Introduction to Animal science

BONGA UNIVERSITY

COLLAGE OF AGRICULTURE AND NATURAL RESOURCE MANAGEMENT

PLANT SCIENCE DEPARTMENT

Handout for the course introduction to animal science

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CHAPTER ONE

INTRODUCTION: DOMESTICATION AND ORIGIN OF ANIMAL HUSBANDRY

INTRODUCTION

This chapter introduces you about general concept of animal science which is the important introduction part for the course. Domestication and origin of animal husbandry, Role of livestock production and classification of livestock production systems in Ethiopia can be discussed briefly.

Learning Objectives

After you have studied this chapter, you should be able to:-

- ✓ *Describe briefly what mean animal science.*
- ✓ *Describe how, why, and when domestication occurred.*
- ✓ *Give an overview on the role of livestock production.*
- ✓ *Explain livestock production systems in Ethiopia.*

1.1 Introduction to Animal Science

Animals, we live with them, worship them, consume them, admire them, fear them, love them, care for them, and depend on them. They are part of our nutrition, our sociology, and our day-to-day lives. Because they are so important to us, we also study them and apply what we learn to improve their lives and enhance their roles in our lives. The branch of science that deals with domestic animals is animal science.

Much of our use for animals revolves around their contributions to our food supply. To coax a more stable food supply from the land, humans developed a complicated resource management system called agriculture. Agriculture is combination of science and art used to cultivate and grow crops and livestock and process the products. In agriculture, domestic plants and animals are kept to produce for humankind's needs. Humans have practiced agriculture for thousands of years and, either directly or indirectly, every person on the planet depends on agriculture for his or her daily food. Because this is true, it is also ultimately true that all of humankind's other occupations are tied to agriculture. This is especially the case in the world's developed countries. In fact, the entire urban industrial complex of the developed world is sustained only because of food surpluses generated by agriculturists.

Humans have found many other uses for domestic animals in such areas as sports, recreation, manufacturing, religion, scientific research, and as companions. Add these uses to food production and we discover that animals are at the core of virtually all of our lives, whether or not we are aware of it. Because agriculture and its animals are integral to our existence, they have become a dominating part of our culture, our influence on the landscape, and, either directly or indirectly, our day-to-day activities.

Exactly when individual animal species were domesticated is unknown. Humans did not plan their dependence on the animals they tamed and then domesticated. Hunter-gatherers (who first domesticated animals) used the meat, bones, and skins just as they had done before domestication. The only difference after domestication was convenience. The additional uses (milk, clothing, power, war, sport, and prestige) came later. This happened after people had lived in the company of animals for a long time in a more sedentary lifestyle.

Humans had hunted and consumed animals for 2 million years before domesticating them. The behavioral change required for hunters and gatherers to become farmers was a major cultural revolution and a major step toward what we call ***civilization***. With our acquisition of domestic animals came the need to ultimately manage them, care for them, and learn to use them to our best advantage. Meting those needs led to the development of the discipline of study that we call animal science.

Animal science is simply the collective study of domestic animals. This includes every aspect, from conception to death, behavior to management, physiology to nutrition, and reproduction to product distribution. Animal science represents an accumulation of knowledge that began with observations of those hunter-gatherers who began the process of domestication long ago. As animal scientists have learned more and more about animals, the accumulated wealth of information has become too large for any one person to comprehend completely. Out of necessity, its study is divided into disciplines, or specialties, as a means of creating manageable pieces. These specialties may be broken down several ways. **Genetics:** The science of heredity and the variation of inherited characteristics. **Heredity**: The transmission of genetic characteristics from parent to offspring. **Animal breeding**: The use of biometry and genetics to improve farm animal production. **Biometry:** The application of statistics to topics in biology. **Genetic code:** The set of rules by which information encoded in genetic material (DNA or RNA

sequences) is translated into proteins (amino acid sequences) by living cells. **Nutrition**: The study of nutrients and how the body uses them. **Physiology**: The study of the physical and chemical processes of an animal or any of the body systems or cells of the animal. **Animal health:** The study and practice of maintaining animals as near to a constant state of health as is possible and feasible. **Animal behavior**: The study of animal welfare assessment, optimizing production, behavioral control, behavioral disorders, and behavioral genetics. **Meat science:** The science of handling, distributing, and marketing meat and meat products. **Meat**: The flesh of animals used for food. **Dairy product science**: The science of providing milk and milk products as food. **Biotechnology**: A collective set of tools and applications of living organisms, or parts of organisms, to make or modify products, improve plants or animals, or develop microorganisms for specific uses.

1.2 Domestication and Origin of Animal Husbandry

To domesticate means to adapt the behavior of an animal to fit the needs of people. The domestication of animals began when early humans had contact with wild animals, which they hunted for food and skins. After a period of time these early humans began to confine some of these animals to ensure a steadier supply of food and clothing. Domestication was not a single event, but a process repeated at various periods in different places. The first wild animal to be domesticated was the dog.

These animals were bred in captivity to replace those that were used. Humans later learned to select animals with certain desirable characteristics to use for breeding purposes. As a result of selective breeding, identifiable breeds began to be developed that would breed true for those characteristics that were determined to be desirable. Before the human race learned to tame and raise animals, it was dependent on hunting and wild plants for food and clothing. With the domestication of animals came the beginnings of a more settled way of life. Domesticated animals supplied a surer source of food and clothing. A better food supply meant an increase in population. More people made it possible to divide the labor within the tribe. Some historians believe that the human race would never have become civilized without the domestication of animals. Domesticated animals are those that are of use at home and are easily bred and looked after by humans. Common domesticated animals are dog, horse, cow, sheep, buffalo, fowl etc.

Animal Husbandry is branch of science, which deals with the study of various breeds of domesticated animals and their management for obtaining better products and services from them. Animal husbandry is the branch of agriculture concerned with animals that are raised for meat, fiber, milk, eggs, or other products. It includes day-to-day care, selective breeding and the raising of livestock. The term husbandry derives from the word "husband" which means 'one who takes care'. When it incorporates the study of proper utilization of economically important domestic animals, it is called Livestock Management.

Husbandry has a long history, starting with the Neolithic revolution when animals were first domesticated, from around 13,000 BC onwards, antedating farming of the first crops. By the time of early civilizations such as ancient Egypt, cattle, sheep, goats and pigs were being raised on farms.

Traditionally, animal husbandry was part of the subsistence farmer's way of life, producing not only the food needed by the family but also the fuel, fertilizer, clothing, transport and draught power. Killing the animal for food was a secondary consideration, and wherever possible its products, such as wool, eggs, milk and blood (by the Maasai) were harvested while the animal was still alive. In the traditional system of transhumance, people and livestock moved seasonally between fixed summer and winter pastures; in mountain regions the summer pasture was up in the mountains, the winter pasture in the valleys.

Domestication of animals produced a dramatic change in the way people lived. Civilizations which had relied on hunting and gathering as a means of subsistence now built permanent settlements and engaged in a pastoral existence relying on their cale and crops. Once people realized that animals could be tamed, the creatures became incorporated into the most basic and widespread rituals of the culture.

1.3 The Role of Livestock Production

Livestock plays a vital role in the livelihood of many people in the world. In Ethiopia, livestock are an **integral (essential) part of the farming community** in the highlands; while they are the **entire/major basis** for the livelihood of pastoralists and agro-pastoralists in the lowlands. In general, livestock production in tropical countries of the less-developed world has been and will be one of the most important economic and social activities of human culture. They are valued for one or several (sometimes all) of the following traits: **capital**, **credit**, **traction, milk, meat,**

hides, fuel and fertilizer. Thus, for families without land, livestock are primarily a means of increasing family income.

In general, livestock have the following roles:

i. ***Sources of food***: they provide high-quality food **(meat, milk and eggs)** by converting large quantities of materials that cannot be used directly for human food. Animal foods are generally preferred over plant foods by human.

ii. ***Sources of power:*** livestock provide the power to cultivate at least 320 million hectares of land (FAO, 1994), or one-quarter of the total global cropped area. In Ethiopia, livestock are the major sources of power for **cultivation, threshing and transportation**. They provide power for about 96% of the cultivated land.

iii. ***Sources of natural* fertilizer and fuel**: livestock provide **organic fertilizer** which helps to enhance soil fertility and vegetation cover. One tone of manure provides about 230 kg organic matter, 4.6 kg Nitrogen, 4.6 kg potassium and 2.3 kg phosphoric acid. Manure can also be used for fuel either as manure cake or methane gas and hence reduce the pressure on natural vegetation.

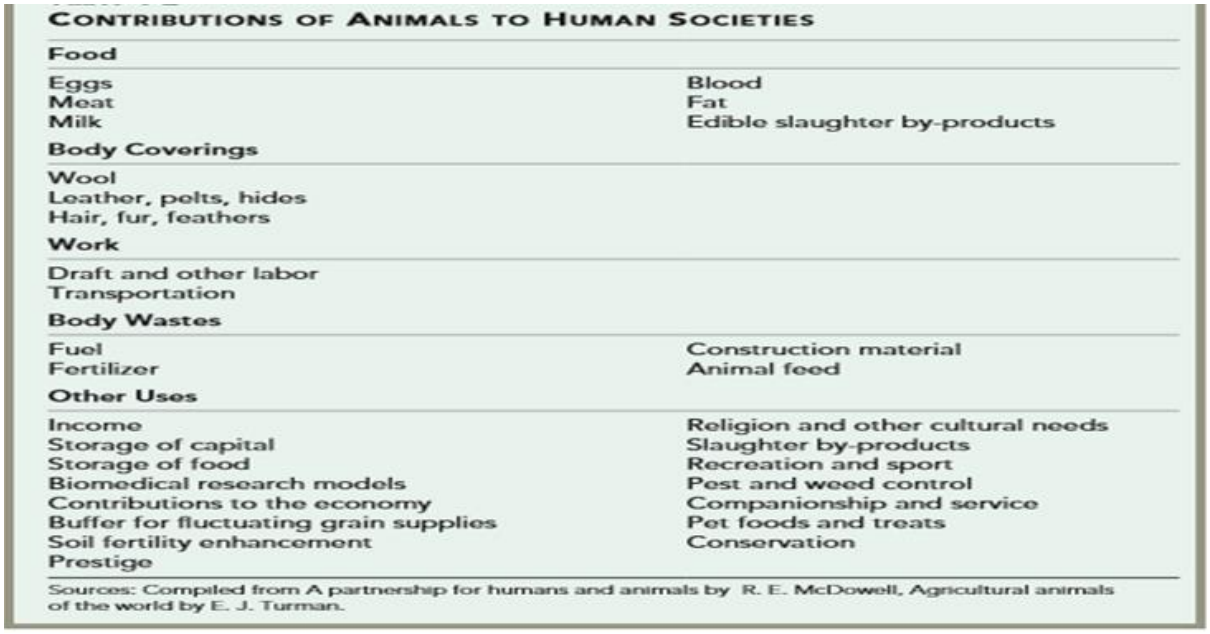
iv. ***Sources of income and living bank:*** Livestock are important sources of income for at least 200 million smallholder farmers in Asia, Africa and Latin America. Since the rural capital market is limited, livestock are farmers' **largest capital asset** (live bank), and **cash at hand**. They are often sold to generate cash for the purchase of **food** and **agricultural inputs** and to meet **social obligations** etc.

v. ***Source of employment***: Some of the livestock (dairy, the meat sectors and small scale processing and marketing, etc.) enterprises are labor-intensive. Backyard goat, sheep and poultry are important sources of work for landless households especially women and children.

vi. ***Foreign currency***: livestock also plays a significant role in producing **export commodities** such as hides and skins, live animals, meat, honey, beeswax to earn foreign exchange to the country.

vii. ***Social activity***; Beyond the important role that livestock play in the provision of food and nutrition in people's diets, they also have important social functions. They raise the social status of owners and contribute to gender balance by affording women and children the opportunity to own livestock, especially small stock.

They also enable good use of the resources available to farmers-land, **labor, capital, and management ability.** In mixed farming, livestock reduces the risk through diversification of production and income sources. Moreover, they enable to fulfill **social, cultural, religious requirements** and **obligations** of the community.



CONTRIBUTIONS OF ANIMALS TO HUMAN SOCIETIES

Food	
Eggs	Blood
Meat	Fat
Milk	Edible slaughter by-products
Body Coverings	
Wool	
Leather, pelts, hides	
Hair, fur, feathers	
Work	
Draft and other labor	
Transportation	
Body Wastes	
Fuel	Construction material
Fertilizer	Animal feed
Other Uses	
Income	Religion and other cultural needs
Storage of capital	Slaughter by-products
Storage of food	Recreation and sport
Biomedical research models	Pest and weed control
Contributions to the economy	Companionship and service
Buffer for fluctuating grain supplies	Pet foods and treats
Soil fertility enhancement	Conservation
Prestige	

Sources: Compiled from A partnership for humans and animals by R. E. McDowell, Agricultural animals of the world by E. J. Turman.

1.4 Livestock Production Systems in Ethiopia

The principal livestock production system in Africa is **extensive grazing. However**, livestock production systems in the tropics can be divided into **two major types**, namely **traditional** and **modern**. They are distinguished mainly through the following **four** general points:

1. **General production factors, such as** land, labor and capital.
2. **Feed sources**, namely range, pasture, crop residues, forage, household waste, concentrate feed.
3. **Movement of people and their herd** such as Nomadic, transhumance, semi-sedentary, sedentary and
4. **Intensity of management** (intensive, semi-intensive and extensive).

A classification of livestock production systems in the tropics

Type	System	Movement	Production factor	Feed source	Management
Traditional	Pastoral	Nomadic/semi-sedentary	Land	Range	Extensive
	Agro-pastoral	Transhumance /sedentary	Land/labor	Range/crop by-product	Extensive

	Mixed crop-Livestock (Agricultural)	Sedentary	Land/labor	Crop by-products/pasture	Extensive
Modern	Ranching	Sedentary	Land/capital	Range/forage	Extensive
	Urban/per-urban	Sedentary	Land/capital	Pasture/forage/concentrate feed	Semi-intensive
	Feedlot	Sedentary	Capital/labor/land	Concentrate/forage	Intensive

1.4.1. Traditional Livestock Production Systems

Traditional livestock production systems are far more prevalent in sub-Saharan Africa than modern systems. Traditional systems mainly rely on family labor and the extensive use of land while modern systems have large capital requirements and employ substantial amounts of hired labor. Traditional livestock systems can be sub-divided into three as **pastoral**, **agro-pastoral** and **mixed crop-livestock**. Classification is based on the following factors.

a. Degree of dependence on livestock products for income or food of household
b. Types of agriculture practiced in association with livestock
c. Mobility and duration of movement
    - Nomadic-year round movement without a fixed base
    - Transhumance/semi-sedentary-seasonal movement with fixed base
    - Sedentary- no movement with fixed base

1.4.1.1 Pastoral Production System

This production system is characterized by the following properties.

