

# CHAPTER 2

## Animal Improvement

### OBJECTIVES

At the end of the chapter, students should be able to:

- â—† explain the meaning of animal improvement.
- â—† state the aims of animal improvement.
- â—† describe the various methods of animal improvement.
- â—† state the effects of each of the process in animal improvement.
- â—† explain the term artificial insemination as an instrument of breeding.
- â—† state the advantages and disadvantages of artificial insemination.

### 2.1 Introduction

Most of the livestock owners allow their animals to mate freely and accept the results as they come. However, with trained personnel in animal production as well as increase in the demand for animal products, modern breeding techniques are required to meet these challenges. Animals with desirable characteristics are selected and crossbred or improved using up to date biotechnological techniques to obtain desirable results. Some of the desirable characteristics are high milk yield, high feed conversion, meat quality, resistance to disease and pests, early maturity and good body conformation.

### 2.2 Meaning of Animal Improvement

Animal improvement is a process whereby inherited superior traits are transferred from one animal to the other of the same species.

Certain characteristics such as good feed conversion, growth rate, meat quality, high milk yield, good body form, egg size and resistance to diseases and pests are the major considerations in animal improvement. The knowledge of genetics and reproduction is essential to enable the farmer to combine

certain factors as to get good results. Most of the indigenous breeds of animals are relatively small in size but highly resistant to diseases and pests, while exotic breeds are big and early maturing but with low resistance to diseases and pests. When they are crossbred the genetic transfer takes place and the result is better.

### 2.3 Aims of Animal Improvement

The following are the aims of animal improvement:

- â—† To improve yield in terms of meat, milk and egg.
- â—† To produce animals with high growth rate.
- â—† To produce animals that are resistant to diseases and pests.
- â—† To produce animal products with improved quality such as butter fat percentage in milk, yolk size, hardness of shell and wool quality in sheep.
- â—† To transfer an inherited superiority from one species to another.
- â—† To produce animals with high rate of feed conversion.
- â—† To produce animals that adapt to the prevailing climatic conditions.
- â—† To produce animals that meet a particular purpose. For example, work animal, dairy animal.
- â—† To produce different breeds of animals.

### 2.4

### Methods of Animal Improvement

There are various methods of animal improvement as discussed below:

- (a) Introduction
- (b) Selection
- (c) Breeding
- (d) Genetic engineering

### 2.4.1 Introduction

This involves the movement of breeds of animals from one country to the other or from one farm to another farm. Most of these breeds possess high productive capacity and desirable characteristics.

Animals to be introduced are often quarantined for a stipulated period according to international regulation. The period of quarantine depends on the incubation period of the disease under consideration. Where the animal fails the quarantine test, it is returned or destroyed at the expense of the importer.

Introduced animals must be better than the local breeds. Introduction can be in the form of physical importation of animals or their spermatozoa. Foreign animals are referred to as exotic breeds. They are mostly used to improve animals like poultry, pigs, cattle, sheep and rabbits.

Examples of exotic livestock breeds are

**Pig:** Duroc, large white

**Cattle (dairy):** Friesian, Holstein Jersey

**Cattle (beef):** Aberdeen Angus, Short horn, Red Devon.

### Advantages of Introduction

â—† Animals which were originally alien are brought in and reared in other countries.

â—† Breeds of animals with better quality are produced.

â—† It enhances greater productivity.

â—† Animals introduced nearly perform better than the local breeds.

â—† It leads to increase in the number of herds of animals.

### Disadvantages of Introduction

â—† It may encourage the introduction of diseases and pests in an area.

â—† Animals may find it difficult to adapt to the prevailing climatic conditions.

â—† The animals may not perform as expected.

â—† Animals may be susceptible to local diseases and pests in the environment.

### 2.4.2 Selection

This is a method where by a preferred animal is chosen from the population for breeding based on phenotypic features. Such features include

â—† growth rate

â—† colour of the coat or feathers

â—† size

â—† resistance to diseases and pests

â—† fertility rate

â—† milk quantity and quality.

### Types of Selection

There are two types of selection namely:

**1. Natural selection**

**2. Artificial selection**

**Natural selection:** These operate on the basis of the survival of the fittest. Individuals with the ability to withstand the unfavourable environmental forces survive to reproduce. Those which are

not able to withstand the environmental forces die off. This is based on Charles Darwin theory that nature selects those traits or characteristics that are useful to it and rejects those not useful.

**Artificial selection:** This is a type of selection carried out by man using his intelligence and influence to select and mate graftimproved stem cells in the animals. There are five types of artificial selection namely:

1. Mass/individual selection
2. Progeny selection
3. Pedigree or family selection
4. Selection based on show ring (animal show)
5. Selection based on the type of the animal

**Mass/individual selection:** This type of selection is based on the merit or individual performance. Animal with a distinct desirable characteristics are chosen from the group.

