5. Introduction to animal production

5.1.History and domestication of animals

All definitions of domestication, whether dealing with plants or animals, recognize that domestication involves a relationship between humans and target plant or animal populations.

The primary difference between different definitions of domestication lies in the degree of emphasis placed on either the human or the plant/animal side of the equation. Some definitions, especially those focusing on animal domestication, cast humans as the lead partner in the relationship. **Domestication is seen as a process in which humans deliberately and with forethought assume control over the domesticates movement, feeding, protection, distribution, and, above all, its breeding—directed at achieving specific clearly identified goals.** Domesticates within this perspective are usually characterized in economic terms as productive capital or by the way in which they become integrated into the social fabric of human society

The domestication of animal is thought to be started in the ancient time while human being was living through **seed gathering** and **animal hunting**. The ancient man had been spending more time in searching for food.

Later on, when humans recognized the importance of these wild animals as **food sources** and **other values** they started to **captivate** the wild animals around their shelters. This was done deliberately with the aim to have a continuous supply of food and other products for the family. Here domestication can be defined as the action of adapting the behavior of animals to fulfill the needs of human beings. The wild animals were hunted for various purposes such as food, cloth, shelter and power etc. With this process, the ancient people began also to use the animal for crop cultivation when they started to practice agricultural activities. They substantially engaged in plant cultivation and animal rising so that to assure constant food supply and reduce time spent for food searching. Selection of animals with certain desirable characteristics was also practiced to use for breeding purpose. Through time this resulted in a more settled way of life. For this reason some scholars believe that animal domestication to be motto for world civilization. Likewise, some historians also witness that there would have been no civilization had it not been for the success of human beings in domesticating animals.

Domestication is associated with three of the oldest civilizations; the Nile in north-east Africa, the Tigris-Euphrates in western Asia and the Indus in the Indian sub-continent. From these centers of domestication people migrated to other parts of the world.

Here dog is believed to be the most first animal that primarily domesticated by human being 10,000-8000 years ago. This was followed with domestication of farm animals like cattle, sheep goat and Camel around 6400, 8000, 7000 and 2,600 years, respectively. Especially these domesticated farm animals were raised so that to fulfill the basic human needs like food, cloth and shelter.

5.2. Livestock Population and Distribution in Ethiopia

Ethiopia does have huge livestock resources comprising various animal species such as cattle, sheep, goat, camel, donkey, horse, mule and chicken. The most common farm animals of the country can be categorized into mammalian, avian and honeybee species. Cattle, sheep, goats, camels, donkeys, horses and mules are the major farm animals that lie under the mammalian category. The country has the largest livestock inventories in Africa, including about 63 million cattle, 31.3 million sheep, 32.7 million goats, 8.85 million donkeys, 2.01 million horses, 1.42 million camels, and 0.46 million mules according to the survey report by CSA (2018). In addition to this, more than 56.06 million chicken and 6.52 million beehives are found in the country

Animal type	**Cattle**	**Sheep**	**Goats**	**Camels**	**Donkeys**	**Horses**	**Mules**	**Poultry**	**Beehive**
Number	60,392,019	31,302,257	32,738,385	1,418,457	8,845,589	2,007,829	461,665	56,056,778	6,523,969

5.3 . Roles of Livestock Production in Sustainable Agriculture & Economic Development

Livestock systems occupy about 30 per cent of the planet's ice-free terrestrial surface area. Currently, livestock is one of the fastest growing agricultural subsectors in developing countries. 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. This growth is driven by the rapidly increasing demand for livestock products, this demand being driven by:

- Population Growth,
- Urbanization
- Increasing incomes in developing countries

Livestock is a major contributor to food and nutritional security, and serves as an important source of livelihood for nearly one billion poor people in developing countries. Keeping livestock is an important risk reduction strategy for vulnerable communities, an important provider of nutrients and traction for growing crops in smallholder systems. Livestock products contribute 17 percent to kilocalorie consumption and 33 percent to protein consumption globally.

To make more efficient of livestock production and answering livestock product demand of the population, increasing livestock productivity through scientific and technological developments is paramount important. So, as one of the task for animal scientists, researchers and scholars should be to understand the present livestock production systems and its analysis in the continent particularly in the tropics helps to maximize the improvement of livestock productivity to reach the desired goal.