- The system is mainly nomadic as in the Fulani people in W. Africa/ seldom semi-sedentary as in the partially nomadic people of Turkana in N. Kenya who move into the more humid higher altitude areas during the dry season and returning to the semiarid low lands during the wet seasons.
- Some are truly transhumance as in the cause of the Nuer in S. Sudan who grow crop in their village during the wet season and graze their livestock in the dry season on the pastureland flooded during the wet season. Pastoral systems are mainly found in the arid and semi-arid zones of West and East Africa and to a lesser extent in southern Africa.
- Extensive management of large herds of livestock grazing on wide communal and public land
- Due to seasonal scarcity of feed and water cattle trek over a long distances.

- Pastoralists have only minimal land holdings at the homes base where they keep a " wet herd" for milk.
- The main functions of livestock production in pastoral households are to provide subsistence products (milk, blood and meat), to meet social obligations (bride price, stock alliances and stock patronages) and to insure against disaster (drought, epidemics, raids).
- Women and children also stay at home bases and take care of the animals
- The " dry herd" travel long-distance sometimes up to 400 km, hence pastoralists are unable to settle and take the advantages of civilization
- In this system, more than 50% of household income is derived from livestock and livestock products
- Indigenous breeds/ types are reared

1.4.1.2 Agro- pastoral production systems

- The system is between pastoral nomadism and settled agriculture.
- Crop agriculture is practiced together with extensive management of livestock.
- Common in semiarid areas, the system is either transhumance or sedentary.
- The commonest species kept in agro-pastoral systems are cattle, but sheep and goats are also found.
- Between **10 and 50%** of the household income comes from livestock.

1.4.1.3. Mixed Crop- Livestock (Agricultural) production system

- Mixed systems are found in the semi-arid, sub-humid, humid and highland zones of sub-Saharan Africa.
- Here **livestock production is secondary to crop productio**n.
- The system is sedentary extensive in the sense that the number of animals per total area of land is low.
- Accounts for about half of all cattle reared in the tropics.
- Characterized by smallholdings (1-3 ha of land and 2.4 heads of cattle).
- Cattle are used primarily of work purposes, meat and milk production are secondary activities.
- Multiple purpose breeds are needed for work, milk and meat production.
- Some crossbreds may be found.
- In this system, less than **10 % of household income** is derived from livestock.

1.4.2 Modern Types of Production Systems

The modern livestock production systems can be divided into the ranching, peri-urban and feedlot production systems. Production systems in these categories are **characterized by high inputs**. The production systems are **market-oriented** and farmers **adopt improved technologies**

to optimize productivity**, specialized in one species** and product (commodity), keep the most productive and **improved breeds** and most of them are **capital intensive**.

1.4.2.1 Ranching

- Ranching is an extensive form of modern production systems in which **land and capital** are the main production factors.
- Ranches are generally commercial enterprises, with generation of a cash income as the primary function of the livestock raised on them.
- Ranching systems consist of labor-extensive enterprises specializing in one or more livestock species and producing mainly live animals for slaughter (for meat, skins and hides), but also for wool and milk.
- Management is characterized by grazing within the fixed boundaries that delimit tenure
- Ranching systems are commonest in the arid and semi-arid zones of East and southern Africa and occur only sporadically in the drier parts of West and Central Africa.
- A large number of animals kept in an extensive grazing land of as to produce a specific product e.g. beef cattle to produce beef, dairy cattle to produce milk, sheep for wool or mutton production, etc

1.4.2.2 Urban/ Peri-Urban Production Systems

- Mostly located **within or around major cities** of highly populated urban centers where the producers have easy access to consumers.
- The production system is **market-oriented** where the producers have adequate resources.
- The system is semi-intensive, sedentary with minimum land where producers use **zero grazing or semi- grazing.**
- The main sources of feed are **crop-residues**; cultivate fodder and agro-industrial by-products.
- The types of animals used are **usually high grades or improved ones**.

1.4.2.3 Feedlot Production System

- These are large scale specialized farms in which **land and capital** are the main production factor.
- They utilize **high energy conserved forage**, Maize silage, industrial by-products and maize grains as the sources of animal feed.
- In most of the cases they are **intensive zero-grazing**; cut and carry forages are used to provide green feed
- These production systems are characterized by the **application of high inputs.**
- They use **highly improved animals**, **improved technologies**, some of them may conduct research.
- They produce on a large scale and control the world market at large.

CHAPTER 2

CATTLE PRODUCTION AND MANAGEMENT

INTRODUCTION

This chapter introduces you about cattle production and management. It starts with discussion on cattle's origin domestication and distribution. Cattle breeds, production systems, roles and Challenges in Ethiopia also discussed. Cattle nutrition, health, improvement and housing also part of this chapter.

Learning Objectives: At the end of this chapter you should be able to:

- ✓ *Explain origin domestication and distribution of cattle*
- ✓ *Explain indigenous breeds and exotic breeds of cattle in the world.*
- ✓ *Explain the role of cattle production in Ethiopian economy.*
- ✓ *Clarify challenges and opportunities of cattle production in Ethiopia.*
- ✓ *Explain cattle production system, genetic improvement and important diseases.*
- ✓ *Explain housing and routine management of cattle.*

2.1 Origin and distribution of cattle

The family of animals that includes all types of domestic cattle are known as the *Bovidae*. They are the dominant family of hoofed mammals and one of the most recent to evolve. Cattle are domesticated bovine farm animals that are raised for their meat, milk, hides or for draft purposes. The animals most often included under the term are the Western or European domesticated cattle as well as the Indian and African domesticated cattle. The origin of domestic cattle has perplexed archaeologists for more than a century. A genetic study of cattle has claimed that all modern domesticated bovines are descended from a single herd of wild ox (**aurochs**) which lived 10,500 years ago. The aurochs were huge animals. It is an extinct species of large wild cattle.

Modern cattle are descendants of *Bos taurus* and *Bos indicus*. *Bos taurus* are domestic cattle that came from either the Aurochs or the Celtic Shorthorn. The Aurochs were common in Europe. *Bos indicus* are the humped cattle originating in tropical countries and are common in modern cattle production. They are more resistant to some diseases, parasites, and heat than are cattle that came from *Bos taurus*.

Cattle have spread over the globe in the service of man. And, either under man guiding hand or by accident of nature, a host of type and breeds has emerged. Among these types and breeds, some have their place in the lush pastures of well watered portion of the temperate zones; others have adjusted to the hot, humid weather and the course feed of the tropics; still others serve in the cold highlands and well in to the northern and southern latitudes. Some are specialized for dairy production, others for beef. The dual purposed animal has also found its place for the combined production of beef and milk. In many areas triple purpose animal have been the primary type, providing man with milk, meat and draft power. In still other areas, where religious taboos prohibit the eating of beef, emphasis has been on animals for draft or for milk production or for the combination of these two functions.

This host of local types and breeds may be classified broadly in to two major group or types, the hump-less cattle of European and northern Asiatic origin (*Bos taurus*) and the humped zebu cattle of southern Asiatic origin (*Bos indicus*).

In the terminology used to describe the sex and age of cattle, the male is first a bull calf and if left intact becomes a bull; if castrated he becomes a steer and in about two or three years grows to an ox. The female is first a heifer calf, growing into a heifer and becoming a cow.

2.2 Domestication and major purposes of cattle

As we have discussed in chapter one, exactly when individual animal species were domesticated is unknown, however most authorities considered that the first steps towards cattle domestication were taken in southwest Asia and that domesticated cattle entered Europe with pastoralists migrating from this region. Domesticated taurine cattle were thought to have entered Africa in successive waves from southwest Asia, while zebu cattle migrated into Africa at a later date from Arabia and the Indian subcontinent. Cattle were probably tamed early in the Neolithic (New Stone) Age. The Neolithic Age occurred about 18,000 years ago. Early man used cattle for draft, meat, and milk. Cattle were also a measure of wealth. They are mentioned in records at least 4,000 years old. Various types of cattle were known at that time.

Importance of cattle

Cattle have been and are of considerable importance and utility to farmers all over the world. It is significant that they were chosen as farm animals universally even in early times; when communications had not developed and different countries were separated by vast stretches of

land or sea. The people of the world could not possibly have learnt the uses and value of cattle from one another in those days. The development of cattle as farm animals took place independently in various countries. Also, it is clear that cattle were available all over the world for capture and domestication. Cattle, and to a smaller extent horses, have been providing the chief motive power to farmers in the different countries of the world. Horses are comparatively faster, but are not useful otherwise. Cattle are different. They are an integral part of the farm and are useful in many ways. They provide the chief motive power and manure for the farm, besides producing milk, a valuable human food. They also provide beef for consumption. Tractors and machinery have supplanted horses, which were the sources of farm motive power in Western countries, but cattle have not been so replaced, nor will it ever be done. In modern world cattle are principally raised for beef and milk production.

2.3 Cattle breeds and production systems in Ethiopia

Breeds as they are known today did not always exist, and many are of recent origin. The definition of a breed is difficult and inexplicit, although the term is commonly used and, in practice, well understood. It may be used generally to connote animals that have been selectively bred for a long time so as to possess distinctive identity in color, size, conformation, and function, and these or other distinguishing characteristics are perpetuated in their progeny. Breeds have been established by generations of breeders aiming at the attainment and preservation of a particular type with its identifying characteristics.

The two species of cattle are *Bos indicus* and *Bos taurus*. *Bos indicus* have loose skin, large ears, and humps over their shoulders. *Bos indicus* cattle are resistant to heat and insects and are well suited to hot, humid climates. They are more rarely used than *Bos taurus* breeds. *Bos taurus* cattle originated in Europe. In comparison to *Bos indicus* species, they have tight hides and small ears. *Bos taurus* cattle do not have humps. They are more tolerant of cold weather. Breeding cattle from these two species has created several breeds of cattle, such as the Brahman and Brangus.

Most of the cattle breed in the tropics evolved **through natural selection**, for adaptability and survival to local environments. Most indigenous cattle breeds in the tropics are **multipurpose** (milk, meat, draught) and that **only a few breeds have good milk potential**. Cattle can be classified in to indigenous and exotic breed.

2.3.1 Indigenous Cattle Breeds

The term indigenous mean originating or occurring naturally in a particular place; native. Indigenous livestock breeds are important because, through many generations of natural selection and selective breeding, **they are adapted to local conditions and farming systems**, and are more likely than exotic breeds **to tolerate seasonal variations** in climate and forage supply, and resist local diseases and parasites. Indigenous livestock breeds and landraces provide an invaluable/very useful reservoir of genetic variation and breeding potential for adaptation to changing climatic and farming conditions.

Fogera: found in the area around Lake Tana in Gondar and Gojam. They are large sized being tall animal with long leg. The breed have black and white or black and gray coat. Muzzle and hoofs are almost always black. The horns and hump are very small and the animal is docile. Currently they are used as meat, milk and draught animals; potentially they are excellent in milk production **(1500 kg/lactation)** and can be improved genetically for the trait.

Barka: derived from west Eritrea. It is a tall animal with long legs, the coat color is variable but black pied is common. The hump is very large in male and often falls to one side. The head is small and short. The cattle have good milk yield and they can be genetically improved for milk production.

Borana: originated from Borana area of south Ethiopia. At present these breeds are found in Somalia and Kenya. They are fairly large and long-legged animals with good body conformation. They are whitish-grey in color; the male has black color on their hump. The hump is very well developed in the male and smaller in females. Horns are usually small, thick at the base, pointed and directed forward. Have huge body conformation and thick skin, drought and pest resistance and ability to travel long distance.

The breed is used by semi nomadic people primarily for milk and if selected for milk Borana cows are moderately good milker. Currently, the breed is used for milk production especially in crossbreeding programs. On the ranches they have been selected for beef and have potential for beef. *It is found to be excellent beef breeds in Africa*.

Sheko breed: - The only hump less short horned taurine breed in east Africa and it is distributed in the humid parts of southwestern Ethiopia around Bench-Maji zone. Relatively better adaptive with trypan tolerance polled or has floating type of horn and brown or black and white colour and glossy-red hair. Comparing with other breeds in the country better attention has been given to breeding and conservation.

Horro Cattle

Distributed in Horro Gudru of Eastern Wollega; also in Western shewa, and adjoining areas of Illubabora and Shewa, Zenga type. Adaptive in to humid and wetter agricultural area dominantly brown or reddish brown coat color thin skin; horns moderate but larger than the common zebu.

Not only these Abergelle, Anuak, Afar, Arsi, Begait, Guraghe, Ogaden, Hammer Cattle etc are there. In general currently, 28 breeds of cattle have been recognized in Ethiopia with an estimated total number of 59.5 million, of which 98.2% of are indigenous cattle. Indigenous cattle breeds have diverse functions ranging from provision of food and income to society, and support many social and cultural functions in addition to their ecological roles.

2.3.2. Exotic Cattle Breeds

Most temperate breeds are artificially selected for productive traits and they are hence improved breeds for either beef or dairy production.

Dairy breeds

Holstein Friesian*:*

They originated in ***Netherlands***. They are large breed, producing lean meat. They are either black and white or red and white in color. They rank **1st in their milk production** producing **6577 kg** /lactation and rank **5th in their milk fat content (3.5%).** Lactation refers to the period in which the cow gives milk after one birth: it is approximately 10 months. They are poor grazers they need intensive feeding, and they produce more in cool regions.

***Jersey*:**

They originated in **the island of Jersey** in UK and they are the **smallest dairy breed**, with yellowish-brown or fawn in color. They have a strong udder attachment, rank **5th in their milk production (4536 kg /lactation**), **1ts in their milk fat content (5.4%),** are relatively good grazers and good in feed conversion efficiency and can produce well in tropics.

Guernsey*:*

Originated in **Guernsey Island**, in UK are Yellowish-Brown or Fawn in color. Their milk is especially yellow in color: they rank **4th among dairy breeds in their milk production (4808kg)** and **2nd in their milk fat content (5%).** Guernseys are well known for having the minimum of calving complications.

***Brown Swiss**:*

Brown Swiss breed are originated in Switzerland. They are solid brown in color. They are larger breeds and relatively heat tolerant. They rank 2nd among the dairy breeds in their milk production **(5488kg)** and 3rd in their milk fat content (4.1%).

***Ayrshire**:*

Ayrshire breed are originated in Scotland, red and white in color. They have well developed udder and excellent grazing ability. They stand 3rd among the dairy breeds in their milk production **(5307kg)** and 4th in their milk fat content (4%).

Summary of the mild yield and butter fat contents of temperate dairy cows

Breed	**Milk yield (kg / lactation)**	**Rank**	***Milk fat (%)***	***Rank***
Holstein	6577	1st	***3.5***	***5th***
Brown Swiss	5488	2nd	***4.1***	***3rd***
Ayrshire	5307	3rd	***4.0***	***4th***
Guernsey	4808	4th	***5.0***	***2nd***
Jersey	4536	5th	***5.4***	***1st***

Beef breeds

Many modern beef breeds had their origin in Europe. There are approximately 250 breeds of cattle recognized throughout the world, and several hundred breeds that are not currently recognized.