**Progeny selection:** This is the selection of breeding stock based on the performance of the offspring or progeny. Mother of the animals with desirable characteristics/quality is retained while those with undesirable traits are culled or sold out.

**Pedigree/family selection:** This involves selecting animals based on the family merits. It requires adequate record keeping. Some animals inherit certain traits from their ancestors and as such, the animals may even perform better than their ancestors.

**Selection based on showing (animal show):** This selection is based on prized animals displayed at the agricultural exhibition. Animals in this group are believed to have passed a series of tests and are exhibited for their proven traits.

**Selection based on the type of the animal:** Selection is based on the type of the individual animal. This is commonly used in selecting animals in commercial herds or purebred herds. Animals that meet selected standards or ideal are chosen for breeding. The whole animal or its components such as the semen or stem cells are used for breeding.

### **Advantages of Selection**

- â—† Animals with desirable traits are selected.
- â—† Animals from best breeds are used for breeding purposes.
- â—† It reduces the spread of diseases and pests.
- â—† Animals of undesirable characteristics are culled or rejected.

### **Disadvantages of Selection**

- â—† Certain desirable traits may be obscure or not exposed in the animals due to environmental factors.
- â—† It requires expertise in order to practice which may not be available.
- â—† It is time consuming and expensive.
- â—† Does not introduce new genetic traits, and so new desirable traits are not introduced.
- â—† Selection is based on the phenotypic features only.

### **2.4.3 Breeding**

Breeding is a process of developing new types of animals with improved characteristics. This is done through conventional (traditional) and modern breeding (biotechnology and genetic engineering) techniques.

### **Conventional Breeding Techniques**

There are five types of conventional breeding methods namely:

1. Inbreeding
2. Out breeding

3. Crossbreeding
4. Line breeding
5. Upgrading

**Inbreeding:** This is the act of mating genetically closely related animals such as mother and son, father and daughter.

These are described as follows:

- â—† Full sibs (full brothers ã— full sisters)
- â—† Half sibs (full brothers ã— full sisters)
- â—† Parents ã— offspring (father ã— daughter, ã— mother ã— son)
- â—† Cousins ã— cousin
- â—† Uncle ã— niece
- â—† Aunty ã— nephew

### **Advantages of Inbreeding**

- â—† It helps to identify and cull undesirable recessive genes.
- â—† It helps in the study of the actual genetic worth of an animal.
- â—† It helps to develop inbred lines that can be used for crossing purpose to exploit hybrid vigour.
- â—† It increases homozygosity as most desirable genes are dominant.
- â—† It helps the farmer to get desired character or quality well developed in an animal.
- â—† It enhances prepotency as the farmer is sure that the animal is virile and has the ability to exhibit the trait in the offspring.

### **Disadvantages of Inbreeding**

- â—† There is reduction in genetic variability in the population; hence no progress is possible from selection.
- â—† Continuous inbreeding leads to fixation of genes at various loci.
- â—† Certain deleterious genes become homozygous with disastrous consequences.
- â—† It creates inbreeding depression.
- â—† It increases mortality in poultry.
- â—† Rate of egg production and number of eggs are reduced.
- â—† Inbreeding reduces hatchability and also sexual maturity.
- â—† They tend to grow more rapidly and are more economical to rear.
- â—† Their progeny possess better qualities than their parents.
- â—† It promotes higher yield of eggs, meat and milk in offspring.

**Out breeding:** This is the act of mating unrelated individuals within the same breeds. The performance of the offspring will be better than either of the parent because different traits are combined in the offspring.

### **Advantages of Out Breeding**

- â—† Offspring produced have higher vigour and productivity because new traits have been injected in the animal.
- â—† Offspring of these products can withstand variation within the environment.
- â—† It is used to recover lost trait.
- â—† It produces pureline.

### **Disadvantages of Out Breeding**

- â—† May not improve the resistance or tolerance of a particular breed of animals to certain pests and diseases of that breed.
- â—† It may lead to reduction in production such as low milk yield, egg and slow growth rate.

**Crossbreeding:** This is the mating of unrelated individuals belonging to different breeds to produce offspring which will combine characteristics from both parents. An example is the mating between Nâ€™dama and Muturu cattle. This method gives rise to hybrid vigour or heterosis. It makes the desired trait to be dominant over the undesired trait. Different forms of crossbreeding include

- i. crossbreeding of two genetically different purebred lines
- ii. mating of first generation cross between two breeds
- iii. mating of first generation of the crossbreed with another breed of another variety.

### **Advantages of Crossbreeding**

- â—† Offspring have more vigour and vitality than their parents.
- â—† They are more virile and better to resist adverse weather conditions.
- â—† They tend to grow more rapidly and are more economical to rear.
- â—† Their progeny possess better qualities than their parents.
- â—† It promotes higher yield of eggs, meat and milk in offspring

**Line breeding:** This is the mating of individuals that are not closely related such as (half brothers – half sisters). It is used to consolidate some traits in a sire or dam. Line breeding helps in developing pureline individuals without having to produce several undesirable traits. Individuals with undesirable traits are culled out.