The majority of the world's estimated 1.3 billion poor people live in developing countries where they depend directly or indirectly on livestock for their livelihoods (World Bank, 2008 and FAO, 2009). 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). Livestock in Ethiopia is an integral part of the agriculture and the contribution of live animals and their products to the agricultural economy accounts for 40%, excluding the values of draught power, manure and transport of people and products (Winrock International, 1992) and accounts 19% to the export earnings (Befekadu and Birhanu, 2000). These estimates highlight the important contribution of livestock to sustainable agricultural development. The contribution of livestock to the world's food supply, family

nutrition, incomes, employment, soil fertility, livelihoods, transport and sustainable agricultural production continues and helps for the contribution of Food security and poverty reduction (Randolph et al., 2007). Furthermore, estimates show that globally, livestock provide animal traction to almost a quarter of the total area under crop production and also provides traction for about 50% of the world's farmers (Devendra, 2010). Livestock also provide a safety net in times of need in the form of liquid assets and a strategy of diversification for food production (Freeman et al., 2007). Generally to fully understand the positive contribution of livestock to the production system, with regard to food security and food self-sufficiency, the major contributions of livestock are as followes:

5.3.1 Source of Food and Nutrition

In order to increase livestock's contribution to the livelihoods of developing communities requires improved understanding of livestock's multiple and complex roles. The contribution of food from animal origin to the nutritional status of the world population is well documented (Ndlovu, 2010). Livestock products account for almost 30 percent of human protein consumption (Steinfield et al., 2006).

Livestock are important as producers of meat, milk and eggs, which are parts of the food chain and, which provide high value protein food. They have long played a key role in supplying calories and protein for human food in virtually all parts of the world, both directly (in the form of animal products), and indirectly (from the contribution of manure and draught power to crop production and generation of income to enable purchase of food (Animal Agriculture and Global Food Supply, 1999). The important contribution of livestock into the human dietary protein has been reported by (Cheeke, 1993; Haan et al., 1998; Animal Agriculture and Global Food Supply, 1999). In the first half of the 1990s, residents of developed countries consumed as food 78 kg of meat and 22 kg of fish per capita, with higher amount of meat in the United States and higher amount of fish in Japan. Corresponding figures for Sub Saharan Africa were 12 kg of meat and 8 kg of fish. The significance of livestock in the food chain can be expected to increase over the next decades. While demand for animal products in the developed world will probably plateau or even decline, there will be a strong increase in the developing countries (Haan et al., 1998; Animal Agriculture and Global Food Supply, 1999). Current levels of meat and milk consumption in the developing world are only about one-fifth of those in the industrialized world (Haan et al., 1998). The driving force for the increased demand for livestock products is a combination of population growth, currently relatively low intake, and rising incomes and urbanization (Cheeke, 1993;

Haan et al., 1998). The current demand driven livestock revolution underway is in response to the ever-increasing demand for animal origin food in developing countries. . Considering the significance of livestock in the food chain (which is also expected to increase over the next decades) and the increasing demand (preference) for animal origin food, the role of livestock in food security and food self-sufficiency is and will be important. Both supply of food and meeting preference are elements of food security and livestock contribution to the availability of food is important in the efforts to ensure food self-sufficiency.

5. 3.2 Source of Power

Importance of livestock as major source of power in tropics has been well documented (Steinfeld et al., 1998). Millions of people depend upon animal power for cultivation, planting, weeding, threshing and transportation. Telein and Murry (1991) cited evidence that draft animals provide the power for the cultivation of nearly 50 % of the world cultivated land and the hauling of 25 % carts. More than 240 million cattle and 60 million buffalo are kept as work animals. In Ethiopia, the vast majority of rural people comprising 85 percent of the total population depend on animal power for cultivation, weeding, threshing and transportation. As elsewhere in developing countries (Cheeke, 1993), use of tractors is very insignificant, for reasons of economy, topography and highly fragmented land holdings. Draft animals provide power for about 96 percent of the cultivated land in the Highland areas. Work animals can be also used to cultivate arable land inaccessible to tractors. They are relatively affordable and do not require inputs, which tractors would require such as fuel, repairs, and spare parts. This is particularly important in view of the shortage of foreign currency earnings, which Ethiopia has. In Ethiopia Gryseels et al (1984) observed a positive relationship between the number of oxen owned by farm household and both the area cultivated and percentage of sown to marketable cereals. There are cases where arable lands are not cropped and/or not timely and efficiently cultivated, due to lack of or emaciated (weak) work animals, which in turn reduces overall crop production, regardless of availability of improved agricultural inputs (seed fertilizer etc.). It can be argued that issues of crop production cannot be efficiently addressed in isolation, without considering livestock, which are the major source of traction power. Therefore as source of power livestock are means of crop production and play role in ensuring availability of food, which is an element of food security. Furthermore, as means of transport for agricultural produce to household and market places, they link supply and demand and hence assist in food distribution.

Nevertheless, until recently recognition of livestock as important source of power has not been well established, and for many years aid programs and foreign specialists virtually ignored the roles of draft animals in food production (Cheeke,

5.3.3 Source of Organic fertilizer

Livestock play a significant role in maintaining soil fertility. When spread on cropland, animal manure increases soil organic matter, and improves soil texture (Cheeke, 1993; Haan et al., 1998). For the vast majority of small-holders in the highland area, nutrient recycling through manure, compensate for lack of access to chemical fertilizer, and helps to maintain the variability and environmental sustainability of production (Steinfeld et al., 1998). While global fertilizer use increased from 81 to 96 kg/ha of cropland, fertilizer use in Sub-Saharan Africa in 1988 to 1990 was estimated to be only 11 kg/ha of harvested land. A rate projected to increase to only 21 kg/ha harvested land by 2020 (Animal Agriculture and Global Food Supply, 1999). Chemical fertilizer use in Ethiopia was only 17 kg/ha in 1999/2000 (personal communication), which is very low, indicating the potential role of animal manure as accessible, cheap and valuable fertilizer.