Angus

The official name of the Angus breed is Aberdeen-Angus. The breed originated in Scotland in the shires of Aberdeen and Angus. Angus cattle are black in color. A few Angus carry a recessive gene for the red color. Sometimes, a red calf is born to black parents. They have a smooth hair coat and are polled. They are an alert and vigorous breed. Angus cattle perform well in the feedlot. They produce a desirable carcass of high-quality, well-marbled meat. Nearly all Angus are pure for the dominant polled gene. When used in crossbreeding, nearly all the calves are polled.

Fig : Angus

Charolais

Charolais is one of the oldest of the French breeds of beef cattle. It was developed around Charolles in central France. Charolais cattle are white to light straw color with pink skin. They are a large, heavily muscled breed. Mature bulls weigh 2,000 to 2,500 pounds (907 to 1,134 kg). Mature cows weigh 1,500 to 1,800 pounds (680 to 816 kg). Charolais have a high feed efficiency. They are heavily muscled in the round and loin because of generations of selection for this trait.The Charolais are well adapted to many areas. It is used in many crossbreeding programs.

Chianina

The Chianina breed originated in the Chiana Valley Italy. It is one of the oldest breeds of cattle in Italy and probably one of the oldest in the world. The original Chianina cattle were white with a black switch. The skin pigment is black. They have a high heat tolerance and gentle disposition. Chianina are probably the largest breed of cattle. Mature bulls can grow to 6 feet (1.8 m) at the withers. They can weigh as much as 4,000 pounds (1,814 kg). Mature cows can weigh as much as 2,400 pounds (1,088 kg). Chianina are popular in crosses for a number of reasons. They improve the growth rate of the off spring. In addition, they are good foragers and good mothers. They are well adapted to hot and cold climates, rough terrain, and have a high degree of tolerance to insects and diseases. Chianina have fine textured meat.

Cattle production Systems

Cattle production is one of the main agricultural industries in Ethiopia. Livestock production as a whole contributes about 45 percent to agricultural GDP (cattle being the most important generator), with the country producing over 3.8 billion liter of milk and ~1 million ton of beef per year valued at USD 2.5

billion and USD 5.1 billion, respectively. Per capita consumption is approximately 19 kg of milk and 7 kg of beef per year. The sector is highly heterogeneous encompassing of the traditional pastoral/agro-pastoral and mixed crop–livestock production systems and the market-oriented intensive specialized producers. There are four types of cattle (beef and dairy) production system in Ethiopia: the commercial, the urban/periurban, the mixed crop-livestock, and the pastoral/agro-pastoral systems.

Commercial

The specialized commercial dairy systems involving higher levels of investment are concentrated in the central highland plateau. In terms of scale of operation, the farms are classified as large-, small- or medium-scale. Being licensed farms with operational business plans, they are market oriented specifically targeting consumers in urban areas. Producers tend to have a good understanding of dairy management. The commercial dairy system is labor and input intensive relative to other systems. The animals do not provide draft power but their manure is used as fertilizer. Purebred exotic, high-grade or crossbred dairy animals are used. In the case of feed; hay, concentrated dairy mix, industrial by-products, mainly purchased, though some farms cultivate own pasture are used. Milk yield: 15–20 litres per day per cow is produced.

In the case of beef production it is known as Commercial feedlot production. Many of these feedlot operations are concentrated in the central Rift Valley particularly in East Shoa zone. Animals are entirely confined in a yard fitted with watering and feeding facilities for a finishing duration of 3–6 months. Feedlot operators prefer the Borana cattle breed due to its high market demand; highland Zebu originating from Arsi, Bale and Hararghe highlands are also used to a limited extent. Commonly, intact young males are fattened based on the demand in the live animal export market. Crop residues such as teff and barley straw form the bulk of basal diets while industrial byproducts such as wheat bran, oilseed cakes and molasses are used as supplementary feeds. Marketing targets both on domestic and export markets. The sector is currently attracting some foreign investors.

Urban/Peri-urban

The urban/per-urban production system is an expanding production system, largely found in the highlands and is concentrated in the Addis Ababa milk shed area as well as around the regional capital cities where an adequate market for fresh milk is readily available. There are about 5 200 dairy farms in Addis Ababa alone with an average herd size of 12. It is practiced by many landless urban and suburban poor households. However, some businessmen and retired civil servants also keep some dairy animals depending, wholly or partly, on hired labor. Producers are market oriented and respond to improved technical, input supply and marketing services. Typical breeds are high-grade or crossbred animals. Feed

type such as; crop residues, hay, concentrated dairy mix, industrial by-products, mainly purchased are used. Milk yield about 10–15 litres per day per cow with a lactation period of ~200 days produced. This is also a growing dairy production system in Ethiopia.

Smallholder farmers and landless households around urban areas fatten a few animals at a time. The animals are often tethered and stall-fed. The fattening exercise is mostly done after the oxen have retired from farm work/ploughing in order to replace them with younger animals. Crop residues (*teff*, wheat, and barley straws) are used as basal feed whereas milling and oil industry by-products and *atela* (a residue from traditional distilling and brewing) are heavily used in fattening diets. Typical breed: indigenous Zebu is used. It is an emerging system mostly practiced by landless households or unemployed youth or women's groups.

Mixed crop–livestock

Mixed crop–livestock dairy production is a subsistence oriented farming system concentrated in the mid- and high-altitude agro-ecological zones where cereals and cash crops are dominant farm activities. Cattle are primarily kept to supply draft power needed for crop production. However, milk production is an integral part of the production system. The bulk of the total milk produced nationally and about three quarters of the liquid milk processed commercially is generated here. Typical breeds: indigenous. Milk yield per cow is 1.9 litres per day, on average. Dairy production in the mixed crop-livestock system is pivotal to supplying the bulk of milk and milk products to the Ethiopian population.

Cattle fattening in mixed crop–livestock production system is traditional backyard cattle fattening system. It is a deep-rooted and widely practiced cattle enterprise in highland areas although it is by and large a seasonal undertaking. Old oxen that retire from ploughing are commonly conditioned and finished. Usually, marketing of fattened animals is synchronized with Ethiopian holidays. Cattle fattening in this system almost entirely relies on locally available resources to minimize finishing costs. In areas like Hararghe, farmers buy young oxen from the adjacent lowland pastoralists and use them for ploughing for few years after which they fatten and sell them before they become old and emaciated. Typical breed: indigenous Zebu is used. Crop cultivation and livestock production are strongly integrated in the mixed crop-livestock system, the two sectors complement each other well – livestock provides power, natural fertilizer (manure) and capital for crop production while the crop cultivation provides feed. Cattle are primarily kept to supply draft power needed for crop production.

Pastoral/agro-pastoral

Pastoral/agro-pastoral production is the major system of milk production practiced in the lowland regions of Ethiopia where livelihoods are heavily dependent on livestock. Cattle dominate the livestock

population followed by camel, goats, and sheep. Cows constitute about 40 percent of the herd. Major pastoral areas extend from the north-eastern and eastern lowlands (Afar and Somali) to the southern and south-western lowlands (Borana and South Omo). Dairy cattle population accounts for ~36 percent of the national herd. Milk yield produced is: ~1.5 litres per cow per day.

The pastoral/agro-pastoral cattle production system is a rangeland based livestock production system aimed at exploitation of the natural or semi-natural vegetation via domestic animals, in particular ruminants. The main product is milk and the main function of livestock is subsistence, although social and cultural functions are also important. Excess young males are sold off to highlanders, where they are used as draught oxen, or to feedlot operators. Herd size is maximized (depending on labour for herding, water drawing etc.) to ensure the highest chance of being left with a viable core herd after drought. Other risk aversion strategies used include keeping a mix of different animal species and splitting herds into different management units. Emphasis is put on a high proportion of females among all species to maximize milk production and the reproductive potential of the herd to recover after a decline. Ninety-five percent of the livestock exported from Ethiopia is supplied by the pastoral and agro-pastoral areas of Borana, Afar, and Somali. Formal live animal exports are predominantly cattle about 70 percent, meat exports are almost entirely from sheep and goats, and hides and skins are primarily from cattle. Livestock management is characterized by the adaptation of the feed requirements of the animals to the environment through migration.

2.4 The role of cattle in Ethiopian economy

Globally, livestock contributes about 40 percent to the agricultural gross domestic product (GDP) and constitutes about 30 percent of the agricultural GDP in the developing world (World Bank, 2009). These estimates highlight the important contribution of livestock to sustainable agricultural development. Direct and indirect contribution of cattle for Ethiopian economy is huge. Both cattle production sectors (dairy and beef) are the integral part of the economy. Cattle perform multiple functions in the rural household economy. Besides employment, they provides protein rich food, income for everyday expenses and social obligations, near liquid assets, a store of wealth for savings, manure for crop production and soil fertility, and transport.

2.5 Challenges and opportunities of cattle production in Ethiopia

The major problems identified from the review of ***previous studies*** in Ethiopia include

- Shortage and poor quality of feed
- The scarcity of land for the production of forage
- Low genetic potential of the indigenous cattle

- Traditional husbandry practices
- Absence of marketing infrastructure and lack of improved technologies
- Livestock Marketing Constraints
- Inadequate health service and Disease Problem
- Poor Livestock Breeding and Husbandry Practices
- Lack of Trained Manpower
- Management and Technology Constraints

Improvement Measures of Livestock Production

1. **Improve the quality and quantity of feed**
   a. By adjusting the **stocking rate in the highlands** and by **selling animals in nomadic** areas.
   b. Introduction of improved forage species.
   c. Fertilize the grass lands with chemical fertilizers like urea to increase the biomass of forages and increase the nitrogen content.
   d. Cultivation of improved grass and legume species.
   e. Practicing supplementary feeding.
2. **Improve cattle through systematic breeding programs**
   - Through selection and culling.
   - Proper mating of the selected progeny.
3. **Protecting the animals from the diseases.**
4. **Use improved management practices.**
5. **Strong extension services.**

2.6 Feed classification and Cattle nutrition requirement

2.6.1 Feed classification

The aim of animal production is to transform humanly inedible products such as **roughages and agro-industrial by-products** to highly desirable and nutritious **human food** (milk, meat, and egg), **wool, manure, hide, skin, power** etc. Thus, Animals to produce optimally need to be supplied with the necessary nutrients in the appropriate proportions and quantity. Nutrition contributes to wellness and productivity of animals. Many common health problems can be prevented or alleviated with good nutrition. Poor nutrition results in poor reproduction, poor growth, poor productivity, and higher feed costs because of over feeding.

Animals are dependent on plants for the continuation of their function because plants by virtue of possessing chemical compounds called chlorophyll are in a position to convert the less-complex inorganic forms of nutrients into organic or highly complex type of chemical compounds. The animal system needs inorganic nutrients mainly in the form of minerals but it needs organic nutrients in the form of carbohydrates, protein, lipid (fat specifically), minerals and vitamins. The primary source of organic material is totally plant tissues.

The various feeds and fodders used in livestock feeding are broadly classified as: A) Roughages; B) Concentrates; C) Feed supplements and Feed additives.

Roughages – Roughages are the feed stuffs which contain more than 18 percent crude fiber and less than 60 percent Total Digestible Nutrients. Due to higher crude fiber content, they are more bulky and have low digestibility as compared to concentrates. 1) Maintenance type – Containing 3-5 percent DCP e.g. Green maize, oat. 2) Non-maintenance type – containing less than 3 percent DCP e.g. Straw, 3) Production type – containing more than 5 percent DCP e.g. Berseem, lucerne. (DCP – Digestible Crude Protein) The roughages are further classified into two major groups as: 1) Green / succulent roughages – They contain about 60-90 percent moisture Example; Pastures, cultivated fodders, tree leaves, root crops and silages. 2) Dry roughages – They contain about 10-15 percent moisture e.g. Straw, Hay.

Concentrates - These are the feedstuffs which contain less than 18 percent crude fibre and more than 60 percent TDN. They are less bulky and have higher digestibility. They are concentrated source of nutrients and therefore, they have higher nutritive value than roughages. The concentrates are further classified as: 1) Energy Rich Concentrates – e.g. Cereal grains, cereal grain byproducts, Roots and tubers. 2) Protein Rich Concentrates – i) Plant origin e.g. Oilseed cake, pulse chuni, Brewer's grains and yeast. Most plant proteins contain less than 47% crude protein. ii) Animal origin e.g. Fish meal, Meat meal, Blood meal. Most animal proteins contain more than 47% crude protein with essential amino acids.

Feed Supplements and Feed Additives

Feed supplements are the compounds used to improve the nutritional value of the basal feeds so as to take care of any deficiency. Commonly used feed supplements are 1) Vitamin supplements e.g. Rovimix, Vitablend, Arovit etc. 2) Mineral supplements e.g. Minimix, Milk min, Nutrimilk, Aromin etc.

Feed Additives

Feed additives are the non-nutritive substances usually added to basal feed in small quantity for the fortification in order to improve feed efficiency and productive performance of the animals. Some commonly used feed additives are as below: 1) Antibiotics e.g. Terramycin, Zinc bacitracin, Flavomycin etc. 2) Enzymes e.g. Amylase, lipase, protease, pepsin etc. 3) Hormones eg. Estrogen, progesterone, hexosterol etc. 4) Thyroprotein e.g. Iodinated casein. 5) Probiotics e.g. Microbial species. Lactobacillus. 6) Biostimulators e.g. Extracts of living organs like spleen, liver, ovary, chick embryo etc. 7) Antioxidants e.g. Vitamin E (Tocopherols), BHT (Butylated hydroxy toluene). 8) Mold inhibitors e.g. Propionic acid, acetic acid. 9) Pellet binders e.g Gur, meal, molasses, sodium bentonite. 10) Coccidiostats e.g. Amprolsol powder, Furasol powder.

2.6.2 Cattle nutrition requirement

All living organisms need nutrients to survive. The essential nutrients required by grazing animals are water, energy, protein, minerals, and vitamins. These nutrients are needed to maintain body weight, growth, reproduction, lactation, and health. Plants can obtain the molecules required for cellular function through the process of photosynthesis, most animals obtain their nutrients by the consumption of other organisms. At the cellular level, the biological molecules necessary for animal function are amino acids, lipid molecules, nucleotides, and simple sugars. However, the feed consumed consists of protein, fat, and complex carbohydrates. Animals must convert these macromolecules into the simple molecules required for maintaining cellular functions, such as assembling new molecules, cells, and tissues. The conversion of the feed consumed to the nutrients required is a multi-step process involving digestion and absorption. During digestion, feed particles are broken down to smaller components, and later, they are absorbed by the body.

Nutritionally farm animals are divided into ruminants and non-ruminants, based on the anatomical structure of the digestive system of farm animals. Ruminants are animals having partitioned large stomach where as non-ruminants (monogastric) have simple stomach, not as complicated as ruminant stomach. In ruminants having large size and partitioned stomach create favorable environment for microbial symbiotic activity such as favourable pH, temperature and anaerobic condition. To this effect millions of micro-organisms thrive in the reticulo-rumen of ruminants, and these micro-organisms have the ability to produce enzymes which can hydrolyze the fibrous (cellulose) part of the feed enabling the animals to utilize such feeds.

