Maintaining productivity in livestock breeds is best accomplished by combining two sometimes separate strategies: preserving genetic diversity, and direct selection for productivity. In other words, some traits of economic importance (i.e., survival, fertility, growth, etc.) can be sustained by minimizing inbreeding, which requires genetic diversity. Other traits, like growth rate and meat quality, depend on selection for production. The following guide will outline the importance of minimizing inbreeding and provide a framework for controlling inbreeding on the farm with special consideration for heritage breeds.

What is inbreeding? Inbreeding can be defined as the mating of individuals more closely related than the average of the breed. Extreme examples would include breeding a gilt to her brother or to her father, or breeding a sow to her son. In each of these examples the animals share 50% of their genes in common because of their relationship with each other. These extremely close matings result in rapid accumulation of inbreeding (by 25%) and must be avoided for producers of breeding stock. Half siblings, or animals that share a common father or mother, share 25% of their genes and result in 12.5% inbreeding per mating. In general it is advisable to plan matings so that all pairs of animals are less closely related than second cousins. Because many of our heritage breeds are small populations, and many also have incomplete pedigrees, avoidance of inbreeding for even less related matings may be prudent. While inbreeding can be a useful strategy in conservation breeding, it should always be used strategically and deliberately, and always comes with risks.

Why is inbreeding harmful? Inbreeding is detrimental because it impairs productivity. People often consider the fact that inbreeding results in more animals expressing recessive mutant genes. Those are the obvious effects of inbreeding, but perhaps more important are the impacts on production traits that go unnoticed. A gene represents a possible protein the animal can produce. When genes from both parents are identical, it means the progeny only have one option for what proteins can be produced from that part of the DNA. That means it has fewer options to respond to environmental insults (i.e., it has one option for that gene rather than having two options). The result is that animals with high inbreeding can have reduced performance. It is especially noticeable for traits that are sensitive to the environment, or traits with low heritability. Traits in that category include nearly all reproductive traits (conception rate, litter size, etc.) as well as general viability and disease resistance.
Evidence for the negative effects of inbreeding on productivity was demonstrated by agricultural researchers long ago, and some of the ‘classic’ papers are good examples of why inbreeding should be avoided. Increasing inbreeding reduces litter size\textsuperscript{1-3}. Bereskin and coworkers reported that a 10% increase in inbreeding reduced average litter size by 0.25 pigs. This means a sow resulting from a father-daughter mating would be expected to farrow an average of 0.625 fewer piglets per litter when compared to a female that is not inbred. Growth rate is also impaired by inbreeding\textsuperscript{1-2}. Bereskin and coworkers further reported that a 10% increase in inbreeding reduced weight at 154 days of age by 5.7 pounds. This indicates that offspring from a father-daughter mating would weigh 14.25 pounds less at market than pigs from a litter without inbreeding. So not only are there fewer piglets, they also grow slower! Besides litter size and growth rate, conception rate is greatly affected by increased inbreeding\textsuperscript{4}. This means that high rates of inbreeding lead to decreased productivity and vigor. When high rates of inbreeding accumulate across the breed, this reduced productivity and vigor can accelerate the rate of disappearance of rare breeds. Collectively, past research suggests productivity in rare breeds cannot be maintained without controlling inbreeding.

How can inbreeding be avoided? Several strategies are available to control inbreeding. Schemes include avoiding the mating of close relatives, introducing genetics from other herds, and planned selection strategies, all of which require good pedigrees be maintained. As previously indicated, the continuous mating of close relatives rapidly increases inbreeding and will lower herd productivity, especially in the areas of health, vigor and reproduction.

A good strategy to avoid mating close relatives is to incorporate genetic material from other herds. This can be accomplished by purchasing or leasing boars or gilts from another breeder or through the use of artificial insemination. Semen used for artificial insemination can be either fresh or frozen. Contact your local or state extension agent for more details on collecting, handling and using fresh or frozen semen.

Planned selection strategies also will help avoid the mating of close relatives. One strategy is to only keep offspring from old boars and sows that have farrowed many litters. Fundamentally, this slows the accumulation of inbreeding in your herd by increasing the interval between generations. It also promotes pigs with a long productive lifespan. Unfortunately it can result in loss of diversity; some boars and sows do not live long lives or become infertile, for example, due to accident, and their genes are lost from the herd and perhaps the breed if they have no progeny on the ground. Therefore this strategy works best in conjunction with other strategies for avoiding inbreeding.

A second selection strategy is to use multiple boars for breeding instead of using only a single boar. This approach will help slow the accumulation of inbreeding because it greatly reduces
the number of half siblings in your herd. The challenge to this system, of course, is that for
small farms it means maintaining a larger number of boars than may be practical. For some
farms, this may be overcome by working with nearby farms raising the same breed, or through
artificial insemination. Breeding sows to the same boar only every other or every third year
ensures diversity in her offspring. A third strategy is to retain no more than two gilts per litter. If
sows are mated to different boars each year, this approach will reduce the relatedness of
individuals in your herd.

From the perspective of the breed, the strategy that maintains the greatest amount of genetic
diversity is to assure every breeding animal leaves a replacement: at least one boar from each
boar and one gilt from each sow in the foundation population produce at least one litter. The
‘foundation animals’ can be the original breeding animals in your herd or, for greater
effectiveness at the breed level, the same approach can be taken for animals within the breed.
This results in the least accumulation of inbreeding possible.

**Summary of Key Strategies for Maintaining Genetic Diversity:**

- Avoiding the mating of close relatives
- Incorporating breeding stock from other herds
- Planned strategies for propagating breeding stock
  - Retaining offspring from older boars and sows
  - Using multiple boars for breeding vs. a single boar
  - Retaining no more than two gilts per litter
  - Assuring every boar leaves at least one son who sires litters and every sow
  - leaves at least one daughter who farrows litters

More information about conservation breeding can be found in these books:

Breeders and Breed Associations. Available from: www.livestockconservancy.org

from: www.livestockconservancy.org

Or contact The Livestock Conservancy at info@livestockconservancy.org

**References**


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