Crop response to manure varies with plant and soil types, agro-ecological zones, and with manure quality (Animal agriculture and Global Food Supply, 1999). Powell (1986) reported a response of 180 kg maize grain per ton of manure applied in the sub-humid zone of Nigeria. An added benefit is the residual positive effect of manure, which may persist for up to three cropping seasons after application (Ikombo, 1989; Powell et.al., 1989). McIntire et.al. (1992), estimated increases in grain ranging from 15 to 86 kg grain per a ton of manure applied to cropland. Therefore efficient use of this valuable resource remains vital, in efforts to attain household food security in a sustainable manner. Generally as source of organic fertilizer livestock play great role in boosting crop production. This is in line with ensuring food availability and preference (the currentpreference for organic produce), which are elements of food security.

5.3.4 Source of Income and Living Bank

Livestock are important sources of income for at least 200 million small-holder farmers in the Asia, Africa and Latin America (Haan et al. 1998). In the highlands of Ethiopia livestock are indicators of wealth of a family and are used for wealth ranking. Further, they are the main form of investment because of the absence of financial institutions. Livestock are cash at hand and provide owners with purchasing

power. In many countries, access to food is limited not by availability but by purchasing power (Animal Agriculture and Global Food Supply, 1999). For example in Ethiopia, crop production has increased and the country has become a net exporter. Yet, some of the export has been purchased by the European Community, for distributing to poor Ethiopians who cannot purchase food regardless of its availability. Livestock are often sold to generate cash, amongst others to purchase food (in times of crop failure) and purchase agricultural inputs, which in turn increase crop production. Therefore livestock as a source of cash ensure economic accessibility to food, hence key role in attaining food security

5.3.5 Source of Foreign Currency

The role of livestock in foreign currency earnings is substantial in Ethiopia, a country, which have very limited export items (Cheeke, 1993; Haan et al. 1998). In Ethiopia, there is huge and yet untapped livestock potential in foreign currency earning. Foreign currency earnings generated from livestock, are used for, amongst others, to import different goods and services for the development of the country.

5.3.6 Social functions

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 (Waters-Bayer and Letty, 2010).

5.3.7 Risk buffer

In marginal areas with harsh environments, livestock provide a means of reducing the risks associated with crop failure and a diversification strategy for resource poor small scale farmers

5.4. Livestock Nutrition

Objective

- Discuss the importance of nutrition and digestion for animal growth.
- Explore the basics of animal physiology.
- Determine how nutrients are used by various livestock species.
- Identify classes and sources of livestock nutrients.
- Identify symptoms of nutrient deficiencies.
- Compare and contrast animal digestive systems.

In today's society, one can't turn on the TV or read a newspaper without seeing or reading information about health issues. What is the major factor discussed in these issues? Nutrition. Along with nutrition, genetics and environment are all factors that influence your health. Just like in humans, agricultural animals are influenced by these same factors. If animals don't have proper nutrition, their growth rate, reproduction rate, immunity, and well-being are all affected. Just as proper nutrition is vital for your good health and proper function, it is just as vital for the health and function of agricultural animals.

5.4.1 Importance of Nutrition and Digestion

Nutrition is important for a variety of reasons. Animals need the proper nutrition for growth and maintenance, and to provide energy for work and vital functions. **Maintenance** is the nutrition required for an animal to maintain its current weight. **Energy** is the ability of the body to perform functions. Proper nutrition is also needed to maintain body temperature, produce milk, reproduce, and develop proper bone structures. Without proper nutrition, animals can develop health problems, which could result in treatment costs or even fatality. Good nutrition is essential for all of the systems of an animal to function and work together properly. Animals that do not receive the proper nutrition are more likely to develop health and reproductive problems, and be less productive and marketable. Nutrition is important to have healthy animals, and, in turn, healthy animals help ensure profitability in agricultural operations. Producers must understand not only what nutrition an animal needs but also how to supply that needed nutrition. Producers must know what ration is appropriate for a specific animal and how to provide a balanced ration. A ration is the feed an animal receives over a 24-hour period. A variety of feedstuffs, or basic ingredients, are used in rations, and producers must choose those that best suit their needs. A ration

with all the nutrients an animal needs is a balanced ration. Digestion is the process of breaking down feeds into simple substances that can be absorbed into the bloodstream and used by the body's cells. It is important for producers to understand the digestive process because it helps in selecting the proper feed for the animal's type of digestive system. The digestive system is the system in which food is acted upon through physical (chewing) and chemical (stomach acids) means. It includes all parts from the mouth to the anus. Understanding the digestive system can help the producer become more efficient in feeding, resulting in a more cost-effective livestock enterprise. It also helps the producer have a better understanding of animal health and problems that may occur. Understanding the chemical and physical changes that take place after an animal eats is important in noticing health problems related to digestion.

