Mate Selection

Terry S. Stewart

Introduction

When assigning matings, there are two issues to consider. One is the relationship between the parents, which determines the level of inbreeding in the offspring. The second is the breeding value of the parents, which determines the genetic value of the offspring. A breeder must decide what level of inbreeding is acceptable for a given genetic potential.

Inbreeding

The inbreeding of offspring is determined by the covariance between the parents. While this relationship is important in making short term mating decisions, there is another relationship that is more useful in making strategic breeding plans. The accumulation of inbreeding (F) in a population (herd) over generations is a function of the Effective Population Size (N_e), $\Delta F = 1/2N_e$. Effective population size is the equivalent number of animals in monogamous paired mating that would have the same amount of genotypic variation. In domestic populations, we typically have many more females than males. Therefore the number of sires in the herd primarily determines N_e. A typical 200 sow herd with 10 boars really only has an effective population size equivalent to 38 animals (19 pairs) and will accumulate about 1% inbreeding per generation.

Effect of Inbreeding

The only genetic effect of inbreeding is to *increase homozygosity*. It is the phenotypic consequences of the increased homozygosity that counts. Inbreeding depression is one result. Inbreeding depression is the cumulative effect of reduced genetic variation in the quantitative genes that affect things such as growth and reproduction. The effect per percent inbreeding is small but as inbreeding accumulates, it can become of major economic importance. A second effect of increased homozygosity is the expression of recessive qualitative genes (major genes). Deleterious traits tend to be associated with recessive qualitative genes. So, in inbred populations, we see an increased frequency of things such as Artesia Ani, Hemophilia and Cleft Palate.

Another effect of increased homozygosity is a reduction in genetic response to selection through reduced genetic variation. In addition to the lowered response to selection (directed change), there is an increase in genetic drift (undirected change).

There is a positive side to inbreeding. As homozygosity increases and genetic variation decreases, there is an increase in prepotency of parents. That is, the genotype of the offspring will more highly resemble the genotype of the parents. Therefore, there is increased phenotypic resemblance as well. A highly inbred line exhibits prepotency quite well. In some lines of plants, complete homozygosity has been achieved and the genotype of the offspring is identical to that of the parents. If through selection and inbreeding, you can create a line of homozygous individuals that are homozygous for the desired genes, you can create a valuable genetic resource. The key words are *homozygous for desired genes*. These high levels of inbreeding are typically only successfully achieved with high fecundity or self-fertilizing organisms such as mice and plants. That is because there needs to be high selection intensities to offset the effects of inbreeding depression.

Inbreeding avoidance

Given all the above effects, most breeders choose to avoid inbreeding. Therefore, they need to increase the number of sires they use in their herd. Want a larger N_e. Increasing the number of sires is achieved in one of two ways. You import them, which is effectively expanding your herd to include the animals of the herd(s) from which you import the sires. Or you select more sires within your own herd, which results in lower selection intensity, fewer offspring per sire (reduced accuracy) and therefore less response to selection. So the decision to strictly avoid inbreeding should not be made trivially.

Maximum EBV

The EBV side of this puzzle is much simpler. You want to use the parents with the *best* EBV, largest or smallest depending on direction of selection. Of course in dealing with multiple traits, you select the animal with the *best index* value. If you take this to the extreme, you will only select one sire and dam and use A. I. and embryo transfer to reproduce your entire herd from the one pair. Then what do you do in the next generation when all your selection candidates are full-sibs?

Short-term vs Long-term

In the short-term, you need to know the relationship between the boars available for breeding and the sows needing to be bred. You then assign boars with the largest index value that has an acceptably low relationship to each sow. Of course there are some practical breeding problems to also consider such as number of services per day a sire can provide. In the long-term, you want to populate your boar stud with sires that have low (no) relationship to the sows and replacement gilts and have high $index values. You need to develop a mating plan which produces large numbers of unrelated animals as selection candidates.