The monogastric stomach is simple and its internal environment not allows the development of micro-organisms. So these animals are not in a position to utilize highly fibrous feeds. Therefore, the nutrients in the two groups differ. In the case of ruminants one can give them with fibrous feeds or cellulose rich diets and by virtue of the presence of micro-organisms in their stomach, the inedible products will be converted to edible (available) product in which case the ruminant can utilise and transfer it to highly valuable and quality products such as meat and milk (hides, skin, hair, etc).

In the case of monogastric, which lack the symbiotic effect of micro-organisms as a result of their simple stomach, they require very low fibrous feeds as grains and there is a competition for such feeds with humans (example, poultry, and swine). But grains are given to ruminants in intensive animals production systems like for fattening. As well to digestion, the final product of digestion and absorption is different in different farm animal (monogastric and ruminants). After absorption, the nutrient will go

to different tissues and changed to animal products, the transformation is taken place by metabolism, and the metabolism of different nutrients will be considered.

Nutrient requirements define the specific nutrients and amounts that must be included in complete and balanced diets for healthy animals. Nutrient requirement is generally agreed to be the average amount nutrient required for a particular function. Nutrient requirements of animals affected by the following factors:

1. Species
2. Breed
3. Weight
4. Body condition
5. Age
6. Sex
7. Growth
8. Stage of gestation
9. Level of milk production
10. Work
11. Environment
12. Others (genetic potential, disease, stress)

The nutrient requirements can be broken down into four principal components: **Maintenance**, **Lactation**, **Growth**, and **Reproduction**. From these components, requirements for energy, protein, minerals, and vitamins are calculated. By understanding the different factors that affect requirements, producers can make adjustments to changes such as a month of cold weather, moving to a hilly pasture, or the last third of pregnancy.

Maintenance - The maintenance component includes all the nutrients required for the animal to breath, move, digest food, keep warm, repair tissues, and maintain body weight. Weight, age, breed, physiological status, activity, and environmental conditions are the primary variables impacting maintenance requirements.

Lactation- Heavy lactation has greater nutrient demands than any other production state. Nutrient requirements for lactation are based on the amount of milk at peak lactation and the composition of the milk. Animals that produce more milk, and milk with more fat and protein, will have higher nutrient requirements.

Growth - Measured as an increase in body weight. Most rapid early in life, declines gradually until puberty, then even slower rate until mature size is reached. Requirements for growth are determined by actual weight, average daily gain (growth rate), weight at maturity, and composition of gain. Composition of gain simply means whether animals are putting on more muscle or more fat. For example, protein requirements will be higher for young animals because they are gaining more muscle than fat.

Reproduction - Adjustments to requirements for reproduction are based on expected birth weight and stage of gestation. Requirements include development of maternal tissue as well as the fetus. Usually,

pregnancy does not significantly affect requirements until the last one-third of pregnancy when the fetus is growing rapidly. Nutrient deficiencies prior to breeding may result in low fertility or failure to maintain pregnancy. Underfeeding during growth can result in delayed sexual maturity. Fetal tissues have priority for nutrients over maternal tissues. Body reserves may be depleted.

2.7 Reproduction and Cattle Genetic Improvement

2.7 1. Reproduction of Farm Animals

Reproduction is the process of an individual perpetuates (bring about) its own kind. Higher animals especially mammals produce specialized reproductive cells known as **female and male *gamete***. These two gametes unit as a result of mating and products the *Zygote*. **The process of fusion of gametes known as *fertilization*.** The sex gametes are **haploid** where as the Zygote is **diploid**. The gametes produced in the male and female reproductive organs.

Puberty (sexual maturity):- is the period during which the **reproductive organ first becomes functional**. It is characterized by the development of **secondary sexual characteristic** in both females and male animals (viable ovum, spermatozoa and sexual desire development). The female experiences her **first estrus cycle at puberty**.

The age of puberty varies in different species of animals and also there is a great variation with in single spices depending on

- climatic condition,
- mode of nutrition,
- heredity (individual genetic)
- management factor and health of the animals

Approximate average age of puberty

Species	**Male**	**Female**
Cattle	6-9 months	8-14 months
Sheep	6-8 months	7-8 months
Horse	18-24 months	15-24 months
Swine	5-8 months	5-8 months

2.7.1.1 The Male Reproduction System

The anatomy of the male reproductive system consists of the following

A. *Testis*
B. *Epidydimis*
C. *Vas(ductus) deferens*
D. *Urethra*

E. Accessory reproductive organs and *F. The copulatory organ (penis)*

A. Testis

Testis is an organ of production, which produces **spermatozoa** and **reproductive hormones**. Testis together with the **Epidydimis** is enclosed by the **scortum**. The scortum gives size, shape and location for testis.

The scortum is composed of externally skin, fibro- elastic tissue and **cremaster** muscle. This muscle retracts (pulls) the tests up against the external inguinal ring, particular in cold weather. The temperature of the scrotum is **4-5^{o}c** below the body temperature. This helps for storage of spermatozoa. In cold temperature the **cremaster** muscles under the skin of the scrotum contract and pull the testes closer to the warm body.

B. Epididymis

The epididymis is a long, coiled tube that rests on the backside of each testicle. It transports and stores sperm cells that are produced in the testes. It also is the job of the epididymis to bring the sperm to maturity, since the sperm that emerge from the testes are immature and incapable of fertilization. During sexual arousal, contractions force the sperm into the vas deferens.

C. **Vas Deferens**

The vas deferens is a tube that connects the epididymis with the urethra. Sperm cells move through the vas deferens to the urethra. The vas deferens is inside a protective sheath called the spermatic cord.

D. Urethra

The urethra is the tube that carries urine from the bladder. This tube is found in both male and female mammals. In the male animal, both semen and urine move through the urethra to the end of the penis. The urine is the liquid waste that is collected in the bladder. The semen contains the sperm and other fluids that come from accessory glands.

E. Accessory sex Glands

The three accessory glands are the seminal vesicles, the prostate gland, and Cowper's gland.

- The **seminal vesicles** open into the urethra. They produce seminal fluid, which protects and transports the sperm.
- The **prostate gland** is near the urethra and the bladder. It produces a fluid that is mixed with the seminal fluid.
- The **Cowper's gland** produces a fluid that moves down the urethra ahead of the seminal fluid. This fluid cleans and neutralizes the urethra. This helps protect the sperm as they move through

the urethra. **Generally**, the mixture of the seminal and prostate fluid and the sperm is called **semen**.

F. Penis

The penis deposits the semen within the female reproductive system. The urethra in the penis is surrounded by spongy tissue that fills with blood when the male is sexually aroused. This causes an erection that is necessary for copulation to occur. The sigmoid flexure (found in bulls, rams, and boars) and the retractor muscle extend the penis from the sheath, a tubular fold of skin. After copulation, the blood pressure in the penis subsides and the retractor muscle helps draw the penis back into the sheath.

2.7.1.2 Hormones of male reproduction

A hormone is a chemical substance secreted by an organ of the body. When released into the bloodstream, it triggers a specific response in another organ. Reproductive hormones affect the activity of the parts of the reproductive system.

Gonadotrophin releasing hormone (GnRH) is a reproductive hormone produced by the hypothalamus gland, which is found in the brain; GnRH is not present in fowl. GnRH stimulates the anterior pituitary gland in the brain to release both FSH and LH, which are essential to reproduction.

The anterior lobe of the pituitary gland secretes follicle stimulating hormone (FSH) as well as luteinizing hormone (LH).

FSH (Follicular stimulating hormone) affects the tubules in the testicles, causing them to produce sperm.

LH (**Luteinizing hormone)** is also sometimes referred to as interstitial cell stimulating hormone (ICSH). LH causes the interstitial cells in the testicles to secrete androgens.

The sex hormones that control male reproductive development and behavior are collectively called **androgens**. The androgen testosterone is produced in the testicles. Androgens like testosterone stimulate the development, growth, and activity of reproductive parts. The production of androgens triggers a maturing stage called puberty, in which the reproductive parts mature as the ideal hormone level is reached. Testosterone and other androgens also trigger the development of male secondary sex characteristics. These characteristics may include a deep voice, heavy muscling, and aggressiveness. Sex drive, which is the desire and ability to mate, is similarly stimulated by androgens. They also function in the production of sperm.

2.7.1.2 Female Reproductive Systems

The **reproductive anatomy and physiology** of the **female** is far **more complex** than that of the ***male,*** since after fertilization they also **nourish**, **carry** and **protect** the developing **embryo**. Then their mammary glands produce milk to nurse the **new born** after it is born. The female reproductive organ consists of ovary and tubular reproductive tracts.

A. **Ovaries:** Female farm mammals have two ovaries that produce the ova and two female sex hormones (estrogen and progesterone). They are located caudal to the kidney suspended from the dorsal wall of the abdomen by a ligament. They are **oval shaped** in most species of animals. There are hundreds of tiny follicles on each ovary. The ova are produced in the follicles. After the ovum is **released (ovulation**) from the matured **ovarian follicle**, the follicle collapses and **filled with blood**. This latter develops in to ***corpus luteum***, which produces a female sex hormone known as ***progesterone***. However, if the egg is not fertilized the corpus luteum develops into **scar tissue** (**regress** it (go back)).

B. Tubular Reproductive Organs

1. **Oviducts** (fallopian tube/ uterine tube):- is **paired twisted muscular tube** that extends from each ovary to the horns of the uterus. Anatomically the oviduct consists of **three regions** (segments)

   Infundibulum is a proximal funnel shaped structure which surrounds the ovary during ovulation. It receives the ova from the ovary and transports the ova to middle of the oviduct.

   Ampulla is the middle portion of the oviduct. It is the site of fertilization

   Istmus is the distal portion of the oviduct which joins the uterine horn.

Generally oviduct transport ovum and Zygote to uterine horn and transport sperm towards ovum. The movement is achieved by the contract of smooth muscles in the oviduct and the oviduct is suspended by the part of broad ligament.

2. **Uterus: -** uterus of mammals is a Y-shaped structure consisting of the body, two uterine horns, and the cervix. The upper part of the uterus consists of the two uterine horns that develop into the oviducts or Fallopian tubes. In all species of farm animals, the fetus grows within the uterus, where it remains until parturition. The **cervix** is the lower outlet of the uterus. It is relatively relaxed during estrus to allow the passage of sperm into the uterus; during pregnancy it remains tightly closed to block the entrance of any foreign matter into the uterus.
3. **Vagina**: The vagina is the passage between the cervix and the vulva. The lining of the vagina is moist during estrus and dry when the animal is not in estrus. During copulation, the semen is deposited in the vagina. The vagina expands to allow the fetus to pass through at birth.
4. **Vulva:** is the external part of the female gentalia, which extends from the vagina to the exterior.

5. **Clitoris**: - sensory and erectile organ of the female. The clitoris develops from the same embryonic tissue as the penis in the male and produces sexual stimulation during copulation.

2.7.1.2 Female Reproductive Hormones

Some of the hormones produced by females are also found in males. For example, as in the male, gonadotrophin releasing hormone (GnRH) is produced by the hypothalamus. Follicle stimulating hormone (FSH) and luteinizing hormone (LH) are also secreted from the anterior pituitary gland. Other hormones, however, are unique to the female, such as estrogen, which is secreted by the follicles in the ovary. Another hormone produced in the ovary is progesterone, which is secreted by the corpus luteum, a body that develops from a follicle that has released an ovum. The hormone prostaglandin is released by the uterus.

The hormones must interact in a balanced manner to ensure the proper development and functioning of the reproductive system.

As it does in the male, GnRH stimulates the pituitary to release FSH and LH. In the female, FSH stimulates the follicles in the ovaries to develop a mature ovum. FSH also triggers the secretion of estrogen.

Estrogen causes the sex organs and secondary sex characteristics to develop and stimulates a desire to mate. Estrogen has an effect on other hormones as well; when estrogen is released, it suppresses the production of FSH and encourages the production of LH by the pituitary. Estrogen also causes uterine contractions that aid in transporting sperm to the oviduct to fertilize the egg.

LH causes the follicle to release the egg, a process referred to as ovulation. In addition, this hormone develops the corpus luteum, also known as the yellow body, from the follicle after the egg is released.

The hormone **progesterone**, secreted by the corpus luteum, stops the production of FSH and LH. It thus prevents follicle development and the secretion of estrogen.

The hormones then play different roles depending on whether the egg is fertilized or not. If the egg is fertilized, the corpus luteum stays in place, and progesterone is produced to maintain the pregnancy by preventing uterine contractions and triggering the release of secretions to nourish the fertilized egg. Progesterone also blocks ovarian activity by inhibiting the secretion of GnRH. If the egg is not fertilized, the corpus luteum deteriorates due to the secretion of prostaglandin in the uterus, ending progesterone production. When progesterone levels are low, GnRH is released and the cycle starts again.

Estrous and Estrous Cycle

The estrus, or heat, period is the time during which the female will accept the male for copulation or breeding. The female mammal begins to have estrus periods when it is old enough to be bred. The estrus

cycle begins when a follicle on the ovary begins to develop. The hormone estrogen is produced, and causes the animal to show the signs of estrus.

The signs of estrus in cattle include:

- Standing when mounted by another cow
- Nervousness.
- Swelling of the vulva.
- Swollen appearance on lips of the vulva.
- Frequent urination.
- Mucus discharge from the vulva.
- Trying to mount other cattle (cattle not in estrus may do this).

Estrous cycle is the recurring physiological changes that are induced by reproductive hormones in most mammalian females. Estrous cycle of different specious of animals & duration of estrus different.

Animal	Estrous cycle	duration of estrus
Cow	21 day	14 -18 hours
Mare	21 day	5 day
Ewe	17 day	3-84 hour

Gestation period – is the period from the time of fertilization to the time of parturition (the expulsion of the Fetus from the uterus). Gestation period of different animals

Animal	Gestation length
Cow	9m (282) /273-296D/
Ewe	5m (150d) (140-155d)
Doe	5m (148-156d)
Sow	3m 3w d3 (114d)

2.7.2 Cattle genetic improvement

Genetic improvement of livestock depends on access to genetic variation and effective methods for exploiting this variation. To make cattle profitable; Productivity (milk, meat, production per animal) needs to be increased. There are two main ways in which we can attempt to increase the performance of cattle. We can either improve their environment **or** try to change their genetic make-up in order to increase their potential. Environment improvement consist all non-genetic improvements like management. However, by environment improvement, milk or meat production cannot be increased beyond the animal's genetic potential. The genotype of an animal refers to the genes that make up the animal. The genetic potential of an animal is inherited from its parents; so improving the genetic potential of one animal can improve the future generation from that animal.

Genetic improvement thus **does not come free of cost** but once attained it is genetically there without the need for further effort.

The essential steps for a successful genetic improvement program are:

1. Identification and recording of large number of animals of the selected breed in an area.
2. Identification of best performing animals (Bulls and Cows) for producing next generation of bulls and heifers – called “Selection”
3. Maximize use of these "Selected" animals in breeding program to produce all the replacement heifers – called “Multiplication”.

It is important to measure and record the relevant traits along with the pedigree details of large number of animals in an area. From this pool of recorded animals, best animals can be identified and selected.