How Nutrients are Used

Does a pregnant mare need the same nutrients as a horse that is ridden occasionally? No. The nutrient requirements of animals differ because of factors such as age and pregnancy. Animals that need nutrients to sustain the body condition they are in (no weight loss or gain) need nutrients for maintenance. Animals that require maintenance levels of nutrients are not pregnant, lactating, or producing products such as wool.

Young, growing animals require nutrients to meet the needs of the specific growth stages. Young animals need the proper nutrition for growth and development of bones, muscles, and organs. Some agricultural animals, such as chickens, grow rapidly. As animals grow, their nutrient needs change, and as they mature, their diets become closer to those of adult animals. Older animals may have health problems related to aging, which could require different nutritional needs such as vitamin and mineral supplements.

Animals that are pregnant or lactating have specific and increased nutritional needs. Pregnant animals need nutrition not only for themselves but also for the developing babies. Some agricultural animals commonly give birth to only one offspring (cattle and horses) while others give birth to multiple offspring (pigs, chickens, sheep and goats). Animals that are lactating or nursing their young also need specific nutrients to provide nourishing milk to their offspring.

Animals that exert large quantities of energy, known as working animals, need additional nutrients. Working animals are used for some type of work such as pulling heavy loads. Additionally, horses that are used for competitive events require different rations than horses that are ridden only for pleasure.

Have you ever worn a wool sweater? If so, the wool came from sheep that needed the proper nutrients to produce good quality wool. Many agricultural animals are raised for meat and products such as eggs, milk, or wool. In order to produce products or have the quality of meat consumers will purchase, proper nutrition is essential.

5.4.2. Classes and Sources of Nutrients

What nutrients do animals need? There are six major classes of nutrients: water, protein, carbohydrates, fats, minerals, and vitamins. Nutrients can be obtained from various sources. Common sources of nutrients for agricultural animals include roughages and concentrates. **Roughages** include feed that is high in fiber and low in energy, such as grasses, hays, and silages. **Concentrates** include feed that is high in energy and low in fiber, such as grains.

a. Water

How long can one survive without water? Not long. Water is vital for all animals and makes up more than one-half of most animals' bodies! It forms the basis of fluids in the body and is essential for processes such as digestion, blood circulation, and waste elimination. Water helps dissolve nutrients and also regulates body temperature through perspiration and evaporation. Animals need a fresh, clean source of water. Most of the water an animal consumes comes from the water it drinks. Water also can be obtained from feed sources such as forage. Water is essential, especially for working animals or during hot weather. During hot weather or when working hard, horses can require 20 or more gallons of water per day.

b. Protein

Protein is made up of amino acids that are necessary for healthy animals. **Amino acids** are the building blocks of protein and are used for the formation of tissues and muscle production. Protein is needed for healthy growth, reproduction, and maintenance.

Protein can be obtained from both plant and animal sources. Plant proteins are more common in livestock feeds and include soybean, cottonseed, linseed, peanut, and sunflower seed meals. Protein also can be obtained from legume hays such as alfalfa or clover. Legumes are plants that produce or fix their own nitrogen. Sources of animal protein include tankage, fish meal, meat scraps, and milk products. Animals need different amounts of protein, depending the on needs. For example, young, growing animals need more protein than older animals. Protein is often the most expensive ingredient in feed. **Crude protein**

refers to the total amount of protein in a feed while **digestible protein** is the protein that can be digested and used by an animal.

c. Carbohydrates

Carbohydrates are nutrients that provide the main source of energy for activities the body performs. Carbohydrates provide energy for growth, maintenance, and reproduction. They also help produce body heat for warmth. Carbohydrates come from plants and include sugars, starches, and cellulose. The main sources of carbohydrates in feed are grains such as corn, oats, wheat, barley, rye, and grain sorghum. Forages and hay are also sources of carbohydrates.

d. Fats

One may not think of fats as being essential, but they are. Although fats are needed in small amounts they are a necessary part of the diet. Fats provide energy and store excess energy. Fats help produce body heat and carry fat-soluble vitamins in the body. Many sources of proteins are also sources of fats. Fats are found in both plants and animals. Plant fats include oils that are within seeds, which are the main source of fats in agricultural feeds.

e. Minerals

Minerals provide material for growth of bones, teeth, and tissue and also help regulate many of the body's chemical processes. Minerals also help in muscular activities, reproduction, tissue repair, and body heat. Although mineral intake may account for a small portion of the total diet, it is essential.

