11. ANIMAL BREEDING AND SELECTION

Can you recall ?

Terms : Breed, breeding and selection

11.1 SYSTEMS OF BREEDING

The animal breeding programmes involves selection of superior animals and mating them to obtain progeny with better genetic potential.

The combination of effective selection with proper mating / breeding system is essential for success of any breeding programme.

Objectives of animal breeding

1. To increase production of milk, meat, egg and wool.
2. To improve growth rate.
3. To improve quality of milk, meat, egg and wool.

There are two main systems of breeding 1. Inbreeding. 2. Outbreeding.

Introduction to scientist

The origin of animal breeding lays in the United Kingdom. Robert Bakewell (1727-1795), who introduced keeping accurate records of performance of animals so that objective selection and breeding became possible. He was the first scientist to improve animals for meat production and carcass quality.

11.1.1 Inbreeding

Inbreeding is the mating of related animals.

Advantages

1. It increases homozygosity and decreases heterozygosity .
2. It helps in producing seedstock (elite animals) for crossbreeding.
3. It helps in development of families or inbred or purebred lines.
4. It helps in elimination of undesirable recessive genes.
5. It increases uniformity of productive characters.
6. It helps in selection of desirable animals and also culling of undesirable animals.

Disadvantages

1. It decreases growth rate, body size and body weight.
2. It reduces reproductive efficiency and production performance of the progeny.
3. It slows testicular development, reduces vigor in males and delays puberty in both sexes.
4. It increases early embryonic death rate and mortality in progeny.

Remember...

- **The decreased growth and reproduction efficiency due to inbreeding is termed as inbreeding depression.**
- **The inbreeding depression results from homozygosity.**

5. It results into appearance of genetic abnormalities.
6. It increases susceptibility to infection.
7. Reduce tolerance to survive under adverse environmental condition.

Types of inbreeding

According to the relationship of the mating individuals, inbreeding is classified as:

1. Close breeding
2. Line breeding

1. Close breeding

Close breeding means the mating of closely related animals than the average of the population. It involves mating of dam and son or sire and daughter or full brother and full sister.

Remember...

- **Close breeding should be used if both parents are of outstanding performance.**
- **It is practiced to develop inbred lines with a high level of homozygosity.**

Advantages

1. It helps in detection and elimination of harmful or undesirable recessive genes.
2. It develops uniform progeny.
3. It is always used for testing of breeding bull to declare him free from undesirable or deleterious recessive genes and brand him as a proven bull.

Disadvantages

1. It rapidly increases homozygosity and hence risky.
2. It usually increases breeding problems and reduces resistance to diseases in progeny.
3. It sometimes fixes undesirable characters in the progeny.

Internet my friend

Genetic disorders resulting from inbreeding.

