screw tails, we had selected mildly. Against still others, such as hernia, crooked legs or bad eyesight, we had selected strongly.

There are reasons to think that the main useful effect of inbreeding is to make families distinctly different from each other for economically important but slightly hereditary characteristics and to hold them separate until they can show their real merits unmistakably. Selection between lines is far more effective than selection between individuals, provided the lines really differ much in average merit.

6. Which Inbreeding Intensity is Best for Making Inbred Lines? The four-sire and two-sire lines give us more freedom to select and to correct mistakes which the progeny prove were made in former selections. But if we inbreed mildly we can not make as many inbred lines with the same number of hogs. With 10 sows per boar and 200 sows we could have 20 one-sire lines but only five four-sire lines. Therefore the more intense inbreeding will permit culling a much larger fraction of the lines after they do declare their merit unmistakably.

As of now it seems that the one-sire or perhaps the two-sire intensity would be best for making the inbred lines. The four-sire method takes too long and limits too much the number of lines which can be made. The inbreeding degeneration is so slight in the two-sire lines that not much is gained by making it slighter still by using the four-sire method. The one-sire lines degenerate noticeably more than the two-sire lines.

Also the risk of losing a line entirely by accident is greater with the one-sire lines. As compared with the two-sire lines, the real merit of each one-sire line in any one year is known with less certainty, since the number of liters and pigs is smaller and chance and accident can play a larger part. Yet the one-sire method permits forming nearly twice as many lines with the same total number of animals, the same cost and the same labor. The one-sire method increases the inbreeding intensity nearly twice as fast.

Crossbreeding has some distinct advantages for producing pigs for market. Crossbred pigs in our experiments gained about 7 to 9 percent faster than purebreds from weaning time to market weight. The crossbreeds had higher vitality, as evidenced by a smaller percentage being born dead, and 68 to 76 percent of the crossbreds born survived to weaning, as compared with 55 to 61 percent of the purebreds.

These advantages are not extreme but they seem large enough to be worth considering by most commercial farmers. The major boost from the crossbreeding is in the vitality of the pigs. Conclusions from the experiments on crossbreeding were reported in the Farm Science Reporter for January, 1941. In general the breeds crossed should be distinctly unrelated and the boar should come from a breed which on the average is strong in those characteristics for which the owner's sow herd needs correction most.

Conclusion

Our results in crossing inbred lines of pigs are promising. In rate and economy of gain and in vitality the line-cross pigs have much exceeded the inbred ones. Whether they will exceed ordinary outbred pigs enough to pay for the cost of producing the inbred lines remains to be learned. Distinct possibilities for more rapid improvement of breeding stock seem to exist along this road, but many questions are yet to be answered.

The rate at which we can travel is necessarily much slower and more expensive than with hybrid corn. A few farmers are buying our extra inbred boars and using them on various kinds of sows. Observations on the results from these boars are part of the information which should be helpful in directing us toward ways to produce hogs which will be still better "mortgage lifters."

These Scoutmaster gilts are from a four-sire line which has had no fresh blood since 1930.

Inherited in a complex manner. Some examples are: Fertility, productivity of sow, vitality in general, and eyesight. For characteristics of this kind it seems more effective to inbreed intensely and quickly as many lines as possible, accepting some depression as inevitable, but being able then to cull the lines which degenerate most and intercross the others to restore the merit lost.

4. Selection for Carcass Characteristics. Preference for plump hams, long sides, wide backs, etc., is automatically practiced when we select for weight-for-age. A little more selection for these is exerted when we reject on account of poor conformation some of those whose indexes are high. But many carcass qualities are measurable only after the pig is killed. So we give the living pig sib credits or penalties for the merits or demerits of the carcasses of its brothers and sisters.

When the selection index was first devised we feared that selecting intensely for weight-for-age would choose pigs which would grow to great size quickly but would not finish at handy weights. This has not happened. Instead we have selected more strongly for fatness than we had intended. Two pigs of the same age will usually differ more in the amount of fat than in the amount of lean or bone they contain. A few of the pigs with high indexes seem abnormally and undesirably fat. It appears now that we should emphasize plumpness of muscles and a large amount of lean in the carcass even more than we have been doing. This extra emphasis could come through more sib credits for desirable carcass characteristics of sisters and brothers.

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