SYSTEM OF MATING

I. Relationship and Inbreeding
II. Outbreeding and Hybrid vigour

There are two kinds of decisions that animal breeders must make:

A. Selection decisions:

- They must decide which individuals become parents,
- How long they remain in the breeding population.
- How many offspring they may produce

B.mating system:

- Breeders must also decide which males will breed to females.

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- A knowledge of mating systems is important because producers can utilize them to preserve genetic superiority and utilize hybrid vigour.

- Systems of mating are designed to combine the genes in a population into the most advantageous genotypic combinations without changing gene frequencies.

- System of mating accompanied by effective selection, is a powerful tool for genetic improvement.

- Selection then system of mating then selection

SYSTEM OF MATING

- Since mating systems are based on the relationship of animals being mated, it is important to understand more detail about genetic relationship.

Genetic relationship:

Refers to the proportion of genes that two individuals have in common because they are members of the same family.

Type of relationships:

1. **Direct relationship**
2. **Collateral relationship**

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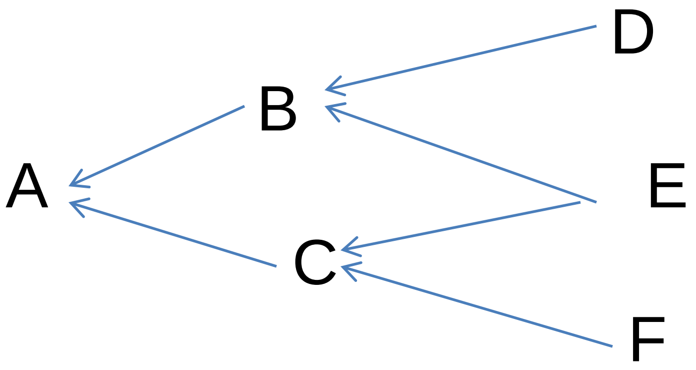
1.Direct relationship

Direct relative has a proportion of their genes in common because one is an ancestor of the other or one is a descendent of the other.

Example:

An individual is a direct relative of his or her parents, grandparents, great grandparents,



A with C, A with F are direct relative

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2.Collateral relationship

Collateral relatives are those that are related because they have one or more common ancestors.

- The half sib B, C have one common ancestors (E)

Importance of knowing relationships

a. Selecting animals on the basis of relative's records as the relationship coefficient measures the fraction of like genes shared by two animals and thus is an indication of how reliable one of the relative's records will be in predicting the genetic value of the other animal.

b. Arranging matings to avoid high levels of inbreeding

c. Establishing lines tracing to desirable animals

d. When an animal offered for sale and has a pedigree similar to that of another animal that sold earlier at another sale for a high price, and the breeder wants to know how much he should pay for this animal.

Importance of knowing relationships

e. For traits such as carcass quality that can not be measured very well until the slaughter of the animal, the slaughter of a relative should give some indication of the carcass quality of the individual in question.

- The value of the relative in this respect would be proportional to the degree the two individuals were related.
- A full brother or sister would be worth more than a half brother or sister in this respect.
- Full brothers and sister within an inbred line would be more closely related than would be full brothers and sisters that are not inbred.

Computing the relationship coefficient

Relationship is based on the fraction of 1/2. One half is used because of the Halfling of the genetic material is passed from parent to offspring.

$$R_{XY} = \frac{\sum (1/2)^{n+n} (1+F_{CA})}{\sqrt{(1+F_x)(1+F_y)}}$$

R_{xy}: is the relationship coefficient between animals X and Y.

$\sum$ is the Greek symbol meaning to sum or add.

n: is the number of generations (arrows) from ancestor to one of the animals for which relationship is being computed.