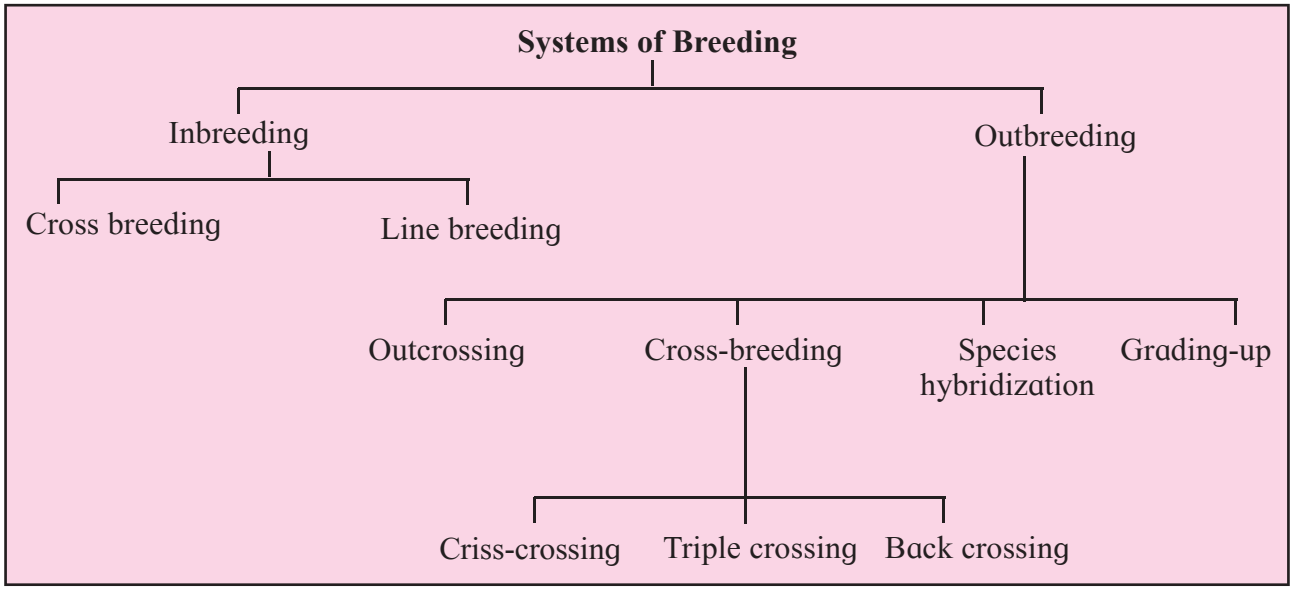


Fig. 11.1 Systems of Breeding

2. Line Breeding

Line breeding means mating of distantly related animals.

It involves mating of grand sire and grand daughter or grand son and grand dam or half brother and half sister

Advantages

1. It promotes uniformity in progeny.
2. It slowly increases homozygosity and hence less risky than close breeding.
3. It slowly develops undesirable characters.

Disadvantages

1. It develops desirable characters slowly.
2. It gives less benefit for few generations because animals are selected on the basis of pedigree record giving no importance to real individual merit.

Table 11.1 : Difference between close and line breeding

	Close breeding	Line breeding
1.	Mating of closely related animals	Mating of distantly related animals
2.	It is intense form of inbreeding	It is mild form of inbreeding
3.	Animals are selected for breeding on individual merit.	Animals are selected for breeding on pedigree record.
4.	Homozygosity reaches quickly, hence more risky.	Homozygosity reaches slowly, hence less risky.
5.	Both desirable and undesirable characters develop rapidly.	Both desirable and undesirable characters develop slowly.

11.1.2 Outbreeding

Outbreeding is defined as mating of unrelated animals.

Types of outbreeding

The following are the types of outbreeding

1. Outcrossing
2. Crossbreeding
3. Grading up
4. Species hybridization.

1. Outcrossing

Outcrossing means mating of unrelated purebred animals within the same breed.

It involves mating of animals which do not have common ancestors in the first 4 to 6 generations in their pedigree .

e.g. Mating of unrelated Deoni sire and Deoni cow

Advantages

1. It is the best method for genetic improvement of cattle within the breed.
2. It helps to bring changes in traits according to market standards or demands.
3. It is good for traits of high heritability (qualitative traits) like body coat and colour.

Disadvantage

1. It neither increases nor decreases the variation therefore the improvement in economic characters is very slow.

2. Crossbreeding

Crossbreeding is the mating of animals of different well established breeds of the same species.

e.g. 1) HF (Sire) x Deoni (Cow),

2) Murrah buffalo bull x Surti buffalo

Crossbreeding is usually practiced to combine desirable characters from different breeds for improving productivity.

Crossbreds are mainly used for production and not for further breeding purpose.

Do you know ?

Eueopean missionaries started crossbreeding of cattle in India in 1875. Taylor breed of cattle was developed around Patna, Bihar by crossing Shorthorn bulls with native Sahiwal, Hariyana, Tharparkar, Sindhi & Gir.

Advantages

1. It increases the hybrid vigor in the progeny.
2. It helps to bring desirable characters in progeny.
3. It increases growth rate, fertility and productive ability in progeny.
4. It is useful in producing new breeds.
5. It helps to produce animals with better adaptability in adverse environmental conditions.
6. It helps to produce progeny with increased resistance against diseases.

Disadvantages

1. It requires maintenance of two or more pure breeds.
2. It increases heterozygosity and thereby reduces breeding merits of progeny.
3. It may sometimes produces progeny with undesirable traits.
4. It reduces the uniformity of desirable characters.

