Genetic Improvement Management Practices

Genetic improvement management practices are used to improve the genetic makeup of offspring, which leads to better quality animals. Developing a superior animal through these management practices allows the producer to achieve greater efficiency in production, since he or she has a higher quality animal.

Management Practices

Management practices that will improve a producer's stock genetically require the careful selection of animals for breeding by the producer. Genetic selection, evaluating the animal, and artificial methods of breeding are general management practices.

Genetic selection is a major management practice used to improve genetics in a breeding program. Genetic selection can be achieved using several different techniques, such as tandem selection, culling, and selection indexing.

Tandem selection involves breeding for one or two traits at a time. The selection process becomes limited and ineffective when selecting for more than two traits, because the desired traits will have less of an impact on the breeding program as more are selected. When using this technique, an individual identifies a desired trait and selects an animal possessing that trait for breeding.

Culling is a management practice that is widely used for many species. Culling eliminates less desirable traits by removing individuals possessing those traits from the breeding program. Unlike tandem selection, culling involves the removal rather than the addition of traits from the stock.

Another management practice involves using a selection index, which is a type of scoring system. Criteria are developed reflecting the desired qualities for the breeding animal. Animals are ranked for each quality, with a low score being best. The animal that has the lowest overall score based on the criteria of the index is used for the breeding program. In contrast to tandem selection, this practice considers all of the traits of the animal when selecting the best animal for the breeding program.

Evaluating animals by comparing the pedigrees (lists of an animal's ancestors), individual appearances, performance records, and progeny tests of different animals can help an individual select the proper animal for use in a breeding program. This type of management practice does not involve trying to analyze the genetics of an animal but rather evaluates its heritage and performance. For example, performance records include data on the measurable aspects of an animal's performance through its life stage that can be consulted when deciding whether or not to include it in a breeding program. Progeny tests compare sires based on the estimated performance of their offspring; they cannot be used for a young sire that has not yet produced a large number of offspring. When making improvements to a breeding program, items such as these should be considered to achieve a balanced program.

Other management practices that can be used to improve the genetic makeup of a producer's stock include artificial breeding methods. The use of these breeding methods can broaden the choices available to the producer when he or she is trying to select an animal for a breeding program. Management practices like artificial insemination (AI) and embryo transfer (ET) can be utilized after the right animal has been selected for breeding. With these techniques, the genes of exceptional males and females can be spread more extensively than they would if natural mating was used. Genetic improvement is achieved by selecting a genetically superior sire for AI or a genetically superior female for ET.

Breeding Systems

A breeding system is a system that determines the offspring's breed and its relationship to other offspring and to its parents. The two types of breeding systems are straight breeding and crossbreeding. These two systems are used in a breeding program to improve the genetic makeup of animals and the desired outcome of that program.

Straight breeding is a system that involves the mating of two animals from the same breed. Straight breeding helps to maintain a purebred stock for commercial producers, who use them in their operations to produce high quality animals. Several types of straight breeding may be utilized.

Purebred breeding is one type of straight breeding. The male and female are both purebred animals and are of the same breed. Purebred breeding results in a greater standardization of genetic material, which may at times have the negative effect of causing less desirable recessive traits to appear in the offspring.

Another type of straight breeding is inbreeding, the mating of animals that are more closely related than the average of the population. Inbreeding is used to improve genetic purity in a breeding program by further selecting for a desirable characteristic of that breed. This type of breeding is further broken down into two categories. The term close breeding is used if the relationship is a close one and the animals share more than one ancestor, such as a sire and daughter or brother and sister. In another type of inbreeding, line breeding, the mating of related animals is used to maintain a close genetic relationship to an outstanding ancestor. Examples of line breeding include the mating of cousins or a female and her grandsire. This breeding system requires a careful use of selection and culling for best results.

Outcrossing involves breeding a male and female that are of the same breed but different pedigrees. The purpose of outcrossing is to bring new desirable traits into the stock.

Another method that can be used to improve genetic stock is called grading up or upgrading. In upgrading, a purebred male is bred to a grade female, which has one purebred parent and one of a mixed or unknown breed and so cannot be registered with a breed association. Grading up results in slower overall improvement, but a marked genetic improvement is present after the first breeding, clearly demonstrating the enhancements that have been made.

Crossbreeding is the other type of breeding system. It involves the breeding of two animals from different breeds; the animals may both be purebred, or a purebred male and a grade female may be bred. The major benefit of crossbreeding is hybrid vigor. Hybrid vigor is evident when the offspring displays superior qualities in comparison to the average of its parents, such as an increase in size, rate of growth, and vitality. Crossbreeding also results in animals that combine desirable traits not found in any one breed. Several different crosses may be made when using the crossbreeding system.

One type of crossbreeding system is the two-breed cross. This cross involves mating a female and male from different breeds. An example of a two-breed cross is the breeding of a Hereford cow to an Angus bull.

A three-breed cross involves the mating of a crossbreed female to a male of a different breed. For example, if a crossbreed Angus-Hereford cow were produced by the first cross described above and bred to a Simmental bull, it would be a three-breed cross.