Minerals can be categorized as macrominerals or microminerals. **Macrominerals** are needed in larger amounts by the body, and **microminerals** are needed in smaller amounts. Macrominerals include calcium, chlorine, magnesium, phosphorus, potassium, sodium, and sulfur. Microminerals include chromium, cobalt, copper, fluorine, iron, iodine, manganese, molybdenum, nickel, selenium, silicon, and zinc. Minerals are often added to animal feed or fed **free choice**, which means animals are able to access at any time. For example, salt and mineral blocks are fed free-choice where animals are able to lick them anytime they want.

Animals may be able to tolerate minerals in excess of recommended quantities; however, excess minerals in some species can cause toxicity, even leading to death. Producers should always ensure that minerals are given in the appropriate amount to animals. Sheep are susceptible to copper toxicity, which can lead to death. Symptoms of copper toxicity in sheep include lethargy, anemia, pale membranes, thirst, and jaundice. Excess of some minerals can cause weight loss and slower rates of gain in some animals. Hogs

that are given excess minerals may have slower gains, and cattle that have an excess of sodium and chloride can have reduced milk production and weight loss. Selenium toxicity in horses can cause appetite loss, hair loss, paralysis, and eventual death. An excess of some minerals may also interfere with the metabolism of other minerals. For example, sulfur toxicity in cattle can interfere with the metabolism of selenium, copper, molybdenum, and thiamin.

f. Vitamins

Vitamins are essential for normal body functions such as digestion, cell metabolism, growth, and reproduction. Like minerals, they are also needed in relatively small quantities. Vitamins help in tooth and bone formation, assist the body in fighting stress, and prevent infection in the body. Vitamins can be obtained from many different sources such as forages, hay, and cereal grains. Just as in minerals, it is important for the producer to provide the appropriate vitamins. Vitamins are fat soluble or water soluble. Water-soluble vitamins are dissolved in water, and fat-soluble vitamins are dissolved in fat. Fat-soluble vitamins include vitamins A, D, E, and K. Vitamin D is necessary for bone development, and it is produced in the animal's body. In order to produce vitamin D, the animal must be in sunlight for a portion of the day. Some of the main benefits of the other fat-soluble vitamins include blood clotting (vitamin K), reproduction and muscle development (vitamin E), healthy eyes, and preventing infection (vitamin A).

Water-soluble vitamins include vitamin C and the B-complex. Vitamin C is needed for teeth and bone formation, and the prevention of infections. B-complex vitamins are necessary for growth and reproduction. The B-complex vitamins include thiamine, riboflavin, niacin, pyridoxine, pantothenic acid, biotin, folic acid, benzoic acid, choline, and B-12. The B-complex vitamins help many body functions such as red blood cell maturation (vitamin B-12) and energy metabolism (riboflavin).

5.4.3. Animal Digestive Systems

The digestive systems of animals are divided into two main categories: ruminants and monogastrics. The digestive process of ruminants and monogastrics differs. **Ruminants** are animals that have stomachs with more than one compartment. The main components of the digestive system of ruminants are the rumen, reticulum, omasum, and abomasum. The large compartment is the rumen. Because the rumen can store large quantities of roughages, ruminants have a greater ability to process and utilize large quantities of bulky roughages. Examples of ruminants are cattle, sheep, and goats.

Monogastrics, also known as nonruminants, are animals with relatively small, simple, one-compartment stomachs containing limited mircroorganisms. Nonruminants are better adapted to processing and utilizing concentrated feeds such as grains. Examples of monogastrics are pigs, chickens, turkeys and horses.

a. Ruminants

The first step in the digestive process occurs when feed is taken into the mouth and chewed just enough to make swallowing possible. The feed then moves down the esophagus to the rumen, where it is acted on by millions of microorganisms. A portion of this feed, in the form of a bolus (cud), is forced from the rumen back into the mouth where it is rechewed and reswallowed.

The feed then returns to the rumen and reticulum for further storage and action by microorganisms. The feed then moves to the omasum, where water is squeezed from the food and then on to the abomasum (true stomach) where it is mixed with digestive juices. From the absomasum, feed moves to the small intestine where the digestible portion of the feed is absorbed. The undigestible portion of the feed moves on to the large intestine and is formed into feces. The feces is stored in the rectum and expelled through the anus

b. Monogastrics

The digestive system of monogastrics can be divided into several subdivisions. Some have a functional cecum which increases the animal's ability to digest roughage in feeds. Examples of monogastrics with a functional cecum include horses, rabbits, guinea pigs, and hamsters. Others have a nonfunctional cecum in which the cecum is relatively small and has little function, limiting the animal's ability to digest roughage in feeds. Examples of nonruminants with a nonfunctional cecum include pigs, dogs, and humans. Another subdivision of nonruminants is the avian digestive system. Avians have a digestive system where special organs (crop, gizzard) soften, crush, and grind feed. Examples of avians include chickens and turkeys (poultry). The digestive process for monogastrics with both a functional and nonfunctional cecum begins when feed is taken into the mouth, chewed, and mixed with saliva. The feed then moves down the esophagus to the stomach where it is churned and mixed with digestive juices. The feed then moves into the small intestine where most of the digestible portion is absorbed. After the small intestine, feed moves to the cecum. In animals with a functional cecum, additional digestion and absorption takes place. In animals with a nonfunctional cecum, feed moves on through the digestive system. After feed moves through the cecum, the undigested portion of feed moves into the large

intestine, where water is absorbed and the rest of the feed is formed into feces. The feces is stored in the rectum until it is expelled through the anus.