Methods of Crossbreeding

1. **Two Breed crossing :** Mating of two different breeds to produce crossbreds.

   e.g. 1. Holstein Friesian (HF) x Deoni ⟶ Holdeo (F_1 : 50 % HF : 50 % Deoni)

2. **Three Breed Crossing :** Mating of three different bred to produce crossbreds.

e.g. Jersey (Sire) × Gir (Dam)
(100%) (100%)
↓
F_1 × HF
(Jersey : Gir) (100%)
(50% : 50%)
↓
F_2
(HF : Jersey : Gir)
(50 % : 25 %:25 %)

3. **Back - Crossing :** Mating of crossbred female to one of its purebred parent.

e.g. HF (100%) × Deoni (100%)

↓

F_1 (HF : Deoni) (50 % : 50 %) × HF (100 %)

↓

F_2 (HF : Deoni) (75 % : 25 %)

4. **Rotational crossing**

a) Criss - crossing : Mating of hybrid with two different breeds in an alternate manner.

e.g. HF (100%) × Deoni (100%)

↓

F_1 (HF : Deoni) (50 % : 50 %) × Deoni (100%)

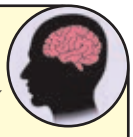
↓

F_2 (HF : Deoni) (25 % : 75 %) × HF (100%)

↓

F_3 (HF : Deoni) (62.5 % : 37.5 %)

Can you recall ?



1. **Triple cross cow developed by MPKV, Rahuri**
2. **Different crossbred cows developed in India.**

b) Triple crossing : Mating of hybrid with three different breeds in a rotational manner.

e.g. HF (100 %) × Deoni (100 %)

↓

F_1 (HF : Deoni) (50% : 50%) × Jersey (100 %)

↓

F_2 (HF : Deoni : Jersey) (25 % : 25 % : 50 %) × Deoni (100 %)

↓

F_3 (HF : Deoni: Jersey) (12.5 % : 62.5 % : 25 %) × HF (100 %)

↓

F_4 (HF : Deoni : Jersey) (56.25 % : 31.25 % : 12.5 %)

3. Grading-up

Grading up is defined as mating of purebred sire with non-descript females and their offsprings for generation after generation till the progenies are reaching nearly to 98-99 per cent inheritance of original breed. e.g. Mating of Murrah buffalo bulls with local buffaloes.

Grading up is mainly used for upgradation and improvement of non-descript animals.

Remember...

Generally after 5 to 6 generations, the graded animals will be more or less similar to the purebred animal that has been used for grading up.

Table 11. 2 : Change in % of inheritance due to grading up

Crossing Sire × Dam	*Generation*	*per cent inheritance in offspring*	
		Murrah	Non-descript Buffalo
Murrah × *Nondescript Buffalo*	F_1	50.00	50.00
Murrah × F_1	F_2	75.00	25.0
Murrah × F_2	F_3	87.50	12.5
Murrah × F_3	F_4	93.75	6.25
Murrah × F_4	F_5	96.87	3.13
Murrah × F_5	F_6	98.44	1.56
Murrah × F_6	F_7	99.22	0.78

Advantages

1. It is the best method for improving the local non-descript animals within reasonable time and expenditure.
2. It helps to develop purebred after few generations.
3. It is simple and economic method for establishing herd of purebreds.
4. It proves the quality of sire and thereby increases its market value

Disadvantages

1. Purebreds used for grading up from temperate zone may not give good result in tropical climate.
2. Male offsprings (graded males) are not suitable for breeding purpose.

Can you suggest ?

Breeding methods for improvement of local non-descript cattle/buffalo in you locality.

Table 11.3 : Difference between inbreeding and outbreeding

Inbreeding	*Outbreeding*
1. Mating of related animals. e.g. Mating of dam to son or sire to daughter.	1. Mating of unrelated animals e.g. Mating of animals of different strains or breeds or species
2. It increases homozygosity and thereby brings uniformity in progeny.	2. It increases heterozygosity and thus decreases uniformity in progeny.
3. It reduces the variation	3. It increases the variation.
4. It increases breeding value.	4. It decreases breeding value.
5. It decreases reproductive efficiency, growth rate and production performance in progeny.	5. It increases reproductive efficiency, growth rate and production performance in progeny.
6. It decreases vigor.	6. It increases vigor
7. It decreases disease resistance.	7. It increases disease resistance.
8. It leads to inbreeding depression.	8. It leads to heterosis or hybrid vigour.