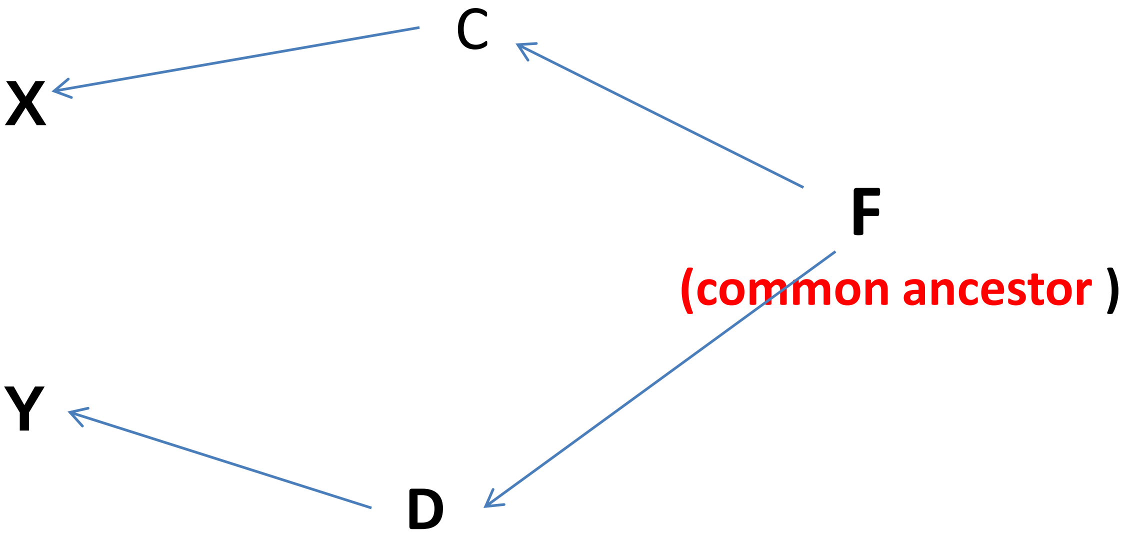
n: is the number of generations (arrows) from ancestor to the other animal for which relationship is being computed.

F_{CA}: is the inbreeding coefficient of the common ancestors.

F_X: is the inbreeding coefficient of the animal X.
F_Y: is the inbreeding coefficient of the animal Y.

Animals are more closely related than the average of the population when they have common ancestors within the first five generations of their pedigree.

Computing the relationship coefficient



Classification of system of mating

1. Close-breeding : which is the mating of related animals,

2. Outbreeding: which is the mating of unrelated animals.

Close-breeding (mating relatives)	**Out breeding** (mating non-relatives)
- Inbreeding - Line breeding	- Crossing species - Crossbreeding - Out crossing - Back crossing - Top crossing - Grading up - Mating likes - Mating un likes

I. Close-breeding (mating relatives)
1. Inbreeding

- Inbreeding is the mating of animals that are more closely related to each other than the average relationship in a population.

- Inbreeding is another tool, in addition to selection, that the animal breeder may use for the improvement of farm animal.

- The inbreeding has been used in the past especially in the early development of some breeds of livestock.

Different forms of inbreeding

1. **Intensive inbreeding**: mating of closely related animals whose ancestors have been inbred for several generations.

2. **Line breeding**: a mild form of inbreeding where inbreeding is kept relatively low while maintaining a high genetic relationship to an ancestor or line of ancestors.

The genetic effect of inbreeding:

The genetic effects of inbreeding is to increase the number of pairs of genes that exist in the homozygous state regardless of the kind of gene action involved.

The genetic effect of inbreeding

A study of this example will show that:

1. An important change has taken place in the percentage of homozygous in the population :
   A. In the parent generation: all of the individuals were heterozygous (Dd).i.e. no homozygous at all.
   B. In the first generation of inbreeding: 50% of the individuals are homozygous dominance (DD) and homozygous recessive (dd).
   C. In the second generation of inbreeding: 75% of the individuals are now homozygous dominance (DD) and homozygous recessive (dd).

- Continuing this self fertilization, we find that the homozygosity of the population produced increases with each generation but a decreasing rate.

The genetic effect of inbreeding

2. Inbreeding did not change the frequency of the genes in the population, but change genotype frequency:

- In the parents: the frequencies of both the D and the d genes were 0.50.
- In the fourth generation: the frequency of each gene was still 0.50.

3. In animals, the genetic effects are still the same, except that homozygosity increases at a slower rate, depending upon the degree of relationship between parents that produce inbred offspring.

Computation of inbreeding coefficients using path tracing method (path coefficients

- Note that inbreeding is computed on one animal where relationship involves two animals.

1. When a population is closed (i.e. no more genetic variation is introduced from outside) and breeding continues at random, then it is inevitable that there is a slow build up in the level of inbreeding through relatives mating together.

