

Purdue University

Purdue e-Pubs

Historical Documents of the Purdue
Cooperative Extension Service

Department of Agricultural Communication

9-1-1966

Animal Improvement Through Mating Systems

K. J. Drewry

W. M. Dillon

L. L. Wilson

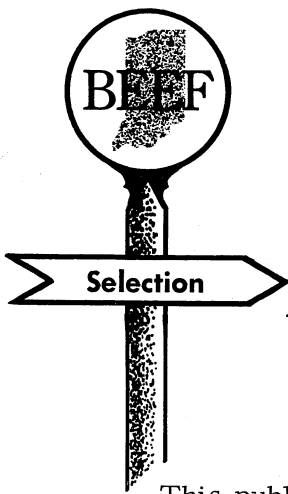
Follow this and additional works at: <https://docs.lib.purdue.edu/agext>

Drewry, K. J.; Dillon, W. M.; and Wilson, L. L., "Animal Improvement Through Mating Systems" (1966).
Historical Documents of the Purdue Cooperative Extension Service. Paper 133.
<https://docs.lib.purdue.edu/agext/133>

For current publications, please contact the Education Store: <https://mdc.itap.purdue.edu/>

This document is provided for historical reference purposes only and should not be considered to be a practical reference or to contain information reflective of current understanding. For additional information, please contact the Department of Agricultural Communication at Purdue University, College of Agriculture: <http://www.ag.purdue.edu/agcomm>

This document has been made available through Purdue e-Pubs, a service of the Purdue University Libraries. Please contact epubs@purdue.edu for additional information.



Animal Improvement Through Mating Systems

K. J. Drewry, W. M. Dillon, and L. L. Wilson, Animal Sciences Department

This publication is designed as a teaching aid for livestock breeding schools conducted by the Indiana Cooperative Extension Service. It is also included in the Beef and Dairy Production Handbooks for County Extension Workers. The purpose of this publication is to help the producer more clearly understand the effects of different mating systems on animal improvement.

Introduction

The animal breeder can alter the genetic merit of animals in his herd through selection and mating systems. Neither of these methods create new genes; however, these methods do allow the animal breeder to increase the proportion of the desirable gene combinations in his animals.

Selection is used by the animal breeder in choosing the animals which will be parents in the next generation. The animals chosen as parents are not exactly like each other in pedigree, appearance or performance.

After the potential sires and dams have been selected, the animal breeder has several methods which he may use in determining how the chosen animals will be mated. The practical consequences and genetic nature of these mating systems may be classified as: (1) mating of likes and (2) mating of unlikes. The likeness or unlikeness may be based on either (1) similarity of pedigree (genetic constitution or genotype) or (2)

similarity of individual appearance or performance (phenotype).

In any animal breeding enterprise the type of selection-mating system used will be determined by several factors. These factors include: (1) type of enterprise - purebred or commercial, (2) number of males and females, and (3) past, present, and future goals.

Mating Systems

The various mating systems which may be combined with selection for animal improvement are: 1. random mating 2. mating of likes (a) pedigree - inbreeding, linebreeding, and mating of animals within a family, (b) phenotype - mating of animals of equal desirability, 3. mating of unlikes (a) pedigree - species crosses, breed crosses and crossing of animals of different lines or families within a breed, (b) phenotype - mating of animals having contrasting desirability.

Random Mating

Random mating is the mating of animals in the selected group without regard to pedigree or performance. Of the various mating systems, random mating is the least frequently used system. In most of the livestock breeds the animals are mated because some pedigree or performance standard is desired. Random mating has probably been

more closely approached in the past by some of the larger commercial beef operations where sire identification was not known. In these cases a few selected males were placed in the "breeding pasture" with a large number of selected females. Each male would supposedly have an equal chance to mate with each female.

Many factors contribute to a lack of random mating. Some of these are: (1) goals of breeders are not the same, (2) size of herd or flock (many have only one sire), (3) acceptability or popularity of a certain line or family, and (4) practical management practices which influence breeding efficiency (breeding efficiency is much better if swine are hand mated).

Mating of likes - pedigree

Inbreeding - Inbreeding is the process of mating animals which are more closely related than the average of the population. Several degrees of inbreeding are possible. Most breeders reserve the term inbreeding for the mating of close relatives such as, half brother and sister, sire and daughter, dam and son or other closely related animals. Linebreeding is a form of inbreeding. With linebreeding the animal breeder is attempting to keep animals in his herd closely related to an outstanding ancestor. Most of the present breeds of livestock were formed by inbreeding and linebreeding. Such items as breed type, general refinement, prepotency, color pattern and other breed identifications were fixed in the foundation animals by use of inbreeding and linebreeding.