3. Species Hybridization

It means mating of animals of two different species. It is extreme form of outcrossing. e.g.

Jack (Male ass)	×	Mare (Female horse)	⟶	Mule
Stallion (Male horse)	×	Jennet (Female ass)	⟶	Hinny
European cattle	×	American Buffalo	⟶	Cattalo
Stallion	×	Female Zebra	⟶	Zebroid

Advantages

1. It produces progeny having more vigour and disease resistance than parental species.
2. It produces progeny which shows better adaptability in adverse climatic conditions.

Disadvantage

1. Progeny is usually sterile.

11.2 SELECTION

Selection is defined as the process in which certain individuals in population are preferred over others for producing offspring of the next generation.

Do you know !

1. **Why selection is important in animal breeding ?**
2. **How to improve livestock productivity?**

11.2.1 Kinds of selection

1. Natural selection
2. Artificial selection

1. Natural selection

It is the selection of animal by nature on the basis of survival of the fittest.

2. Artificial selection

It is the selection of animals by human interventions by adopting different basis of selection.

11.2.2 Basis of Selection

1. Individual selection
2. Pedigree selection
3. Progeny testing.

1. Individual Selection

It means the selection of individuals on the basis of their phenotypic characteristics. It is the most commonly used method for selective improvement in livestock. Its accuracy depends on the heritability of the traits.

Advantages

1 This method is most accurate and easy.
2. It is very effective when heritability of the trait is high.
3. Generation interval in selected animals is very short.
4. Selection can be done on the farm under normal managemental conditions.

Disadvantages

1. It is less effective when heritability of the traits is low.
2. It is not useful for sex-limited traits and carcass traits.
3. It is difficult to make selection for traits which are not expressed until maturity.

2. Pedigree Selection

- It means the selection on the basis of performance of ancestors.
- It is based on the fact that relatives possess many of the same genes.

Advantages

1. It is useful when inadequate information is available about the individual.
2. It helps in selection of individuals at young age.
3. It is useful for selecting the individuals when the traits cannot be measured in them.
4. It is very useful when the traits selected are highly heritable.
5. It is useful for selection of sex-limited traits in both males and females.

Disadvantage

1. Its accuracy is low as compared to other methods.
2. Pedigree record maintenance is time consuming.

3. Progeny Testing

It means the selection of individuals on the basis of average performance of their progeny.

Advantages

1. It is useful for selection of males.

2. It is highly useful for selection of sex-limited traits.
3. It increases the accuracy of selection for traits having low heritability.

Disadvantages

1. Generation interval is long.
2. High reproductive efficiency is required.
3. Selection intensity is very low because only few animals can be tested.

11.2.3 Methods of Selection

The different methods of selection are

1. Tandem method
2. Independent culling method
3. Selection index method.

1. Tandem method

In this method, only one trait is selected at a time. The process of selection is continued till goal for selected trait is achieved. After achievement of first goal, selection is directed towards another trait.

Advantage

1. Selection for one trait results in improvement in other traits also.

Disadvantages

1. This is highly inefficient method if traits are not genetically related.
2. Sometimes improvement made in the first trait is lost when selection is directed to another trait.
3. The rate of genetic improvement is very slow.

2. Independent culling method

In this method, selection is made for few traits at a time.The minimum standard is set for each trait and the animals which do not meet the minimum standard are culled. The effectiveness of this method depends on the standard chosen for each of the traits.

Advantages

1. Selection can be practised for two or more traits simultaneously.
2. Animals which do not meet the minimum standard can be culled at an early age.
3. This method is superior than tandem method.
4. The rate of progress per unit time is more as compared to tandem method.

Disadvantages

1. The animals which are superior in one trait and little inferior in another trait are also culled.
2. The number of animals selected will be very small, if high standards are fixed.
3. The adequate number of animals are not culled, if low standards are fixed.