2.7.2.1 Selection

Selection: - is the process of **choosing some individuals** in preference to others as the parents of the next generation. It is the basic method used by both nature and by humans to change the attributes of animals. Basically, there are two types of selection which are as follows:

Natural selection: - is the process in nature by which organisms better adapted to their environment tend to survive and reproduce more than those less adapted to their environment. it depends up on the genetic difference among the individuals in ***fitness characters*** such as ***disease resistance, libido, mating behaviors and anatomy and physical superiority***. **It is the survival of the fittest.** Only strong and those adapted to the environment can survive and produce large number of offspring.

Artificial selection: - it is a type of selection performed by **man**. It is the **most powerful** with which the breeder determines which animal to be reproduced and which to be retained for replacement. Thus, selection acts by allowing selected individuals to be parents of the next generation and contribute **more traits to the next generation** than other individuals in the same population.

Methods of Artificial selection

1. ***Tandem selection***: - here selection is practiced ***for only one trait at a time until satisfactory improvement is done in this trait.*** The second trait is considered for the selection and so on. If there is a **positive correlation** between the first trait selected and any other trait **both will improve**. If there is **negative correlation**, progress in one trait is affected by a decrease in another and will **invalidate the effect**. E.g. Milk yield and fat percentage, heat tolerance and milk yield

Disadvantage: - it is ***least efficient method and more effort and time consuming***. Negative correlation between several economic traits will invalidate the improvement.

2. ***Independent culling method:*** - is a selection strategy whereby animal is **culled** if it does not meet the requirement for a single trait, regardless of its levels on other traits. Is practical **for two or more trait at a time**. For each trait **a minimum standard is set**. Animal **should meet** standard for selection. Failure to meet the settled standard for any one trait will disqualify the animal.

E.g.

Character	Birth wt	Age at first caving	Milk yield	fat %
Minimum standard	30kg	30 month	2000kg/lactation	5%

Advantage

a. Selection for **more than two traits** at a time will bring about **simultaneous improvement**.
b. Animal can be **culled at an early age for failure to meet the minimum standard**, thus ***reduce the cost of maintenance***.

Disadvantage

a. Animal is culled for failure to meet the minimum standard set for one trait although it is superior in other traits.
b. Animal may be culled at an early age for its failure to meet the minimum standard without giving chance to reveal superiority in later stages of its life.

3. *Selection Index:* - In this method **value is separately determined for each of the trait to be selected;** and these values of each trait selected are added to give *a total score* for all the traits. However the value for each of the trait depends upon

a. Relative **economic value** of the trait
b. Heritability of the traits, **higher h^2** more the value
c. **Genetic correlation** with other important traits

Advantage

a. If animal is ***slightly deficient in one trait and superior in other trait it will be saved***
b. The efficiency of this index selection is more than that of independent culling level.

Disadvantage

a. It is highly complex
b. The genetic parameters (heritability, correlation) and economic values are not constant for all the population and in all the time and depends on many factors thus lead to revise the index.

2.7.2.2 Basis for selection/the production records

1. Individual selection*:* - selection is based on the performance of individual itself. ***The phenotype of individual is the sole criteria for estimating his genotype***. This is also **most commonly used basis** for selection in livestock.

Advantage

a. Simple since the characteristics such as **milk yield, growth rate, weight gain** etc can be directly evaluated from the individual itself.
b. Selection can be made even ***without the knowledge of the pedigree***.
c. **Less time consuming** compared to progeny testing (son and daughter).
d. It can be used as **preliminary selection before progeny testing**.

Disadvantage

- ☞ Many of the economically important traits are sex limited and hence expressed in one of these sexes (female). Therefore selection of males cannot be based on their own performance for the traits (milk yield, egg yield).

2. Pedigree selection

This is a method of selection **based on the performance of ancestors**. Pedigree information is most **useful when no data are available for the individual animals**, either because it is **too young** or because the expression of the trait is **sex linked.**

3. Progeny testing

The assessment of the breeding value of an animal on the **basis of the performance of its offspring** is known as a progeny test. As in most livestock species ***males produces many more offspring during their life time than females,*** progeny tests are ***usually applied to males***.

4. Collateral Relatives

Collateral relatives are those **individuals** who are ***not directly related either as ancestor or progeny***. Eg. Full sibs, half sibs. *These is most useful*

- when **family size is large**
- when traits are **highly inherited**
- when there is a **close genetic relationship** between members of the family

2.7.2.3 Breeding

The aim of breeding is **to produce outstanding and improved types of animals** which can give better services to man. Selection and system of breeding constitute the only tools available to the breeder for improvement of the animals.

General Objective of Breeding

- ☞ To produce the future progeny of good genotype to make further profit.
- ☞ To bring together the desirable gene combination after selection.
- ☞ To enhance the effect of heterozygosis.
- ☞ To overcome hereditary defects.
- ☞ To form a base for synthesis of new strain/line/breed.

Systemic breeding (mating): It is mating of female animal with male, which are either closely related or distantly related. Common types of systemic breeding include the following:

- **Inbreeding:** mating of ***closely related individuals*** such as families. This system results in more ***homozygous*** traits.
- **Cross breeding:** mating of ***distantly related breeds***. They can be two pure breeds. In this system of breeding more ***heterozygous*** is expressed.

2.7.2.4 Artificial Insemination (AI)

One of the reproductive technologies applied in animal breeding is AI and it continues to be the **most important** in many livestock production system in the temperate as well as in the tropical regions. ***Artificial insemination*** is the technique in which semen with living sperms is collected from the male and introduced into female reproductive tract at proper time with the help of instruments. With AI one ejaculate from a bull can be used to serve 400 to 500 cows and therefore one bull can produce sufficient semen for more than 50,000 cows per year.

Advantage of AI technology; there are several advantages by artificial insemination over natural mating or servicing.

- There is no need of maintenance of breeding bull for a herd; hence the cost of maintenance of breeding bull is saved.
- It prevents the spread of certain diseases and sterility due to genital diseases. Eg: contagious abortion, vibriosis.
- The semen of a desired animal can be used even after the death of that particular sire.
- The semen collected can be taken to the urban areas or rural areas for insemination.
- It makes possible the mating of animals with great differences in size without injury to either of the animal.
- It is helpful to inseminate the animals that are refuse to stands or accept the male at the time of oestrum.
- It helps in better record keeping.
- Old, heavy and injured sires can be used.

Disadvantages of AI technology:

- Requires well-trained operations and special equipment.
- Requires more time than natural services.
- Improper cleaning of instruments and in sanitary conditions may lead to lower fertility.
- If the bull is not properly tested, the spreading of diseases will be increased.
- Market for bulls will be reduced, while that for superior bull is increased.

2.8 Cattle health, disease and disease controls

Being familiar with the diseases and parasites that affect cattle can help farmers plan preventive programs that reduce health problems and increase profits. Scheduling routine visits by a veterinarian can save money by helping prevent health problems before they become serious. Observing the vital signs (temperature, pulse rate, and respiration rate) in an animal can help in the early detection of health problems. Vital signs will vary with activity and environmental conditions. Normal vital signs in beef

cattle are: • Temperature (normal range is 100.4°F to 102.8°F [38°C to 39.3°C]; average is 101.5°F [38.6°C]). (Usually temperature is higher in the morning than in the afternoon; younger animals will show a wider range of temperature than mature animals do.) • Pulse rate (normal range is 60 to 70 heartbeats per minute). • Respiration rate (normal range is 10 to 30 breaths per minute).

It is better to prevent health problems than to try to cure them once they have occurred. Good sanitation programs are essential in preventing diseases and parasites.

Some common disease of cattle

Mastitis: - is an inflammation of the mammary gland or udder. Mastitis in dairy cows is caused by udder infections, usually resulting from bacteria introduced either during the milking process or from environmental contact. Examples include contamination from milking equipment, milking personnel, manure contamination or dirty stalls.

Antibiotics can be administered to treat mastitis in dairy cows.

Anthrax

Anthrax is a disease caused by bacteria that may remain in the soil for 40 years or longer. Certain conditions cause the bacteria to become active. Anthrax affects mainly cattle and sheep. Infection may result from grazing on infected pastures. The bacteria usually enter the animal's body through the mouth. They may enter through the nose or through open wounds. Biting insects, such as horseflies, may spread the disease from one animal to another. The first sign of anthrax is often the sudden death of the infected animal. Less acute infections show symptoms of high fever, sudden staggering, hard breathing, trembling, and collapse. Death usually occurs within a few hours after these symptoms appear. The carcass of an animal that has died from anthrax should be burned or buried at least 6 feet deep and covered with quicklime. Care must be taken when handling the carcass of an animal suspected of having anthrax since the disease can be transmitted to people.

Vaccines may be used to control anthrax. In areas where anthrax is a problem, animals should be vaccinated on a yearly basis. Where it is not a common disease, vaccination should be done only on the advice of a veterinarian.

Brucellosis

Brucellosis, a disease caused by a microorganism, causes heavy economic losses in the cattle industry. The germs that cause brucellosis are also dangerous to humans, causing undulant (Malta) fever. Cattle with brucellosis often abort during the last half of pregnancy. Infected cows may retain the afterbirth

(placenta). Other symptoms include sterility in cows and bulls, reduced milk flow in cows, and enlarged testicles in bulls. Calves born to infected cows may be weak.

Brucellosis is spread by infected cattle that are brought into the herd. It may also be picked up by fence-line contact with infected animals. An aborted fetus that carries the Brucella organisms may be brought from one farm to another by dogs or other carnivorous animals. Unborn calves may be infected by their mothers and become sources of infection after birth. Cattle can also contract brucellosis by eating or drinking feed or water in which the organism is present. Sniffing or licking an aborted fetus or a calf from a cow with the disease can also spread the disease.

There is no cure for brucellosis. Prevention is accomplished by good management practices. Calves should be vaccinated between 2 and 6 months of age to increase their resistance to the disease.

Parasitic disease

External parasites of beef cattle include flies, lice, mange, mites, and ticks. There are high losses from these parasites. Some of these parasites irritate the animals; others are bloodsuckers. They slow down weight gains and, in some cases, damage the hides of the animals. Others carry diseases from one animal to another. Chemical, biological, mechanical, and cultural control methods are used to reduce losses from parasites. Chemical control methods are the most economical. A program of parasite control includes sanitation. Pens, barns, and feedlots must be kept clean. There are a number of internal parasites that affect cattle. The most common are roundworms, flatworms, coccidia, and anaplasma. Economic loss results from internal parasite are loss in weight, lower milk production, poor growth, wasted feed, and lower breeding efficiency.

Bloat

It is nutritional health problems affecting animal production in the world. Rapid fermentation (breakdown of carbohydrates by enzymes) in the rumen causes too much gas to be produced. The rumen swells and the animal cannot get rid of the gas. This condition is called bloat. The animal is unable to get rid of the gas by normal physiological means. Bloat easily kills ruminants. The major cause of bloat is eating too much green legume too fast. Other feeds can also cause bloat. Some animals will bloat on dry feeds.

One of the main ways to avoid bloat is to prevent animals from overeating legumes in too short a period of time. Feeding grain, dry roughage, or silage before turning the animals onto legume pasture also helps in prevention. Free access to water should be provided at all times. A stomach tube passed through the mouth helps the animal get rid of the gas. Other treatments include walking the animal on rough ground

to make it belch, forcing the animal to drink mineral oil or poloxalene (trade name, Bloat Guard), or inserting a trocar and cannula (a sharp-pointed instrument attached to a tube) into the rumen through the side to allow the gas to escape. The use of the trocar and cannula should only be considered after other methods have failed.

Bloat: is a disease of all ruminants. Bloat also called tympani, which is characterized by the distension of the rumen and reticulum with gases of fermentation. The animal is unable to get rid of the gas by normal physiological means. Bloat easily kills ruminants.

Causes of bloat

Bloat can occur when the animal grazes on lush young pasture, particularly if the pasture is wet. Some plants, e.g. clover, lucerne and alfalfa are especially dangerous in causing bloat but any fast growing plants can cause it. Sometimes ruminants kept by the household and fed only feed such as dry bread can develop bloat.

Bloat is caused by not only accumulation of gas in the ruminant stomach but also by the production of a froth or foam. The foam makes the gases to be mixed with the content of the paunch and belching out these gases is impossible.

Symptoms of Bloat:

- a swelling high in the left flank
- the animal stops grazing
- the animal shows signs of discomfort, and may lie down
- lying down and kicking at the belly
- increased rate of breathing
- breathing is through the mouth which is held open; the tongue protrudes, and there is copious saliva production
- If no relief is given, the animal may die within 10 minutes.

Preventing bloat

- Avoid moving animals to wet pasture, especially first thing in the morning.
- Do not allow very hungry animals to graze a pasture.
- Offer dry, cut grass first before turning out to graze.
- Keep a watch on animals at pasture.

Treatment

Give a drench (drink) to the animal. The drench used can be one of the following:

- Two large spoons of washing up liquid, e.g. Fairy, Lux.
- A solution of sodium bicarbonate (cooking or baking soda) and water.
- A small amount of kerosene (paraffin) in warm milk.
- A small bottle of peanut, soya or linseed oil.
- Use a commercially available medicine.

2.9 Housing and routine management of cattle

Management is a general term, denoting all operations connected with the maintenance of cattle. It includes feeding, housing, providing drinking water, grooming and washing animals, providing exercise, treating sick animals and training young stock. The feeding of cattle has already been dealt with.

Housing

Cattle are kept in sheds or stalls of various types, which are designed to give adequate protection to the animals against the weather. The sun is rather severe in the tropics and cattle are affected when they are exposed to the hot midday sun, particularly during summer. Cattle may commonly be seen stopping grazing during noon and seeking the protection of trees in the grazing grounds. If the animals are exposed to rain and cold winds, considerable body energy is taken up for maintaining the body temperature and this leads to lowered health and predisposition to diseases.

Factors to consider when planning house construction are:-

- Number of cattle in the farm.
- Space requirements per head.
- Kind of facilities used.
- Environmental requirements.
- Feed storage and handling methods.
- Amount of land needed.
- Amount of money and labor that is available.
- Opportunity for expansion of the enterprise.

The type of housing constructed depends on climate, geographical, economical and the type of farming, which has impact on the growth, and productivity of the animal.

- **Generally there are two types of livestock houses namely loose and conventional barn (stanchion type).**

A. **Loose housing: -** is the types of housing where by the animals are kept in an open paddock or pasture throughout the day and night except at milking time.

- ✓ The open paddock is provided with shelter along one side under which the animals can retire when it is very hot or cold.
- ✓ A common watering tank is provided and fodder is fed in common managers.
- ✓ Concentrate are fed at the time of milking.

This type of housing system is suitable to most countries except temperate region and heavy rainfall area.

B. The stanchion type of housing (conventional barn)

- ✓ This refers to housing in which the cows are confined together in the house and may secured at neck by stanchion of neck chain.
- ✓ The cows are fed as well as milked in this barn.
- ✓ Has pens equipped with feed and watering trough and also drainage.
- ✓ The barns are completely roofed and walls with better ventilation.
- ✓ The cows are kept and fed individually using manager.
- ✓ The animals are kept tied the whole day except 2 or 3 hours when they are allowed on the paddock for some exercise, cleaning, washing.