The digestive process of the avian system begins when feed is taken into the mouth. The feed immediately moves down the esophagus to the crop where it is stored and soaked. The feed then moves to the proventriculus (true stomach) where it is mixed with digestive juices. From the proventriculus the feed moves to the gizzard where it is crushed and ground. Then the feed moves through the small intestine, ceca, and large intestine where it is absorbed or formed into feces. The feces is expelled through the vent.

5.4.4 Major Livestock Feed Resources

The major feed resources in Ethiopia were natural grazing lands, crops residue, agro-industrial by-products and cultivated pasture and forage-crop species. The same author also reported that grass hay, agro-industrial by-products, improved forages and other feeds are also used as animal feed with different levels of contribution. However, depending on the production system being employed, there are reports that livestock feed source contribution of crop residues outweigh far more than grazing land. The same study reported that crop-residues and stubble grazing accounted for 74.15% of the total annual feed supply which was the major source of feed starting from harvesting of food crops to the wet periods during the time at which feed from grazing areas is inadequate or almost unavailable in Sinana sub-district (Bale area). Similarly, in most intensively cultivated areas, crop residues and aftermath grazing accounts for about 60 -70% of the basal diet, particularly, wheat straw is the dominant feed in wheat-based farming system

5.4.4.1. Natural Pasture

Natural pastures include annual and perennial species of grasses, forbs, shrubs and trees naturally grown. Many researchers and development workers agreed that natural pasture comprises the largest feed resource, but estimates of the contribution of this feed resource vary greatly. The reliability of natural pasture as a feed source is restricted to the wet season and animals feed source is extensively based on roughages for long periods of the dry season. This is mainly because of the continuous declining of natural grazing lands in the highlands and rangelands in the pastoral areas. Earlier, it was estimated that about 62 million ha of natural pasture land were available in the country but because of the continuous change of grazing land into cropping, the size has reduced to 40 million ha. It is likely that the available

grazing land has diminished more during the last few years and is expected to continue in the future. The emerging urbanization could lead to further shrinkage of the existing natural pastureland, as exemplified by the Selale area Hence, the share of natural grazing pasture at the national level as livestock feed resource, has become reduced to about 57% from an earlier level of 90%. Moreover, the productivity of grazing lands is estimated to range between 0.5 to 6 tons DM/ha, which is typically low productivity as compared to yield from improved pasture. From grazing viewpoint, production or yield is one of the most important measures in pastureland productivity. Biomass (yield) as regards to forage refers to the weight of plant material present at a time. Most estimates of biomass or standing crop includes only that above the soil surfaces and this material is commonly available to large herbivores. Direct harvesting is considered the most reliable method of determining biomass above the ground.

5.4.4.2. Crop Residues

Crop residues are abundantly produced in almost all parts of the world where there is crop production. Cereal straws such as teff, barley, and wheat and pulse crop residues are stalked after threshing and fed to animals during the dry season when the quality and quantity of available feed from natural pasture declines drastically in different parts of the Ethiopian highlands. Livestock also have access to crop stubbles and weedy fallows, but stubble grazing is declining drastically because of restricted grazing. The supply of these crop residues is a function of the proportion of land used for cropping and the edible feed yields per unit area of land, and the straw type. Among all crop residues, account for more than 29.61 present of the total crop residue yield in Ethiopia and also yields 61.29 present of the total feed resources in Bale highlands. On the average, crop residues provide generally 10 to 15% of total feed intake in the mixed crop-livestock producing areas. In the central highlands of Ethiopia, but in most intensively cultivated areas, crop residues and aftermath grazing account for above 60-70% of the basal diet.Moreover, most of the crop residues used as livestock feed fluctuate in seasonal supply and used without any treatment and/or strategic supplementation

The crop residues have long been known as important maintenance feed for ruminants. However, when used alone, they are of very low feeding value with poor metabolizable energy (ME), negligible available protein and seriously deficient in mineral and vitamins .On the other hand, crop residues vary greatly in chemical composition and digestibility depending on varietal differences (Reed *et al.*1986) and

agronomic practices .The feeding value of crop residues is also limited by their poor voluntary intakes, low digestibility and low nitrogen, energy, mineral and vitamin contents .The CP content of crop residues ranges form 2.4-7% and the value of IVDMD for straw is between 34 and 52% .However, the nutritional values of crop residues vary according to the type of crop used (Daniel Keftassa, 1988). For example, cereal straws have a CP, NDF, and IVDMD mean values of 4.5, 79.4 and 51.1%, respectively in contrast to pulse straws, which have a CP, NDF and IVDMD mean values of 7, 62.9 and 63.5%, respectively. Furthermore, straw from oil crops have CP and NDF values of 5.4 and 66.4%, respectively