3. Selection index method or Total score method

In this method several traits are selected simultaneously. It is the most effective method of mass selection. The selection is made on the basis of selection index calculated for each individual based on different traits.

The selection index is calculated based on the weightage given for each trait which depends upon relative economics of the trait, heritability of the trait and genetic correlation between traits.

The individuals with higher selection index are selected for breeding.

Advantages

1. It is superior to both Tandem and Independent culling method.
2. Selection can be made for several traits at a time.
3. The superiority of this method increases as the number of traits increases.
4. There is maximum progress per unit time.

5. Less time and efforts are required.

Disadvantages

1. Use of selection index sometimes results into masking certain bad characters.
2. Practical indices are not available for all classes of animals.

11.4 Conservation of Local Germplasm :

Can you tell ?

Which is the best method of selection & why?

Can you recall ?

1. **The difference between conservation and preservation of local breed?**
2. **Why conservation of local germ plasm in livestock are essential?**

In India the indigenous cattle breeds have evolved over generations to adapt to the local agro-climatic and socio-economic needs of people. These indigenous breeds of cattle are now subjected to fast genetic degradation and dilution because of unplanned breeding, crossbreeding and introduction of exotic germplasm. The extensive crossbreeding of native breeds of cattle with exotic breeds in order to increase milk production is the main factor which has contributed to loss of cattle biodiversity. Further, mechanization of agriculture and introduction of various means of transportation, the utility of male cattle is reduced.

Causes of genetic erosion / losses of Indigenous cattle breeds

1. Low milk producers with poor reproduction performance.
2. More emphasis is given to introduce exotic /crossbreds.
3. Adaption of mechanization in agricultural operations and transport.
4. Natural disasters such as drought and floods.
5. Effect of global warming

The FAO expert panel on conservation of Animal Genetic Resources proposed that whenever the population size of breed reduces to 5000 breeding females, appropriate action should be initiated for conservation. The panel observed that in case of developing countries, a breed with an effective population size of less than 2000 is to be taken as a rare, with less than 500 as vulnerable and less than 100 as endangered. The following classification is suggested for Indian condition.

Table 11. 4 Classification of breed on the basis of number of breeding females

Sr. No.	Status	No. of breeding females
1	Normal	more than 25000
2	Insecure	15,000- 25,000
3	Vulnerable	5,000- 15000
4	Endangered	2000-5000
5	Critical	Less than 2000

Observe and discuss...

- **Some Indigenous breeds are getting threatened, while others are in process of replacement by certain high producing strains. If this trend continues for few years, the valuable native breeds germplasm would grossly be depleted or even lost forever.**
- **Conservation of Indigenous breeds of cattle is essential due to their potentiality for sustainable milk production with locally available fodder, draught tolerence, high resistance to diseases and heat tolerance ability.**

Internet my friend

Classify the status of native breeds of Maharashtra based on current livestock census.

Based on the classification, many of our indigenous breeds are under insecure stage. Therefore, it is necessary to improve and conserve the valuable local germplasm.

Methods of conservation

The methods of conservation of animals are as follows:

1. ***In-situ* conservation:** It means the conservation of germplasm in its natural habitat. It can be achieved by establishment of cattle breeding farms.

Advantages

1. Live animals can be evaluated and improved over the years.
2. Genetic defects can be identified and eliminated.
3. Live animals act as a gene bank for future use.

Disadvantages

1. It involves a large infrastructure viz., land, building, feed and fodder sources, water supply and man power.
2. This method is not appropriate for the breeds which are uneconomical.

Remember...

A herd size of about 100 breedable females is necessary for *in situ* conservation of breed.

2. ***Ex-situ* conservation :** It means conservation of germplasm outside the natural habitat. This can be achieved by cryogenic preservation of sperms (frozen semen), oocytes, embryos, DNA and embryonic stem cells.

Advantages

1. It is possible to maintain population without genetic change.
2. It is comparatively more convenient, economical and easy with the application of modern reproductive technologies.