With inbreeding systems, the animal breeder is trying to (1) increase the chance that genes in different animals of the herd or flock come from the same ancestor(s), and (2) increase the uniformity of the performance or appearance of his animals by decreasing the percentage of heterozygous gene pairs in his animals. These two events happen with predictable frequencies at different degrees of inbreeding.

The relationship coefficient is a number which gives a measure of the probable percent of genes which any two animals may be expected to have in common because of the same ancestor(s). The highest this percentage can be is 50 unless inbreeding has occurred.

The inbreeding coefficient is a measure of the percent decrease in heterozygous gene pairs expected with different degrees of inbreeding. This coefficient should be calculated using some initial population as a base population. With most pedigrees very little is gained by going past the fifth generation in calculating relationship and inbreeding coefficients.

When the parents are not inbred the inbreeding coefficient is one-half of the relationship coefficient between its parents.

The effects of inbreeding are:

1. Does not change the genes (either dominant or recessive) in the population.
2. Does change the relative frequency of the various genes combinations. This is due to an increase in the homozygous gene combinations and a decrease in the heterozygous gene combinations.
3. Does allow hidden recessives to be uncovered. Hence, the most "acid test" for a sire is to mate him to several of his daughters. One progeny showing the recessive trait is proof that the sire is a carrier of the recessive gene.
4. Does cause the formation of distinct families or lines. Animals within these distinct lines are more uniform in their productivity and show increased prepotency or the ability of a sire (or dam) to make its offspring resemble the parent and other offspring more closely.
5. On the average, inbreeding causes a decline in the performance or productivity traits. The various inbred lines will differ considerably in their productivity. Some of the lines will be low in performance traits

and other lines will be high in performance. This permits more selection between lines than would be possible under random mating.

Inbreeding systems should be used only if the breeder: (1) has definite goals, (2) has accurate measures of merit, (3) realizes that both desirable and undesirable genes will become fixed in his animals, (4) realizes that the many undesirable combinations may be a large financial burden and (5) starts with animals of outstanding merit.

Inbreeding of 25 percent coming from an outstanding ancestor might be safer than inbreeding of 10 percent coming from a mediocre ancestor.

Linebreeding - Linebreeding is a form of inbreeding and is generally favored by the purebred breeders. Linebreeding is the choosing of pedigrees of animals which are mated such that their offspring will be kept closely related to some ancestor which was unusually desirable. This is accomplished by mating of animals which have a high relationship to the ancestor but are themselves little, if at all, related through other ancestors.

The effects of linebreeding are the same as those of inbreeding. With inbreeding, matings are made without considering the relationship of offspring to common ancestor and with linebreeding the purpose is to make this relationship as high as possible. This serves to emphasize the importance of linebreeding to an ancestor that is superior genetically and which carries a minimum of detrimental recessive genes.

In many cases, linebreeding is usually not practiced until the common ancestor is dead. This points to the necessity of increased accuracy in measuring the merit of animals before they are dead. In beef and dairy animals the closest possible mating would be that of full-sibs.

Linebreeding should be used only in purebred herds having outstanding performance and is usually practiced when the herd performance is higher than others in the breed.

Linebreeding might be considered as selection among ancestors instead of selection among individual animals.

Mating of likes - phenotype

The phrase "breed the best to the best" implies that the mediocre has been discarded or culled (thus selection has been practiced). Mating of likes is the mating of animals having similar degrees of desirability. These degrees of desirability may be for single visual characteristics, single productive characteristics, or a net merit scale which combines both visual and productive characteristics. Mating of likes by phenotypic desirability requires mating the best to the best, the mediocre to the mediocre and the worst to the worst regardless of their pedigree. The practice actually followed is that of selecting the more desirable animals and allowing these to mate. These animals may be similar in desirability because they possess genes which produce the same degree of desirability or their previous management may have made them appear similar. The genes which these animals possess that cause increased desirability may or may not be the same set of genes in the different animals.

Effects - 1. Does not produce homozygotes, except in rare cases, due to the many genetic combinations possible which could give the same degree of desirability. 2. Does tend to form distinct lines or families, but not at the rate one finds with inbreeding. 3. Does increase the resemblance among parent and offspring and among full sibs due to the fact that sire and dam have genes which give the same degree of desirability. In actual practices the mating of likes to likes by phenotype

is accompanied by prior selection of parents and actually is nearly impossible due to different selection differentials for the males and the females.

Mating of unlikes - pedigree

These mating systems consist of those in which the animals are less closely related than the average of the population. This could vary from species crosses, to breed crosses, to crossing of lines within breeds.