Energy values vary with the cereal variety and the management of the residue after grain harvest. Straw is high in lignin, which lowers its digestibility. Bire *et al.* (1993) also reported that, cereal straws are characterized by their high content of lingo-cellulose and low level of nitrogen and are poorly digested and can only support a low level of production when they are used as a basal diet for ruminants. Straws of most crops are low in CP and minerals, especially phosphorous, and straw alone is seldom able to provide a maintenance diet for sheep (Elisabeth, 2005). Its main advantage is that it is readily available, cheap roughage that can be used together with other feeds to provide a source of roughage for feeding sheep during dry season.

The coarse physical nature of straws limits the activity of micro-organisms in the rumen and contributes to the low rate of passage through the digestive system, consequently results in low voluntary intake. However, the feeding value of straws can be improved by adding supplements of energy, protein and mineral sources, which will give an adequate supply of nutrients to both the rumen micro-organisms and the animal, and the efficiency of their use in mixed diets is an attractive option for increasing livestock production.

2.1.3. Agro-Industrial by-Products

The term agro-industrial by-products refer to the by-products obtained from the processing of main cereal crops and animal products. They contain less fiber and are generally of better nutrient content as compared to crop residues. classified the major agro-industrial products as oilseed and grain by-products that are obtained from the processing of oilseeds and grains for human consumption, respectively. have emphasized that such by-products are becoming increasingly important in the food and fiber system, because they are available for use as livestock feeds at competitive prices relative to other feed commodities. They concluded that for small ruminants, sheep in particular, kept by resource-limited

smallholders in mixed crop-livestock production systems; such a strategy would help them to produce at the lowest cost. Among the feed resources derived from agro-industrial by-products, noug seed cake is available in several areas of Ethiopia. These feed resources can therefore be used as a supplement to low-quality basal diets.

Agro-industrial by-products have special value in feeding livestock mainly in urban and periurban livestock production system, as well as in situations where the productive potential of the animals is relatively high and require high nutrient supply. The major agro-industrial byproducts commonly used are obtained from flour milling industries, edible oil extracting byproducts, brewery, and sugar producing industries. Traditional brewery by-products such as *Atela* and *Brint* also contribute as supplement feed source for livestock. Agro-industrial byproducts are rich in energy and/or protein contents or both. They have low fiber content, high digestibility and energy values compared with the other class of feeds. have also reported more than 35% CP and 50-70% *in vitro* organic matter digestibility (IVOMD) for oil seed cakes and 18-20% CP and more than 80% IVOMD for flour milling by-products. Supplementing ruminants fed on low quality feeds with agro-industrial by-products enables them to perform well due to higher nutrient density to correct the nutrient deficiencies in the basal diet.

5.4.4.3. Improved Forage

Improved forages play varying role in different livestock production systems. In general, however, they are important as adjuncts to crop residues and natural pastures and may be used to fill the feed gaps during periods of inadequate crop residues and natural pasture supply. Even in the presence of abundant crop residues, which are often free fed to ruminants, improved forage crops especially legumes are needed to improve the nutritional values of crop residues. Improved forages also provide benefits such as soil fertility through their nitrogen fixing ability and reducing soil erosion. Due to its positive biological impact on degraded lands the government of Ethiopia has given due attention in stock exclusion and watershed areas. However, not much progress achieved till recently.

Improved forages have been grown and used in government ranches, state farms, farmer's demonstration plots and dairy and fattening areas. Forage crops are commonly grown for feeding dairy cattle with oats and vetch mixtures, fodder beet, elephant grass mixed with siratro and desmodium species,

Rhodes/Lucerne mixture, phalaris/trifolium mixture, hedgerows of sesbania, leucaena and tree-Lucerne being common ones. Due to unprecedented population increase, land scarcity and crop-dominated farming, there has been limited introduction of improved pasture and forages to smallholder farming communities and the adoption of this technology by smallholder mixed farmers has been generally slow.

5.4.4.4. Other Feed Resources

Livestock feed resources are classified as conventional and non-conventional, where the non-conventional ones vary according to feed habit of the community and others, e.g. vegetable refusals (tobacco, stimulates) are non-conventional. Related to this anything used as livestock feed in the area additionally were added into the production of the feed resources to estimate its dry matter production. The most commonly used non-conventional feed in the area is by-product of beer which is commonly known in local name as fagullo and locally distilled beverages in Bedele towns. It contributes a lot especially for the urban and periurban dairy farmers.