The arrangement of cow shade in conventional barn can be single row or double row based on the number of animals. In double row, the housing can be arranged in tail to tail system or face to face housing system. It should be simple and easily done from the available material.

There are different sections of this housing type.

a. Cattle crush
b. Feeders
c. Waterer
d. Feed stores
e. Offices
f. Isolation pen
g. Calf pens
h. Maternity pens
i. Loading and unloading rump

CHAPTER THREE

CAMEL PRODUCTION AND MANAGEMENT

Introduction

This chapter encompasses general points under camel production and management. Origin domestication and socio economic importance of camel will be firstly discussed. Features of camels that differentiate them from other animal will be also explained. Feed and feeding practice of camel also enlightened.

Learning objectives

At the end of this chapter you should able to**:**

- ✓ *Explain camel origin and domestication.*
- ✓ *Explain socio economic importance of camel.*
- ✓ *Explain features of camel.*
- ✓ *Explain anatomical, physiological and behavioral adaptation mechanism of camel.*

3.1 Origin and Domestication of Camel

The word camel is derived from Latin word: “camelus” which refers to any of the seven members of the family Camelidae. A camel is in the genus Camelus that bears distinctive fatty deposits known as "**humps**" on its back. Camels are cud chewers like ruminants such as cows and buffalo but lack the split hooves of most ruminants. A camel stomach has three compartments while that of cattle has four (Omasum absent).

The Camel is one of the most unique mammals on the planet and has adapted perfectly to life in the desert where feed and water can often be scarce and the temperature changes rapidly from the scorching-hot days to the cooler nights.

Camels are belong to the family Camelidae and thereby, to the suborder Tylopoda. Tylopoda themselves belong to the order Artiodactyla animals. The family Camelidae contains the genera Camelus (old world camel) and Lama (new world camel). The Camelidae ***originated*** in ***North America***, where the earliest fossil remains have been found. The genus Camelus migrated from North America in the late tertiary across the existing land bridge to Asia and Africa. The Lama on the other hand reached South America in the ice age across the Central American landbridge.

The genus camelus has two species. The heavily built, two-humped Bactrian camel (***Camelus bactrianus***), which inhabits the deserts of central Asia. The name "bactrian" for the two-humped

camel refers to the area "Baktria" in North Afghanistan where this type of camel is thought to have originated. Bactrian camels are hairy double humped animals. Found primarily in Central and East Asia, they are adapted for cold regions and have reddish brown or black hair and have relatively thin, short legs, and heavy bodies. Their calloused feet can handle ice, rocks and snow. They can drink salt water. Their hair may reach a length of foot in winter.

The other species is single-humped Arabian (*Camelus dromedaries*) commonly known as dromedary. The term dromedary is derived from the Greek word "dromados" (run) and, in the strict sense, is used for riding camels. Dromedary or Arabian camels are short-haired single humped animals. Found primarily in Africa, the Middle East and West Asia, they are adapted for hot regions. 2 to 3.4 meters in length and weighing 450 to 550 kilograms, they have long spindly legs and relatively thin bodies and soft padded feet adapted for walking in the desert. Most are light brown. Dromedary and Bactrian camels can breed and produce fertile offspring. Ethiopian camels are all single humped.

Where and when camels were first domesticated has not yet been established. The oldest written reference to camels is in the Bible, where it is stated that Abraham sent his servant with ten camels from Palestine to Mesopotamia to seek a bride for his son Isaac. The Bactrian camel is believed to have been domesticated in Central Asia 5,000 years ago. The Dromedary camel is believed to have been domesticated in Arabia 5,000 years ago. They may have been first been raised for milking purposes.

In just a few centuries camels have spread from where they originated into several areas where they found great use as important pack and milk animals. The two-humped *Bactrian* extended its range over broad regions of Asia, in the East to the Northern China, and in the West to Asia Minor and Southern Russia. The dromedary spread chiefly in the wake of the campaigns of conquest of the Islamic Arabs to East and North Africa as well as South West Asia. With few exceptions, camel husbandry is concentrated in areas with short periods of precipitation and long hot dry periods. Bactrians are mainly kept in areas where the annual mean temperatures do not exceed 21°C. Bactrian camels weigh 300 to 1,000 kg and dromedaries 300 to 600 kg.

Approximately 11 million dromedaries, representing two thirds of the world's camel population, are in the arid areas of Africa, particularly in North East Africa, i.e. Somalia, Sudan, Ethiopia and Kenya. The majority of camels in this region are kept by pastoralists in subsistence

production systems. In Somalia where the ratio of man to camel is one to one, camel milk is one of the main components of the human diet.

3.2 Socio economic importance of camels

Camels act as an essential element of human life supporting, over vast dry land areas. This is due to its unique physiological features and it's complementary of resources use with other domestic species. Camel utilizes resources in friendly manner with the ecosystem. In Ethiopian pastoral communities, camel is greater than any material wealthy. The camel's zone encompasses more than half of Ethiopian land surfaces. It is often considered that camels were primarily used in the past for transport of people and goods in desert and semiarid areas. Milk, meat, hair and hides were the subordinated to by product status of the supposed primary function. Camel hide is used for making suitcases. Camels are playing very important roles in the life of nomadic tribes rearing them. Socially, herd size is a very important indicator for the standing of the man in nomadic community (for example Camel man is a man; goat man is half- man; cow man is not a man at all Somali proverb).

Camels play a significant role as a primary source of subsistence in the lowlands. In many parts of Africa and Asia today, camels pull ploughs, turn waterwheels and transport people and goods to market along desert routes unpassable by wheeled vehicles. Humans have used camels can carry about 170 to 270 kilograms on their backs. This earned these beasts of burden a nickname, "ships of the desert".

Camels have diverse roles in livelihood of the pastoralists, including the building of assets, insurance against unexpected events, transportation of goods, food supply and income generation. Milk is valuable product obtained from camel. A female may yield about 3-5 liters daily. Camel milk on average consists of 5.1% lactose, 4.8% fat, 3.8%protein and 0.9% ash. The milk composition varies with breed, plain of nutrition, stage of lactation etc. the milk is consumed mostly as liquid milk. It usually gives milk 10 to 18 months since parturition. Very recently camels also start to play pronounced role in the export revenue of the countries in both live animal and carcass export. Camels live in wide arid and semiarid areas, which are not suitable for crop production and less suitable for other livestock production. Therefore, in these areas camel is superior to all other livestock in terms of food security. With continuing land degradation and rapidly growing human population, the camel's importance is increasing.

3.3 Distinguishing Features of Camels

Contrary to popular belief, a camel does not store water in its hump. It is in fact a mound of fatty tissue from which the animal draws energy when feed is hard to find. When a camel uses its hump fat for sustenance, the mound becomes flabby and shrinks. If a camel draws too much fat, the small remaining lump will flop from its upright position and hang down the camel's side. Feed and a few days' rest will return the hump to its normal firm condition.

For survival in desert environment, camels have physiological, anatomical and behavioral adaptation mechanisms. Water conservation ability, the unique features of blood, thermoregulation, and efficient digestion and metabolism are among the physiological adaptations. Anatomically the nature of skin coat, eye, nostril and lips, large body size and long height and large foot pads contribute for their survival. Moreover the feeding, drinking, thermal and sexual behavior of camels also plays a major role in succeeding their existence in the desert environment.

Adaptations of Camels to the Desert Environment Physiological adaptations

1. **Water conservation:** Desert adapted camels have evolved physiological adaptations that reduce the amount of water lost or are able to tolerate significant amounts of water loss. Under very hot conditions, it may drink only every eight to ten days and lose up to 30 percent of its body weight through dehydration. The digestive and urinary tracts are well specialized in water conservation. The kidneys and intestines of a camel are very efficient at reabsorbing water. In general, to compare between camels and the other livestock, camels lose only 1.3 liters of fluid intake every day while the other livestock lose 20 to 40 liters per day. This is one of the primary methods for resisting water deprivation in the desert.
2. **Unique features of blood: -** The camel can dehydrate without compromising blood viscosity. The camel's blood plays a principal role in adaptive mechanisms to high heat load and dehydration. Camels have oval-shaped red blood cells that help continue blood flow during times when water is scarce.
3. **Thermoregulation: - Body temperature regulation:** When camel dehydrated and exposed to high environmental heat load body temperature may fluctuate by 6 to 7°C, from approximately 34 to 41°C.

4. **Lipid metabolism:** The proverbial capacity of the dromedary to resist thirst and lack of feed is related to remarkable adaptive mechanisms, including the mobilization of the body reserves of lipids (fatty tissue) during malnutrition and the storage of fat during favorable period.

Anatomical adaptation of camels

1. **Skin and coat**: The camels' thick coats insulate them from the intense heat radiated from desert sand and during the summer the coat becomes lighter in color, reflecting light as well as helping to avoid sunburn. Dromedaries have a pad of thick tissue over the sternum called the pedestal. When the animal lies down, the pedestal and other small areas of padded contact points raise the body from the hot surface and allow cooling air to pass under the body. In addition, the camel's coat which is more hairy than wooly create a favorable buffer zone that separate body surface from the surrounding climatic conditions. Coat thickness varies through growth and shedding to cope with prevailing environmental conditions during the different seasons of the year. The sweat evaporates directly from the skin surface in the dromedary camel rather than from the tip of the hairs as it does on heavily furred animals. Latent heat of vaporization is therefore drawn directly from the skin. Evaporation that takes place directly on the skin saves more energy and cools the skin more effectively than if the evaporations took place at the tip of the hairs.
2. **Eye, nostril and lips**: The slit-like closable nostril protects against blowing sand and moistens air on its way to the lungs. When camel exhales, water vapor become trapped in their nostrils and is reabsorbed into the body to conserve water. Split upper lip assists feed selection and easy prehension during browsing and their mouths have a thick leathery lining, allowing them to chew thorny desert plants. The small wound ears covered with tufts of hair is protected from entering of the blowing sand. Camels have long eyelashes that help protect the eyes from the sun and the blowing sand. They have also a third, clear eyelid that protects their eyes from blowing sand.
3. **Large body size and height**: The large size and height of the camel can be of some advantage in heat regulation. A large body mass heats up much more slowly than a smaller mass exposed to the sun. Large-bodied animals gain heat from the environment at a slower rate than do smaller animals because they have a lower surface-area-to volume ratio and higher thermal inertia. The comparatively small surface-area-to-volume ratio of large animals reduces the proportion of the animal exposed to solar radiation, reducing potential

environmental heat load. Body size is related to metabolic rate. While their overall energy requirements are higher, large animals have lower mass-specific metabolic rates than do small animals; these low metabolic rates contribute comparatively less metabolic heat to the total thermal load.

The long legs and the large humps, containing adipose tissue, give camels a large skin surface in relation to the body mass. The height above the ground is used to hold their body far from the hot sand and allows the desert winds free access to the body thus in some circumstances cooling it effectively. It also enables the camels to browse high above the ground reaching 3.5 meters into the canopies of trees and bushes. This characteristic together with their preference to browse on many kinds of bushes makes them an excellent complement for multi-species herds in different kinds of range lands, increasing the productivity of the land without really competing with other livestock.

4. **Large foot pads**: Their large broad 'elastic' pads with two finger nail like toe nails on front are also important structures to easily walk on the desert sand which is not possible for other ungulates to walk on tips of hoof covered toes. The advantage of this broad leathery pad in camels is to disperse their weight in a wider surface area and their feet don't sink in the loose sandy soil

Behavioral adaptations of camels

Behaviors of desert camels that aid thermoregulation and the maintenance of water balance include timing of activity, diet selection, use of microhabitats, social behaviors, body orientation, migration, and timing of reproduction.

1. **Thermal behavior of camels**: - The camel avoids sitting in the sun if possible, otherwise faces the sun and does not expose all the body. In the recumbent position, the camel raises its sternum to ensure a "plate like" shape and this allows air circulation. Standing or sitting, the camel gradually keeps shifting its position throughout the day to keep in line with the sun, thus reducing the area subject to direct radiation.

2. **Sexual behavior**: Species that inhabit arid and semiarid areas with unpredictable environmental conditions display more opportunistic breeding patterns, with young born over a more extended time period. The camel's reproduction is characterized by a seasonal activity which is typically timed to ensure that parturition occurs at a favorable time of year to maximize offspring survival.

3.4 Feed requirements and Feeding habits of the camel

Camels are browsers. Their long legs and neck allow them to browse up to 3 meters above the ground, so they can eat foliage that other livestock cannot reach. The camel selects only a few leaves from each plant and ingests the foliage parts. It prefers halophytes plants (Plant growing naturally in very salty soil). It can take in a very large amount of water at one occasion for compensating previous fluid loss and it can move for a long distance in the desert to seek water.

Camels are very versatile and opportunistic feeders, they accept a wide range of browse species that are often avoided by other species, but also some grasses. Because of the kind of forage they prefer and the fact that they feed at higher levels, camels rarely come into direct competition for grazing with other animals like cattle and sheep. Under normal rangeland conditions, camels select a diverse high-quality diet that provides all the nutrients required by the body. Foraging camels normally spread over a large area thus minimizing pressure on a particular area. The feed requirements of camels are modest, and, under drought conditions, they can reduce both their feed intake and metabolism.

The camel has preference for feeding at night, in the early morning or late evening or when the sky is clouded or just before and just after sunset. At very hot times camels tend to avoid feeding around midday. Under restricted herding conditions where camels are confined at night, behavior cannot be described as natural since nutritional requirements have to be met in a shortened period and rumination and rest take place for the most part during the hours of darkness. If the camel is allowed to feed at night, it settles on the ground early in the morning before the sun has warmed the ground, thus reducing heat absorption by conduction from the earth to its body. Filling up on water, when it's available, is very important for camels. They can drink 30 gallons (113 liters) of water in just 13 minutes. Their bodies rehydrate faster than any other mammal.

Chapter 4

Sheep and Goat Production and Management

Introduction

This chapter deals with sheep and goat production and management. Origin, domestication and classification methods of sheep and goat discussed first. Types of sheep and goats in Ethiopia, Advantages of small ruminants over large ruminants, breeding systems employed in sheep and goat production and Market classes (grades) and marketing of live animals are also part of the chapter.

Learning Objective

At the end of this chapter the student should able to:

- Explain place were sheep and goat are originated and domesticated
- Explain classification methods of sheep and goats
- Explain types of sheep and goats in Ethiopia
- Explain Advantages of small ruminants over large ruminants
- Explain Breeding systems, Market classes and marketing of live animals.

Common Terminologies used in Sheep and Goat Production

Ram: a male sheep that has acquired sexual maturity and kept for mating (breeding)

Buck: a male goat that has acquired sexual maturity and kept for mating (breeding)

Ewe: a female sheep that gives at least one birth

Doe: a female goat that gives at least one birth

Lamb: a young of sheep (either sex)

Ram lamb: a young male sheep

Ewe lamb: a young female sheep

Kid: a young of goat (either sex)

Yearling: sheep and goats that are about one year age

Wether: a castrated male

Lambing: the process or act of giving birth (parturition) in sheep

Kidding: the process or act of giving birth (parturition) in goats

Mutton: meat of sheep

Lamb: meat of young sheep

Chevon: meat of goat

4.1 Origin and Domestication of sheep and goats

Sheep: Sheep (*Ovis aries*) are believed to have been among the first animals to be domesticated, preceded by the dog and goat. The domestication of sheep probably dates back to the pre-settled agricultural period. The place of domestication and origin is **northern Iraq**. The time of domestication was over **10,500** years ago. Sheep was domesticated from the wild species of sheep. The wild species that have contributed to the domestication of sheep are:

1. The Argali (ovis ammon) of central Asia
2. The Urial (ovis vignei) also of Asia
3. The moufflon (Ovis musimon) of Asia and Europe.