Conservation strategies

1. **Survey of breeding tract** : It is very essential to conduct surveys in the breeding tract to know the present status of breed in terms of its population, management practices, physical characteristics, utility and performance and availability of local feed/fodder. The breeding objectives relevant to an area and needs of people should be identified for each indigenous breed.

Can you recall ?

Breeding tracts of native livestock breeds of Maharashtra.

2. **Establishment of livestock conservation boards :** It is necessary to establish livestock conservation boards in each state where data pertaining to the breeds of their state can be maintained in computerized form. The state level data banks should be linked to the national data bank through computer network.
3. **Establishment of Breed Societies / Breeders Association:** There is an urgent need to form breeders association/ societies for each breed. The movement of improvement, up gradation and conservation of the native cattle breeds, can't be successful without involvement of farmers. These societies should

Do you know ?

Where Maharashtra livestock developement board is situated?

monitor all activities related to particular breed including genetic improvement, conducting cattle shows, identifying the areas of research and to act as a liaison between Government, Veterinary/ Agriculture Universities, research institutions, organized farms and farmers.

4. **Live animal repositories :** The existing farms of native breeds should be declared as bull mother farms and used for production of bulls and semen.

Can you tell ?

The breed Societies registered for different native breeds in India.

5. **Establishment of gene banks :** Germplasm repositories in the form of semen and embryo banks should be established in different regions and even the at national level.

6. **Human resource development programmes:** Trained personnel are required for undertaking conservation programmes therefore the training programmes should be organized for persons involved in evaluation of animal genetic resources under field condition.

7. **Information center :** An information center should be established on native breeds of cattle and it should have information about their distribution, physical and molecular characteristics, farming practices, breed herds and availability of elite breeding male and females. The information should be periodically updated and easily available to all through social media.

Internet my friend

Collect information about available websites developed for Indian cattle breeds.

EXERCISES

Q.1 Fill in the blanks

1. …….. is defined as mating of purebred sire with non-descript female.
2. In …….. method of selection only one trait is selected at a time
3. …….. is the most effective method of selection when heritability of trait is high.
3. Mating of unrelated animals of different breeds is called ……..
5 ……. basis of selection of animals can be done on basis of performance of ancestors.
6. When the number of breeding female is less than 2000, the status of breed is categorized as ……..

Q. 2 Make the pairs

A (Status)	B (Number of breeding females)
1. Normal	a. 2000 to 5000
2. Vulnerable	b. Less than 2000
3. Critical	c. More than 25000
	d. 15,000 to 25,000
	e. 5000 to 15000

Q. 3 State true or false

1. The mating of animals of same breed having no close relationship in 4 to 6 generation is known as outcrossing.
2. The breeding between indigenous cows with exotic bulls should be more scientifically called as species hybridization.
3. Mating of sire to daughter or son to dam is the example of line breeding.
4. Progeny testing is the highly useful basis of selection for traits having low heritability.
5. Grading up is mainly used for improvement of non-descript animals.
6. Inbreeding increases while outbreeding decreases the breeding value.

Q.4 Answer in brief

1. Differentiate between close breeding and line breeding.
2. Define inbreeding and give its effect.
3. Distinguish between *In-situ* and *Ex-situ* methods of conservation.
4. Enlist the causes of genetic erosion/ losses in indigenous cattle breeds.
5. Give the systems of breeding in flow chart.
6. Write in brief about tandem selection method.

Q.5 Answer the following questions:

1. Explain the rotational crossing with suitable flow chart.
2. Complete the given table

Male		Female		Progency (F_1)
Jack	×	.....	→	Mule
Stallion	×	Jennet	→	.....
..... cattle	×	American Buffalo	→	Cattalo
Stallion	×	.....	→	Zebroid

3. Explain the triple crossing method with suitable flow chart.
4. What do you mean by independent culling method and give its advantages.
5. Give advantages and disadvantages of progeny testing method.

Q.6 Answer the following questions in detail

1. Explain methods of crossbreeding with its advantages and disadvantages.
2. Discuss in details about the conservation strategies for indigenous livestock.
3. Enlist different methods of selection and explain in detail selection index method or total score method.
4. Define grading-up and explain it with suitable example.
5. Define selection and explain individual selection with its advantages and disadvantages.