- Inbreeding coefficient by Professor Wright's formula:

$$F_X = (1/2)^{ns + nd + 1} (1 + F_{CA})$$

inbreeding coefficients

- F_X: inbreeding coefficient of individual X or the animal in question.
- ∑: sum of all independent paths which connect the sires and dams of X.
- ns: the number of generation from the sire to the common ancestors.
- nd: the number of generation from the dam to the common ancestors.
- (1 + FCA): 1 plus the inbreeding of the ancestor common to the sire and dam of X. If the ancestor is also inbred, there will be an increased homozygosity of X.

Consequences of inbreeding

1. The main genetic effect of inbreeding is to increase the number of pairs of homozygous genes in the individual.

- The more closely related the parents, the more likely they are to be carrying the same genes and the greater the degree of homozygosity in their inbred offspring.

2. Phenotypically, inbreeding (and thus increased homozygosity) usually causes a decline in traits related to physical fitness. Such traits include the survival ability of the young and the performance of the inbred individuals.

- When genes become more homozygous, some detrimental recessive genes that had been previously hidden show up in the homozygous state.

Consequences of inbreeding

3. Inbreeding tends to pair deleterious recessive genes, which would allow culling of affected animals. Inbreeding tends to make all pairs of genes homozygous regardless of their phenotypic expression.

- Inbreeding does not create new recessive genes, nor does it change the frequency of the recessive genes.

Consequences of inbreeding

4. Inbreeding tends to increase breeding purity.

- Breeding purity means that the individual is more likely to transmit the same genes to its offspring. This is illustrated in following genotypes:

Individual 1	Genotype AABBCCDD
Individual 2	Genotype aabbccdd
Individual 3	Genotype AaBbCcDd

- Individual 1 can transmit only genes ABCD through its sex cells.
- Individual 2 can transmit only genes abcd. Individual 3 can transmit any one of sixteen different combinations of genes to its offspring, which decrease breeding purity.

Consequences of inbreeding

- Although individuals 1 and 2 transmit only one combination of genes to each of their offspring, individual 1 would be preferred for two reasons:
- It is homozygous dominant for four pairs of genes, and dominant genes are usually desirable in their effects, whereas recessive genes are usually undesirable.
- Therefore, individual 1 is prepotent because it is homozygous dominant.
- A prepotent individual stamps its characteristics on its offspring so that they resemble that parent or each other more than usual. This phenomenon is called prepotency.
- True prepotency is likely to be observed only for simply-inherited traits or for highly heritable polygenic traits.

Some general points for inbreeding

- It is highly desirable to determine the most appropriate rate of inbreeding. The points to consider have been summarised by Lush. The best rate of inbreeding depends on:

1. The skills of the breeder in his selection.
2. The frequency of the undesirable genes in the population.
3. Any linkage between good and bad genes in the stock.
4. The amount of dominance, epistasis and environmental effects that may deceive the breeder.
5. The size of the population.

- Professor lush considered that 6% inbreeding was the "stop, look and listen" stage.

Applications and uses of inbreeding:

1. Inbreeding increases the chance of expression of deleterious recessive genes, which would allow to select against deleterious recessive gene that is of economic importance by culling of affected and carrier animals and thereby reducing the frequency of the detrimental genes.

- This would require severe culling and might be too costly under such conditions. However, the cost must be balanced against the potential gain.

Applications and uses of inbreeding:

2. To form distinct families within a breed, especially if selection is practiced along with it.

- Selection between such inbred families for traits of low heritability would be more effective than selection based on individuality alone, especially if there were distinct or definite family differences.

- Family selection is more effective than in individual selection, because it tends to reduce some of environmental variations that breeders often mistake for those of genetic nature.

Applications and uses of inbreeding:

3. Inbreeding should be used only for the production of seed stock. But even when the breeder uses it for this purpose, he has to determine how much he can sacrifice in the way of lower production and performance to increase the purity of these breeding animals.

4. To develop lines that can be used for crossing purposes, as is done for hybrid vigour. Crossing of inbred lines results in heterosis, however, in most cases compensates for inbreeding depression.

Applications and uses of inbreeding:

5. From the reach standpoint, inbreeding is of value to determine the type, or types, of gene action that affects the various economic traits in farm animals.

- If inbreeding effects are very great, the trait is affected by non additive gene action.

- If inbreeding effects are very small or nonexistent, the trait is affected mostly by additive gene action.