A rotational cross is another type of breeding system. A rotational cross involves using males of different breeds for several succeeding generations of females, ending with a male of the same breed as the female used in the first cross and then repeating the series. If the offspring of the Angus-Hereford cow from the first example and a Simmental bull was bred back to a Hereford sire, it would be a three-breed rotational cross.

Another type of crossbreeding is called backcrossing. Backcrossing involves the crossbred female being bred to a male that is of the same breed as one of the parents of the female. In the case of a backcross, the crossbred Angus-Hereford cow would be bred to an Angus or Hereford bull.

Artificial Insemination

Once a breeding system and the appropriate animals for breeding have been selected, the female can be bred either naturally or by using artificial insemination (AI). As discussed in Lesson 4, artificial insemination involves depositing semen that has been previously collected from the male in the female reproductive tract. Genetic improvement is achieved through AI by selecting the sire that best complements the breeding program.

Using AI for genetic improvement has a number of advantages.

- The biggest advantage to AI is that it allows an outstanding sire to be used more widely to improve genetics, since the sire does not need to be present for the breeding. The male can therefore produce a greater number of genetically superior animals. The rate of genetic improvement for a producer's stock is increased.

- Another advantage is that AI allows the collected semen to be frozen and stored so that more offspring can be produced from one semen collection. Using AI, the offspring can even be produced after the sire is dead.

- Injured sires can still produce offspring in a breeding program with the help of AI.

- AI can also be used to control diseases.

- Traditional sire ownership becomes unnecessary, eliminating associated costs.

- Sire costs may be lowered, since the producer no longer has to pay for service. However, he or she still has to pay for the services of the technician.

Artificial insemination also has some disadvantages when used as a way of improving genetic stock.

- The collected semen requires careful handling and storage. If a mistake is made when storing the semen for later use, it cannot be used to produce offspring.

- Another disadvantage concerns the thawing of semen. Once semen is thawed, it cannot be refrozen and used again, since the sperm cells are destroyed.

- AI also requires additional management practices and facilities and more time and labor to ensure pregnancy. Each use of AI requires special handling of the animal. Also, estrous cycles must be carefully monitored. Conception depends on breeding at the right time, and if insemination occurs at the wrong time, the female will not conceive and the producer will have to wait through another estrous cycle to try again.

- Since the use of proper technique is vital or conception may not occur, the person doing the procedure must be specially trained.

- A final disadvantage of using AI is that it may overly stress females.

Embryo Transfer

Embryo transfer (ET), as explained in Lesson 4, is the transferring of embryos from one female to others for the rest of the gestational period. It improves the genetic stock by allowing for the best use of the superior female that has been selected for the breeding program. ET, like AI, has its own advantages and disadvantages that should be taken into consideration when determining whether or not to use it.

Embryo transfer has several advantages for the producer.

- The greatest advantage of ET is that it allows an exceptional animal to produce a larger number of genetically superior offspring since the female yields a large number of ova for implantation. Because the female does not have to bear all her offspring herself, she can produce many more offspring during her lifetime. The rate of genetic improvement is therefore increased.

- Another advantage of ET is that the collected embryos can be frozen and remain dormant for months or years to be implanted whenever it best suits the plans of the producer.

- An embryo can be mechanically divided to produce identical twins to increase the number of superior animals.

- Superior females that cannot produce offspring themselves due to some condition may be used in a breeding program.

Disadvantages of using ET also exist.

- Extensive management is required for successful embryo transfer, since the procedure may involve the use of AI as well as the process to recover the embryos after fertilization.

- Special management is also required for estrous synchronization, or matching the estrous cycles of the donor and the host female, which is necessary in order to transfer the embryo to the host at the best time for gestation. If the timing is off, the desired offspring will not be produced.

- In order to have enough recipient females available to carry the eggs harvested from the donor female, the producer will have to keep more stock, with several recipients for every donor. Keeping more animals increases costs for the producer, with no return if the animal is unused.

- In addition to the cost of keeping additional females, ET is itself a costly process.

- Another disadvantage is the low pregnancy rate for frozen embryos implanted in surrogate mothers.

- If the procedure to remove the embryos from the donor female does not work, surgery may be required.

Summary

Genetic improvements are made through a variety of management practices. Proper management practices for breeding involve the selection of the appropriate animals and the use of a particular breeding system. When the animals to be bred and the breeding system to be used are determined, either artificial insemination or embryo transfer can be used to improve the genetic makeup of the stock owned by a producer.

Credits

Baker, Andy. *Animal Science (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1996.

Crossbreeding Systems for Small Herds of Beef Cattle (G2040). University Extension agricultural publications, 1993.

Gillespie, J. R. *Modern Livestock and Poultry Production*. 5th ed. Albany, N.Y.: Delmar Publishers, 1997.

Taylor, R. E. *Scientific Farm Animal Production.* 4th ed. New York: Macmillan Publishing Company, 1992.