**Upgrading:** This is a process of mating a female of low grade stock which is desired to a male of a pure breed constantly. The purpose is to bring about a change of character in the low quality breed. In this case a new breed that is adapted to the environment is developed. Upgrading method is commonly used in poultry, swine, sheep, cattle and goat.

### **Artificial Insemination**

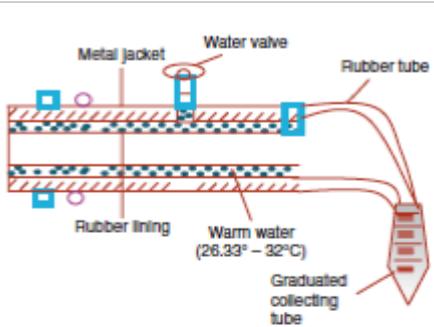
This is a technical process by which the semen is collected from the male animal and introduced into the female reproductive tract at proper time (heat period) with the help of an instrument to effect fertilization and subsequent production of new offspring. The parent animals are carefully selected and proven to have preferred qualities.

The artificial insemination process varies considerably in different species. The semen may be collected from male using the following methods:

- â—† By means of artificial vagina.
- â—† By the use of the breedâ€™s bag, a rubber pouch placed over the penis of the male before service with a female on heat.
- â—† By the recovery of semen from the vagina soon after natural service.
- â—† By electrical stimulation of ejaculation.
- â—† By massage method.
- â—† By mounting a teacher.

### **Steps involved in artificial insemination technique**

- â—† Collection of semen from male animal.
- â—† Examination of semen for quality.
- â—† Semen dilution.
- â—† Semen storage.
- â—† Insemination or deposition of semen in the reproductive tract of the female.



**FIGURE 2.1 Artificial vagina for collecting semen**



**FIGURE 2.2 A bull mounting a teaser**

### 2.5.1 Method of Collecting Semen

Semen may be collected from the male using various methods. But the use of artificial vagina is the most common method. The artificial vagina consists of a metal jacket which is lined with layers of fine and smooth rubber, smeared with Vaseline or any lubricant.

The space in the rubber lining is filled with warm water at a temperature of  $26.33^{\circ}\text{C}$ – $32^{\circ}\text{C}$ . One end of the vagina is open to allow the entrance of the penis, while the other end is fixed to a cylindrical tube to collect the semen.

A teaser is provided to get the bull to concentrate on the sexual act, in order to ejaculate. An old barren cow can be used as the teaser and when the bull mounts the cow, the penis is quickly diverted into the artificial vagina where the semen is collected without contamination. The operation has to be carried out using clean instruments and also in a dust-free clean surroundings. After the collection of the semen, it is diluted 20 times or more with specifically prepared sperm dilutent such as egg yolk, citrate loafer, and stored at very low temperature. While storing under freezing conditions, it is necessary to add some additives like glycerol. This enables the sperm to withstand a temperature of about  $-79^{\circ}\text{C}$  without losing its power to fertilize when thawed. Also it is necessary to add some antibiotics like penicillin, streptomycin, and sulphanilamide to prevent and control the growth of bacteria in the sperm. The antibiotic also prevents and reduces the incidence of diseases, when the sperm contains some pathogenic organisms.

**Insemination process:** It requires:

- â—† a catheter which consists of a long tube similar to the sire penis.
- â—† thin wall plastic pipette to hold the semen which is attached to the catheter.
- â—† small quantity of lubricant to allow easy deposit of the sperm.

### Artificial Insemination Process

â—† Artificial insemination is normally carried out during the oestrus (heat) cycle in the animal.  
 â—† The farmer should endeavour to note the period to enable him carry out the process effectively.

â—† Most animals on heat stand firm when pressure is applied to the loin region in the absence of

a sire (male animal).

â—† The catheter is first lubricated with Vaseline or any lubricant and inserted carefully and firmly into the vagina.

â—† The inserted catheter is twisted anticlockwise until it â€˜locksâ€™ into the cervix.

â—† When the catheter is properly positioned, the plastic semen container/pipette should be attached and squeezed gently to allow the passage of the semen into the vagina. It may take about 10–15 min for a successful operation.

â—† The operator should be patient enough not to do the job hastily; otherwise the semen will be forced out of the vagina.

â—† Properly wash the catheter using hot water and sterilize for about 10 min.

â—† Disinfectants and detergents should not be used in cleaning the instrument.

### **Advantages of Artificial Insemination**

â—† It reduces the spread of venereal diseases in animals as a result of crossing.

â—† There is less wastage of spermatozoa.