Only two of these mating systems have practical importance to the animal breeder. These are (1) crossbreeding - mating of animals from different breeds and (2) out-crossing - mating of animals from different inbred lines, non-inbred lines or families within the same breed.

Species crosses and crossing of animals from inbred lines are two of the mating systems which have been used to a limited extent but have not proven to be of practical importance to livestock producers. The cross of European beef cattle and American bison has not proven to be the most desirable cross. To date, the mating of animals from different inbred lines within a breed and the mating of animals from inbred lines of different breeds has been made primarily in animals breeding research studies. This system has been used in swine with variable degrees of success. Inbreeding depression in the parent lines has been a high price to pay for the line-crosses which were successful.

Crossbreeding - Animals within the various breeds are expected to have more homozygous gene combinations because they all have as common ancestors the foundation animals which formed the breed. These breeds surely differ in those genes which are homozygous. Coat color patterns show this. The various breeds probably differ in genetic make-up due to differences in goals of breeders in the various breeds.

The practical usefulness of the cross-breeding system rests with the fact that the favorable effects of genes are generally dominant over the unfavorable effects. Thus, crossbreeding is genetically the process of combining the desirable characteristics of two breeds in the offspring. The superiority of the offspring over the average of the parents in performance (hybrid vigor or heterosis) is due to an increased number of heterozygous gene combinations in the offspring.

In animal agriculture, the maximum practical usefulness of the crossbred animal is probably that of producing market animals. The superiority of the crossbred animal in performance is not fixed when crossbred parents are mated. The offspring of crossbred animals are generally lower in performance due to the "breaking-down of the heterozygous gene combinations built into the crossbred parents".

Crossbreeding is now practiced extensively in swine since approximately 85-90 percent of all market hogs are crossbred. With swine, the breeder uses systems which utilize the heterosis of the crossbred dam. These systems are based on using purebred boars from two or more breeds on crossbred sows of the previous generation.

The amount of crossbreeding with sheep varies by locality. If crossbreeding is used, the ewes are usually from one-fourth to one-half fine wool breeds and these are mated to purebred meat-type rams.

Crossbreeding with beef cattle has been practiced extensively in some of the Southern states. Because of adaptability, the southern breeder often tries to keep from one-fourth to one-half Brahman breeding in the cow herd. These cows are mated to purebred British bulls to produce replacement heifers and market steers. The percentage of commercial beef crossbred market animals is increasing. Results with swine have indicated

that the principles are sound and that cross-breeding is a commercially successful practice.

Crossbreeding with experimental dairy cattle herds indicates some advantage in early calfhood vigor and livability. More research is needed to determine possible future value of crossbreeding in dairy cattle.

The effects of crossbreeding are: 1. Increases phenotypic uniformity of offspring 2. Increases performance in traits such as size, vitality and fertility. This increase is variable in different crosses since not all breeds "nick" 3. In general, the increased performance from crossbreeding is observed in those traits which are low in heritability and which are affected most by inbreeding

The value of crossbreeding depends upon the productivity of the parents. One should not expect to obtain outstanding performance when mediocre parents are used.

Outcrossing - Outcrossing is the method used by the purebred breeder to obtain the same results within a breed as the commercial breeder does by crossing breeds. In most cases, the purebred breeder is following a linebreeding program and will make an outcross, through the sire, to introduce into his stock some desirable traits. He will then return to using sires from his herd hoping to hold both the good traits which he introduced and the good traits of his line or family.

The results are the same with outcrossing as with crossbreeding. The increased vigor and growing ability of the outcross animals is not expected to be as large as that

observed with crossbreeding. The primary reason for this would be the pedigree restrictions necessary in the purebred operation which result in the mating of animals having many similar homozygous gene pairs that are the same.

Mating of unlikes - phenotype

Mating of unlikes is the mating of animals having contrasting degrees of desirability. The desirability may be for a single visual character, a single productive character or a net merit scale which combines both visual and productive characters.

This mating system is used primarily by the purebred and commercial producers to correct minor defects in their herds or flocks. The female herd or flock may be good in some traits but weak in other traits. Thus, the breeder will try to obtain sires that are equally as desirable as his females but are also exceptionally strong where the females are weak.

Effects: - 1. Does make the offspring more uniform in appearance and production. 2. Does lower the resemblance between parent and offspring since the effects of genes from sire may tend to cancel effects of genes from the dam. 3. Does not affect the percentage of heterozygous and homozygous gene combinations.

The mating of unlikes is useful in obtaining a more uniform group and is useful in correcting defects when the ideal is an intermediate. Again, the mating of unlikes on performance or index would be virtually impossible due to different selection differentials in the males and the females.