Wild species of sheep never existed in Africa, hence Africa never contributed to the origin and domestication of sheep. From an Asian origin, sheep spread to Europe and Africa. Sheep was introduced to American and Oceania with European settlers.

It is assumed that the majority of today's domestic sheep breeds descended from the **urial** which is currently found in central Asian countries and in northern Iran extending up to Tibet and northern China. Although sheep were domesticated as dual purpose animals to produce wool and meat, early people would have valued sheep milk as well.

Goats: Goats (*Capra hircus*) are believed to be the second animal domesticated following the dog. Goats were originated and domesticated in the regions of ***south west Asia***, on the boarder of Iran and Iraq. The time of domestication was estimated to be around 9000 - 7000 BC (before the birth of Christ). The evidence for time and place of domestication or origin is based on the identification of bones from archaeological sites. The wild species of goats have attributed to the domestication and origin of domesticated goats.

4.2 Classification Methods of Sheep and goats

4.2.1. Methods for Classification of Sheep

There are different methods of classification of sheep. The common methods of classification are based on **tail type**, **coat cover** and function/**use** of sheep.

I. **Tail type**: four basic tail types are identified in domestic sheep. These are long-tailed, short-tailed, fat-tailed and fat-ramped. All wild species of sheep had short-thin tails. The different tail types have been developed after domestication as the result of natural selection and selection by breeders.

1. Long-tailed sheep breed

A. Long thin tailed: These sheep breeds are common in Europe, America, Australia and New Zealand, East and South Africa. Examples are Merinos, Rambouillet, etc. They have generally fine wool and are mainly kept for wool production. The tail does not contain excessive fat.

B. Long thick tailed: They have coarse wool or hairy coat cover. E.g. Desert Sudanese sheep. They are said to have been descended from crossing between the fat tailed (tropical) and long thin tailed (temperate) sheep breeds.

2. Short tailed sheep: They are found in northern Europe and Eastern parts of Asia and Central Asia. They are mainly of coarse woolen breed except the small rain forest sheep that are found in the humid tropics of Africa with hairy coat cover.

3. Fat-tailed Sheep: Found in west Asia, North and East Africa. Examples of this sheep breed of Ethiopia are the Menz and Arsi-Bale with coarse wool. The tail serves as a storage site for excess fat which endures the sheep to withstand long periods of semi-starvation without any problem.

4. Fat-rumped sheep: In Africa these sheep breed predominate in Somali and from there they have spread up to South, East and Horn of Africa.

II. Coat Cover: Based on coat cover, domestic sheep can be again classified into three main groups as wool, Hair, and Fur sheep.

1. The Wool Sheep: This sheep breed may be further classified into two groups.

Fine wool sheep: they yield fine wool for closing purposes like sweaters and overcoats. They are mainly the long thin tailed sheep of temperate breeds.

Coarse wool sheep: This sheep breed yield course wool for carpet/mat making and are mainly the fat tailed or fat ramped tropical sheep breeds.

2. The Hair Sheep: They are primarily found in the tropics. The coat cover has almost no commercial value, but the skins of these sheep have greater value than the wool sheep breed because of the skin is thicker.

3. The Fur Sheep: Matured sheep of this breed produce coarse wool for carpet or mat making but they are known for the pelt of the new born lambs for making over coats and head wearing/huts. An example of the sheep breed is Karakul sheep of Ukraine.

III. Function/Primary Use: Based on their function sheep can be classified as mutton, wool, fur and milk/dairy types.

4.2.2. Methods of Classification of Goat breeds

Goat breeds can be classified according to **origin**, **ear shape** and **length**, **function**, **body size/weight** and **height at withers**.

Origin: Based on origin goats may be considered as European, Asiatic or African origin. But Classification based on origin may be not exact criterion, because some breeds may be common to both Asiatic and Europe, or Africa due to movement of goats between territories. There is still some uncertainty with regard to the identifying wild ancestors of goats whether the wild ancestors belong to Asia, Europe or Africa. This problem limits classification of goats based on the origin.

Ear shape and length: This more applicable to sheep than goats, because in goats there is little variation in ear shape and length as compared to sheep with great variation. This method should be combined with their origin.

Function: Goats have been classified in terms of their major functions as meat, milk/dairy and skin or fiber. But goats in the tropics have not adequately bred for specific purposes to identify them in terms of their function. As such classification based on function can only apply to some breeds the majority are all-purpose (multi-purpose animals).

Body size/weight: This method is most widely used method. It requires body weight data for individual breeds.

Height at withers: This method depends on the body size/height of the goats and divides goats into three major groups.

- **Large breeds**: They measure over 65 cm in height at withers.
- **Small breeds**: They should measure between 51- 65 cm in height at withers.
- **Dwarf goats**: Should measure below 50 cm in height at withers.

In general, classification based on height at withers is more precise than other methods, but gives little or no information/attention to anatomically important body features, like ear shape, horn type, color, wattles and beards. It does not also provide any information about the correlation

between height and weight. It roughly relates height with body weight without giving correct figures.

4.3 Types of sheep and goats in Ethiopia

4.3.1 Types of sheep in Ethiopia

Attempts have been made since 1975 to identify and characterize Ethiopia's sheep breeds or types. Different types of sheep have been identified in Ethiopia. The identification/classification is based on:

1. Origin or place of distribution
2. Tail type
3. Coat cover
4. Function/use of sheep.

Based on the above identification/classification methods, the following types of sheep are selected examples of some Ethiopian sheep breeds that have been identified in Ethiopia.

1. Black head Somali (fat rumped type):- They are known as Ogaden and Berber Black head.

Distribution: distributed all over the Somali areas and horn of Africa.

Characteristics: They have got a large deposit of fat on the ramp and at the base of the tail/hind quarter of a sheep. Belong to the fat rumped group, i.e. fat is on the rump, not on the tail of a sheep.

Sheep of this group weigh 30-45 kg & 60 – 68 cm high; they are polled, and have small ears. They have dewlap, thin tail tip, which hangs downward. The coat cover consists of short hairs.

Color: black head with white body & legs. The black area can vary from head to neck & in some cases to shoulders.

Utility: They give little milk but are known for their meat & skins.

Management system: They are well adapted to arid conditions, hence kept by nomadic people.

2. Afar (Adal fat rumped)

Distribution: they are mainly distributed in the danakil and the lower valley of the Awash.

Characteristics: they are polled, they have long lopped ears and the tail has a wide base.

Color: usually they are white or reddish in color.

Utility: they are known for their high quality meat.

Management system: kept by nomadic people.

3. Menz (fat tailed type):

Distribution: throughout the Menz and Selale area of Shewa.

Characteristics: Males are usually horned, females polled.

Size: they are of medium size weighing on average 30-35 kg, they are woolly type.

Utility: for wool production and meat. Shearing is done twice a year with a yield of 1-1.6kg. The wool is used for coarse blanket making. They are most prominent coarse wool bearing sheep in the country.
Management system: Adapted to mixed farming systems.

4. Arsi - Bale (fat –tailed type):

Distribution: they are distributed throughout the high land areas of Harerghe, Bale and Arsi.

Characteristics: Males are horned; females are either polled or may have rudimentary horns. They have woolly under coat, (soft & white hair).

Color: varies from dark brown to grey, with white spots.

Utility: They are known for their meat & skin.

Management system: They are kept are in mixed farming systems.

5. Horro: (thin tailed type)

Distribution: they are distributed in west Ethiopia around Horro-gudru area in Wollega).

Characteristics: males have often ruff mien (mane), they are mainly polled

Colour: They colour is light brown. Size: medium

Utility: they are known for their twin births. Hence they are mainly maintained for meat & skins.

Management system: Mixed farming systems.

6. Washera (Dangla) sheep

The Washera (Dangla) sheep is found predominantly in West and East Gojam zones of the Amhara Region extending to the south of Lake Tana. Washera sheep weigh about 2.8, 13.8 and 22.7 kg at birth, weaning and six months of age, respectively. The growth rate after weaning is comparable and even better than some other indigenous breeds. This indicates the potential of this breed for commercial mutton production for the local and export markets. Washera sheep have high twinning rates.

4.3.2 Types of Goats in Ethiopia

The indigenous goats of Ethiopia are found in all agro-ecological zones of the country. It is believed that these goats have evolved through a process of natural selection. Ethiopian goats in the lowlands are highly valued and reared mainly for milk and meat production. In the highlands, goats are mainly kept for meat. Goats are also sources of manure, valuable skins and cash income. Goats of Ethiopia are classified into four families. Classification is based on

1. Origin/place of geographical distribution
2. Body size like small, medium or large
3. Ear shape – long, short or lop
4. Function –meat, milk, skin, hair or fiber

1. The Nubian family: - Found in North West of Ethiopia, around Wegera on the border with Sudan. Nubian goats they are known for their milk) and are adapted in arid & semi and zones of the country e.g. Begayit goats

2. The Rift Valley family: under this family, there are different goat types, like;- Abergelle, Afar, Arsi Bale, Woyto Guji, Worre.

3. The Somali family: - Under this family, there are different types of goats that are known for their higher milk yield and higher survivals in harsh environment. These include: Short eared Somali goats, Long eared Somali goats, Hararghe highland goats.

4. **The Small East African family**: This family includes goats of Western highlands, Western low land, Central highland, Keffa goats.

4.4 Advantages of small ruminants over large ruminants

- ✓ They have higher fertility rate – twin or multiple birth is common.
- ✓ Have short generation interval to increase their production (can produce two crops per year) more young in life time.
- ✓ Facility required to maintain them is very low.
- ✓ Their purchase price is low (investment cost is low). Therefore, they have less risk to the owner in cases of deaths (accidents) due to diseases, theft and predators.
- ✓ The management, the price, feed requirement and health care etc. of five sheep or goats are estimated to be equivalent to the management inputs required for a single cow. Considering a mortality rate of 20%, and if a farmer owns one cow, the farmer will lose it. But, if a farmer owns five goats instead of one cow, he will remain with four goats. Purchase price is

cheaper, can replace it immediately. But for man who loses a cow, it will be very difficult to him to replace it.

- ✓ They are more convenient to slaughter. They are easier to home consumption where you have little storage facility like refrigerator.
- ✓ They have an ability to survive in harsh environmental condition on low quality and quantity or relatively small amount of feed, no water. They have high resistance to dehydration (loss of water) and perform well in dry areas.
- ✓ They are efficient utilizes of fibrous feeds, which otherwise would not be utilized by large ruminants. They also have lower feed requirements compared to cattle because of their small body size.
- ✓ Easy integration of small ruminants into different farming systems.
- ✓ The increased demand for sheep and goat meat has also increased their importance in lowland pastoral areas as a source of cash income, food security, etc.

4.5 Breeding systems used in sheep and goat production

To improve sheep and goats performance, the same methods are used as other types of livestock. The most common breeding systems in sheep and goat production are *upgrading, out crossing, line breeding, crossbreeding, inbreeding* and *substitution*.

Upgrading: involves successive use of pure bred rams or bucks on the indigenous ewes or does flocks to produce a high grade flock that resembles the characteristics of the pure-bred rams or bucks.

Out crossing: is the mating of individuals more distantly related than average for the population. In other word mating of rams/bucks from distantly related animals with ewes/does of the same breed. The system helps to produce animals with the desired characters from the two strains.

Line breeding: Mating of cousins or more distantly related animals that trace to the same parents in the pedigree. This system avoids the decrease of fertility and vigor as the result of inbreeding.

Crossbreeding: Mating of two separate or different pure-breed individuals. When two pure-breeds are crossed the F1 generation may show un-usually superior performance than the parents which is due to heterosis effect or hybrid vigor as the result of favorable gene combination brought about by the cross. If not superior, they express intermediate performance between the parent types and may show phenotypic similarities to one of the parents. Crossbreeding is the system that is widely used in the tropics to improve productive and reproductive performances of the indigenous sheep and

goat breeds. The objective of crossbreeding is to produce offspring with superior performance to both the parents and that have vigor and thrift.

Inbreeding: Involves the mating of closely related animals such as sire and daughter or brother and sister. It is used to produce a uniform flock characteristics or a flock with uniform genetic make-up. It increases animals with homozygous genes with dominant or recessive genes (AA or aa) combinations but reduces animals with heterozygous gene combinations (Aa). It results in reduced fertility, vigor, poor growth rate of animals due to absence of heterosis effect.

Substitution: Refers to the replacement of the existing flocks/breeds with introduced breeds. The system is very expensive to replace the whole flock and hence not often employed. The system can be only employed under certain circumstances, when the existing population size of indigenous sheep and goat are small and where the level of productivity of indigenous animals is low. However, it is rarely advisable to substitute the existing indigenous flock based on their low productivity because native breeds are well adapted to their environment and have good heat tolerance and disease resistance and have high fertility. These are important merits of indigenous flock that do not permit their substitution.

4.6 Market classes (grades) and marketing of live animals

Market classes/grades it is simply meant type of animals that are produced or raised for marketing. The market classes of animals or type of animals are:

1. Feeder lambs/kids: These are animals that are fed and fattened on a high plane of nutrition (high concentrate feed) after weaning. Up to weaning they grow on milk of the dams and grass alone. After weaning they are provided with high concentrate diets. Producers that grow young animals on milk and grass alone and sell them at or after weaning are termed as Feeder lamb/kid producers. Feeder lambs/kids are then fattened further to produce high quality finishers at the age of 12 – 18 months. The finishers are mostly produced by commercial fatteners

2. Slaughter Animals: These may be produced directly by the producers (farmers), who may sale their cull animals like: rams/bucks, castrates and old or sterile ewes/does. They may be also produced by specialized fatteners who buy matured animals and fatten them for certain time, usually 3 months to slaughter animals and sale them.

3. Pure–bred Breeding Stock: These are animals with superior genetic make-up and used as breeding stock or reproduction. The breed type could be for wool or mutton production. They are

produced both for domestic markets and export of superior breeds. The prices of such animals are very high as compared to commercially produced types (feeder lambs and finishers or slaughter animals. Breeders are interested in selling of highly selected animals with superior genetic make-up at a higher price.

Marketing of Live Animals: Animals are marketed through different ways:

1. Direct dealing: - It is between a seller and a buyer or direct negotiation between the two. Animals may be sold at a farm/village level or local markets to the consumers, the middle men (dealers), the fatteners in case of feeder lambs, the processing plants in case of finishers or exporters in case of finishers and breeding stock. This system of marketing gives an opportunity to look into the individual animals and decide whether a buyer should buy or not.