â—† It reduces the cost of keeping and maintaining a sire.

â—† It increases profit, since offspring of outstanding sire (male) are more efficient producers.

â—† It helps in the improvement of farm animals.

â—† Many female animals can be serviced with the same semen.

â—† It makes for tested and ascertained performance of offspring particularly male within a short time.

â—† It helps to quicken the upgrading of local breeds and movement of animal germ plasma about the world.

â—† Deformed and blind male animals can mate and produce offspring using their semen if they are of proven quality.

â—† It is comparatively less expensive than bringing a live animal for natural mating. Semen is easy to carry.

â—† The semen of a good bull can still be used long after the bull is dead.

### **Disadvantages of Artificial Insemination**

â—† Some diseases that are transmitted through semen, not necessarily through copulation, can still be transmitted by artificial insemination.

â—† The cost of expertise required for a successful programme in artificial insemination is not easy to come by. It also requires training of personnel, semen collection, processing and storage of semen.

â—† There is the problem of detecting animal on heat.

â—† It may be difficult to practice by smallscale farmers.

â—† Animals may be deprived of enjoying sex.

## **2.6 Genetic Engineering**

This is the process of altering the genetic constitution of an organism in order to eliminate undesirable characteristics or to produce desirable new ones.

### **Advantages of Genetic Engineering**

- 1.** It has potential to increase animal food production.
- 2.** It can lead to production of new types of animals that meet specific desires or needs such as milk or meat production.
- 3.** It is also useful to dispose off industrial waste.
- 4.** It helps to diagnose diseases and improve treatment of animals. Apart from selective breeding (selection) and hybridization (crossbreeding), the following modern techniques are important:

**Gene splicing:** This is a process by which scientists alter the genetic materials to form a

recombinant DNA. Genes consist of segments of DNA molecules. In this process one or more desirable genes of one organism are introduced to another organism; if the second organism to which it was introduced accepts the gene(s), then it is called a recombinant DNA, and the organism will exhibit that character.

**Cloning:** This is a process by which scientists remove the DNA containing nucleus from a female's egg and replace it with a nucleus from another animal of similar species. The egg is then placed in the uterus of the third animal called the surrogate mother. When born, the offspring looks like the first animal from which the nucleus was obtained. The first cloned animal to be born by its surrogate mother was "Dolly" a cloned sheep in 1996.

## ACTIVITY

Visit a nearby animal farm and identify the differences and similarities between different breeds of livestock.

## SUMMARY

— Animal improvement involves the process of transferring inherited superior traits from one animal to the other.

— The aims of animal improvement includes

- to improve yield in terms of meat, milk and egg production
- to produce animals with high conversion rate
- to produce animals with high growth rate.

— The methods of animal improvement are as follows:

- Introduction
- Selection
- Breeding
- Genetic engineering

— Artificial insemination is the introduction of semen into the reproductive tract of the female by a method other than natural mating. Its advantages and disadvantages are:

- It is easier and less expensive than natural mating.
- It reduces the cost of keeping and maintaining a sire.
- The animals are deprived of sex readily available.

## REVISION QUESTIONS

### ESSAYS

1. (a) Explain the term artificial insemination.  
(b) State four advantages and three disadvantages of artificial insemination.  
(c) State five advantages of selection. **(NECO 2007)**

2. (a) Write short notes on the following systems of breeding:

- (i) Inbreeding
- (ii) Line breeding
- (iii) Crossbreeding

(b) State the three methods of collecting semen from a proven male for use in artificial insemination. **(WASSCE 2000)**

3. (a) What is animal improvement?  
(b) Describe three methods of animal improvement.  
(c) State the advantages of artificial insemination.

4. Write short notes on

- (a) Mass selection
- (b) Pedigree selection
- (c) Crossbreeding

- 5.** (a) Describe the application of this process to any suitable example of livestock you have studied.  
(b) What are the advantages of this process?

## **OBJECTIVE QUESTIONS**

**1.** When different breeds of animals are mated, the process is known as

- (a) crossbreeding.
- (b) inbreeding.
- (c) out breeding.
- (d) line breeding.

**2.** Mating of animals with close genetic selectionship is termed

- (a) crossbreeding.
- (b) line breeding.
- (c) inbreeding.
- (d) out breeding.

**3.** Which of the following characteristics is not normally considered in the selection of animals for breeding?

- (a) Fertility
- (b) Growth rate
- (c) Horn size
- (d) Resistance to disease

**4.** Progeny selection involves selection of breeding stock on the basis of

- (a) merit of each animal.
- (b) sire-dam relationship.
- (c) merit of the dam only.
- (d) performance of offspring.

**5.** Using Nâ€™dam bull to mate Muturu cow is an example of

- (a) inbreeding.
- (b) selection.
- (c) crossbreeding.
- (d) artificial insemination.