Pure-bred animals are mostly marketed through direct dealing between buyer and seller, because the buyer may be interested in judging animals by direct observation and looking the performance of individual animals based on the records of its own or pedigree performance.

2. Order buyers: Processing plants, fattener's, hotel owners and exporters may buy animals through order or through an agreement between the producers and themselves. They may have an agreement in which the producer regularly delivers/supplies his animals at a regular time. This system of marketing favours the producer either to produce more animals or to limit the number of animals based on the demands of the buyers.

3. Marketing through a commission firm (Commercial Service Companies): There are companies/firms who take animals from the producer on the body weight basis and sell them for the producers. They do not buy animals by themselves but sell them for the producers, because they do not want to have a risk of death of animals during transporting and the loss that may incurred with death of animals. The firms may have facilities to transport animals to distant places. For the services they provide, they charge a commission.

Chapter 5

Poultry Production and Hatchery Management

Introduction

This chapter introduces you about poultry and hatchery management. Topics like: Origin and classification of poultry, Poultry production systems in Ethiopia, Poultry housing, Poultry disease and parasite are studied in your assignments. In this handout we deal with two subtopics. The first will be poultry management and the second incubation and hatchery operation.

Learning Objectives

At the end of this chapter the student should be able to:

- ***Explain poultry management***
- ***Explain incubation and hatchery operation***

5.1 Introduction to poultry

Definition: the word poultry refers to all birds kept for the production of eggs and meat for human consumption. It includes chickens, turkey, ducks, geese, quails, guinea fowl, ostrich, etc. and other domesticated birds and economically important species. In Ethiopia, the term poultry is synonymous to only chicken rearing. Most of other birds are unknown to the people, or are known as wild birds.

The wild ancestors of the domestic chicken were originated, in **South East Asia**. The place of first domestication for the domestic fowl was in **South East India** (2500 BC). Then fowls were spread eastwards and northwards in to Asia from their center of origin (South East Asia). After that they were imported in to the America and Australia by the early European explorers and immigrants. There were different types of wild jungle fowl as ancestors of the modern fowl, however, ***Gallus gallus*** *(*red jungle fowl) had wide distributed and assumed to be the chief ancestor of modern chickens. Therefore, the domestic chicken is Called ***Gallus domesticus***. There were several reasons for the domestication of poultry. The reasons for poultry domestication were include communication (pigeon); vestment (ostrich), pet (cage birds) purpose of entertainment (cock fighting) and beauty color (fancy feather). Through time eggs were used for food. So the first economic importance of chicken was egg production. However, nowadays, the main aims of domestication are egg and meat production.

Some Terminologies in Poultry Production

Layers: chickens kept for egg production

Broilers: chickens kept for meat production

Chicks: young chicken between 0-8 weeks

Pullets: female chickens in their first year of lay.

Hens: female chickens in their second year of lay.

Cockerels: young male chicken before sexually matured.

Cock: sexually matured male chicken used for breeding purpose.

5.2 Poultry management

Poultry management is the art and science of combing resources, capital and labor to produce and market poultry meat and eggs. It also includes the profitability of the farm.

5.2.1 Brooder management

Newly hatched chicks need a source of heat that will prevent their body temperature from falling too low, because chicks do not have feathers; therefore, they cannot maintain body temperature till the feathers grow. Body temperature of chicken is 42°C (107.6^{O}F) which is more than that of other animals and humans (37.8°C). More the difference in temperature between two media, fasters is the temperature loss from the hotter object. Hence, this makes it much more difficult for the chicks to hold body temperature. Therefore, once the eggs are hatched in an incubator, the chicks will have to be reared and looked after. To maintain the chickens' heat, brooder is use as heat source either by natural hen or artificial means for the period of growth of chicks from 0 day (Day old) to 4 weeks. Under natural brooding mother hen will ensure that they are kept warm by protect them against the cold.

However, in artificial brooding, heat sources for chicks are brooders/Heaters**.** It is practiced in wide chicken production stations. This chick brooding method use different brooders/heaters like electric, charcoal and hay box. The day-old chick's temperature is about 3°F below that of an adult's. Its body temperature starts rising about 4 days of age and reaches its maximum at 10 days. The chick needs time to develop temperature control (2 to 4 weeks) and at 5 weeks of age, they maintain their own body temperatures if the room temperature is kept. It is important to light the brooders 24 hours before the chicks hatch or arrive. Determine if the brooders are working properly, and adjust the temperature to 90 (32.2^{O}C) to 95 (35 ^{O}C) °F. In time of stress or vaccination reactions, increase brooder temperatures about 5°C above the recommended temperature until the chicks recover. Check the comfort of the chicks several times each day, especially in the evening. Distribution of chicks around and under the brooder indicates status of heat conditions. Accordingly, when the temperature is too cold, the chicks chirp sharply and

huddle together under the brooder. If the chicks move away from the brooder, pant, and are drowsy, the temperature is too warm. Place an adequate number of feeders and waterers around each brooder. Provide at least two 4.5 liters waterers and two 12-inch or 18-inch chick feeders for every 100 chicks. Feed placed on a few feeder lids under each brooder encourages the chicks to start eating sooner.

5.2.2 Grower management

Growers are chickens at the age of 8-18 weeks (56-126 day) for egg type of chickens and broiler parent. Grower chickens need good quality feed, even better than that of the hens. If the weather is good and the place is safe from predators like rats, large birds and dogs, it might be a good idea to let them pick at some vegetation in addition to their normal concentrated feed. Protein is needed for growth, keeping up a good health status, for maintenance, production, to grow feather, etc. The level depends on the type of plant.

Chicken unable to produce amino acids rather they are 100 percent depends on farmers feed for protein. Protein source feeds are obtained from both animal and plant origin. Plant origin protein source feeds include oil crop by products (contain high fat and protein nutrients), oil factory by products such as cakes. Animal origin protein source feeds include grounded blood, grounded meat, grounded meat and bone, and fish by product such as fish meal. Major energy source feeds include cereal grains such as maize, sorghum, rice, wheat, barley, finger millet, industrial/cereal by products such as wheat bran and wheat middling.

5.2.3 Layer management

Layers are poultry between the age of 20-80 weeks and lay eggs during this time. The intake of dietary energy by laying hens is related to their rate of egg production. A 1% increase in egg production is associated with a 2% increase in feed intake. Laying hens consume 20% more feed on egg forming days than days when eggs are not formed.

Laying hens should have easy access to calcium rich feed that may be supplemented by calcium-rich sources such as crushed snail or egg shells. Do not hatch new chicks if you don’t have enough feed for them. If you hatch too many chicks, they may die from starvation or malnutrition, or their resistance to diseases may be reduced.

Provide nests in the hen house for laying makes it easier to collect eggs and they can be kept clean. There should be adaptation period of the hen for the laying nest before start of laying eggs which is

important to prevent the hen not to lay their eggs outside the laying nest. Nests should be placed inside the chicken house and preferably above the ground. Nests should be of the right size for the hen to feel comfortable. The size and length as well as the number of compartments of the laying nest to be prepared should consider the number of hens. A nest box will typically measure 30 x 30 x 30 cm. The laying nest prepared by this size is enough for 5 layers. It is advisable to place the laying nests in the dark part of the house to prevent exposure to the sun. Don't make them too big, as the hen will not feel comfortable. A calabash or nest basket may measure 40 x 20 x 25 cm (upper diameter x height x lower diameter). A clay pot is made more or less the same as calabash.

5.2.4 Broilers management

Broilers are chickens that are raised (reared) for meat production. The modern broilers require 1) feed and water, 2) environmental protection (temperature, air quality and light), and 3) health protection. For most poultry, the ideal growing temperature zone is between 60 (15.6^0C) to 75 (23.9^0C) ^{O}F which is the temperature range where heat production is at a minimum. If the broilers become too hot or chilled, growth will be retarded. If the heat is below the optimum then broilers eat more to gain more heat from the feed. Since more of the feed energy got to keeping themselves warm and less in to weight gain lead to reduce production. If the heat is above the optimum then broilers the broilers try to lose more heat through panting. Panting cools by evaporative moistures from the respiratory and it takes high energy. As the temperature increase they feed small to avoid heat load from feed energy and lose weight gain lead to reduce production. Research suggests that each degree of deviation from the optimum results in a reduction of body weight at 8 weeks of 20 gm per broiler. Provide all-night light for broilers. Making light (natural and artificial) available 24 hours a day allows broilers access to feed at all times and increases their body weight, especially during the summer months. Keep a 40-watt bulb at least 1.8 feet above broilers after turning off the heat lamps.

Optimum performance of the broilers depends on proper nutrition. It is absolutely essential that broilers be fed a high-quality broiler feed containing at least 20 percent protein. All broilers should be able to eat at the same time. One pie plate or cooking pan for feed and one chick waterer per 25 chicks are needed the first 7 days. Broiler chicks fed ad libitum for 42 to 56 days to an average weight of 1.8 to 2.3kg. Use a 3-stage feeding program 1) starter (first 2 to 3 week), grower (about 2 week), and finisher (for the remainder or 20 weeks). From 7 days to slaughter, provide one tube-type feeder per 20 to 25 broilers. Broilers must have access to clean, fresh water at all times. One 9

litter waterer per 50 chicks is required from the first through the fourth week. One 9 litter waterer per 25 broilers is required after the fourth week.

Good sanitation program prevents parasite problems. Remove the litter after each flock of broilers. Keep old birds away from the broilers, and do not walk from the laying house or pen into the broiler house without thoroughly cleaning and disinfecting your shoes.

The beak of broilers should be trimmed (removed) 1/3 of the top beak and a small part of the bottom at 6-8 days old usually by mechanically operated blade. Beak trimming is used to reduce the incidence of serious physical injuries or cannibalism by preventing feather pecking or vent pecking otherwise can cause high levels of feather loss in a flock and may develop into serious physical injuries. Cannibalism can lead to the death of a large proportion of the broilers with in a flock.

5.3 Incubation and hatchery operation

Incubation is the management of fertilized egg to ensure the satisfactory development of the embryo inside it in to a normal chick. Or it is the process by which eggs are placed in an appropriate environment for development of the embryo. It may be achieved by two methods

1. Natural method, using broody hens.
2. Artificial method, by using artificial incubator.

Natural Incubation: - is hatching eggs by putting them under a broody hen. The natural parents, foster parents of the same or a related species, or even unrelated species may be used to incubate eggs. Choose birds that are reliable incubators and whose reproductive cycle can be synchronized with that of the natural parents. A maximum of 14 to 16 eggs may be brooded in one nest, but hatchability often declines with more than ten eggs, depending on the size of the hen. Feed and water provided in close proximity to the hen will keep her in better condition and reduce embryo damage due to the cooling of the eggs if she has to leave the nest to scavenge for feed. The incubation period for chicken eggs is 21 days and increases up to 30 days for other poultry.

2. Artificial incubation

Hatching eggs by putting them in an incubator is artificial incubation. Incubators are the most important equipment in the hatchery process. Incubator setting capacity ranges from approximately 14,000 to 100,000 eggs. During incubation, the hatching eggs are set vertically, with large ends up in trays or flats in setter and turned mechanically until about 3 days prior to

hatching (setting period). The eggs are then transferred to a Hatcher (hatching period) in a horizontal position and turned during the hatching process.

Advantages of Artificial incubation

- We can hatch eggs whenever we want
- We don't have to wait for a hen to go broody

Disadvantages of Artificial incubation:

- We have to worry about the temperature, ventilation, and humidity.
- If we do not have an automatic turner, we will have to turn the eggs at least three times a day at evenly spaced intervals.

Modern hatcheries usually include areas for; Egg traying, Egg storage, Egg warming/heater, Hatchery unit and Chick processing (removal from trays, vaccination, sexing, counting, boxing, loading for transport) and cleaning.

Necessary environmental conditions inside the incubator

1. Temperature

Control of temperature is probably the most critical single factor for successful hatching of chickens. The temperature inside the incubator can vary from 35.9-39^{0}c but the average temperature is about 37.8^{0}c. In the beginning the temperature may start from 39^{0}c & it will be decreased gradually, finally during the last 18-21 days it should be 35^{0}c as heat will be produced in its body. Too high temperature will result in: - Fast embryonic development (Untimely hatching), High Co_2 liberation and resulting suffocation (Killing by depriving of oxygen) which cause high mortality. Too low Temp will result in: - Low CO_2 liberation, slow embryonic development, deformed weak chicks, Mortality is high and in general embryo is very sensitive for slightly above or below the optimum temperature.

2. Relative Humidity

Relative humidity inside the incubator can fluctuate 60-75%. The capacity of air to absorb & hold moisture increases rapidly as its temperature rises. The drier the air inside the incubator, the more moisture it will take up from the eggs. The RH in the first 18 days is about 60%- 65 % but the last 3 days (19-21 days) is about 70%-75 %. Control of relative humidity is important inside the incubator /or (artificial incubation). Too high humidity causes; Wet (sticky) chicks will be produced, Poor hatch, to low humidity causes, too much moisture loss from eggs (dehydration) and Delayed hatching & poor hatch.

3. Ventilation

Ventilation enables to maintain the concentration of O_2& Co_2. The normal Co_2 & O_2 concentration in the atmosphere is 0.5 & 21%. This represents an optimum gaseous environment for incubating eggs. Embryo uses O_2 for metabolic activity & gives of excess Co_2 & other unwanted gases like Ammonia, which may arise from spoilage of some eggs inside the incubator. Towards the end of incubation, CO_2 is needed to achieve sufficient muscle tone for the embryo to peck its way out of the shell in preparation for emergence.

4. Orientation and turning of eggs during incubation

Set the eggs in the incubator with the large end up or horizontally with the large end slightly elevated. This enables the developing embryo orients the head toward the air cell, which is in the large end of the egg. If eggs set with the small end upward, a chick's head can orient away from the air cell of the egg and not hatch.

Turning keeps the embryo centered in the egg and prevents it from sticking to the shell membrane prevents embryo death and unhealthy hatches. Eggs must be turned at least five times every 24 hours. Turning more frequently is better and once per hour is best. Keep accurate records to ensure the eggs are turned three to five times each 24-hour period. Do not turn eggs during the last three days before hatching. The embryos are moving into hatching position and need no turning.

5.3.1 Hatchery operation

Hatchery is a place where eggs are hatched under artificial conditions. ***Hatching*** is the bringing out of young chicks from the egg by natural or artificial incubation. Hatchability of egg can be affected by following factors (external factors):

- ☞ Egg shell quality
- ☞ Eggs with meat or blood spot
- ☞ Double yolked eggs
- ☞ Nutrition
- ☞ Age of the flock/bird
- ☞ Storage Time
- ☞ Storage temperature and humidity
- ☞ Storage position
- ☞ Extreme porosity of egg shell
- ☞ Misshaped egg

Candling; is identifying egg defects or fertile & infertile eggs using candling devise. Or it is a process of examining fertile eggs against a strong beam of light. The test is conducted in a dark room. In this process the light reaches the eye of the observer after passing through the egg, thereby making the content fairly visible. Candling may be conducted at 5th to 7th day and 18th day of incubation, in order to eliminate the infertile or clear eggs at the early stage of embryonic growth.