5.5. Constraints to livestock production and productivity

The following are some of the main constraints of livestock producion

1. ***Quality constraints:*** Little understanding of processors' requirements, lack of laboratories and instruments for quality control, price and quality of the veterinary services;

 Financial constraints: Lack of capital to invest in assets, equipment and inputs that would improve quality;

2. ***Gender constraints:*** In comparison to men, women face higher disadvantages, in particular in terms of mobility, access to assets and to productive resources, and access to market information, with the result that they find it more difficult to access and maintain profitable market niches and capture a larger slice of incomes;

3. ***Infrastructure constraints:*** Lack or inadequacy of, among others, roads, electricity, weighing stations, cattle dips, slaughtering and processing facilities (which raises transaction costs, exacerbates information asymmetries between producers and traders, and discourages investment in processing);

4. ***Information constraints:*** Limited access to market-related information (e.g. on prices, value chains, competitors, consumer preferences);

5. *Skills and knowledge constraints*: Lack of business management skills (e.g. production planning) and, in particular, inadequate access to the knowledge and
technologies needed to meet rising sanitary standards, making it extremely difficult for smallholders to gain credible certification of compliance with marketing requirements; and

6.*Market constraints*: Low demand, a multiplicity of intermediaries (which increases the charges and shades the transparency of the operation).

5.6. Livestock improvement

5.6.1 Solutions

- Secure and adequate access to basic production inputs together with risk coping mechanisms
- Dissemination of livestock market information to livestock producers;
- Strong relationships among various chain actors (including commitments from these actors to cooperate on mutually beneficial
- actions/investments) and strengthened farmers' organizations;
- Policies and strategies to enhance the ability of smallholders and small-scale market agents to compete in livestock product markets;
- Standards and brand mechanisms to identify high-quality livestock products;
- Kick-starting of domestic markets to allow the poor to exploit market opportunities;
- Reduced fees on the sale or slaughter of livestock;
- New or adapted marketing strategies (for example, promotion of alliances with fair trade chains);
- Adequate responses to volume demand and ability to expand to match increased demand;
- Product differentiation to create niche markets; and
- Linking of poor livestock keepers to expanding urban markets.

6. LIVESTOCK PRODUCTION SYSTEMS

6.1. Classification Bases of Livestock Production Systems

Any production system has its peculiar features that secure its characteristics. Criteria/variables that commonly used for classification of productions systems are land, capital, labour, production objective,

animal number, technology utilization, market access, input, output and others that depend from area to area.

Considering the existing context of our country, the livestock production system is classified as: extensive (traditional), semi-intensive and intensive (modern). Each system has its own differentiating or distinctive characteristics.

1. Extensive livestock production system
2. Semi-intensive livestock production system
3. Intensive livestock production system

6.2. Extensive Production Systems

6.2.1. Pastoral Livestock Production System

Pastoralism is a system of extensive livestock herding in which livestock track the seasonal fluctuations in natural forage availability. It is a subsistence system that based primarily on domesticated animal production. The pastoral system is found in arid and semi-arid areas and the productions system is largely based on increasing animal number as a survival strategy against drought and seasonal disease outbreaks. The production system in general is subsistence oriented and the productivity of the livestock is very low as evaluated by any standard. Pastoralism usually practiced in low rainfall areas. The pastoralists raise a diversified type of animals such cattle, goats, camels and donkeys. This is done deliberately with the aim to utilize the diverse vegetation species. The system is also characterized as low-input based production system in which the production costs are lower. There is disease risk such as tick infestation but that usually reduced by mobility.

In the pastoral system, relatively large herds of cattle are grazed on communal and public land. Due to seasonal scarcity of feed and water cattle trek over long distances. In this system, cattle owners acquire minimal land holdings at the home base. In West Africa the home base is where family stays. In this system a wet herd for milk is kept at the home base and it is the responsibility of women to market the milk and to use the money to purchase family needs. The women also grow cereal crops for domestic

consumption and use the crop residues to feed the wet herd. The dry herd travels long distances sometimes up to 400 km. Pastoralists are unable to settle and take advantage of available production technology. It is estimated that up to 70-80% of Africa's cattle population is within this system. The word pastoralists refer to people who drive their livelihood based on animal raising.

Pastoralists can be categorized in terms of frequency of movement as:

A) Settled pastoralism

Here domestic animals are kept in one place most or all of year. The animals are provided with fodder. It is capital intensive as it needs substantial barns, means of transport feed, watering animals etc.

B) Transhumance pastoralism

Under this pastoral system the pastoralists move with their herd from home base in search of forage and get back to home base after spending some periods (2 – 6 months). Herds move up into mountain pastures in summer during dry seasons and get back to low lands in rainy season.

C) Nomadic pastoralism

This is characterized by moving herds to any available pasture often on opportunistic basis over long distance and with no fixed pattern.

D) Ranching - Ranching involves large herds of cattle or sheep often grazing on communal land and following natural cycles for reproduction. Human labor input is minimal but provides occasional supplemental feed, disease treatment or prevention and predator control. Ranching is commercially oriented and generally entails a higher capital investment than simple pastoralism or subsistence farming. In contrast to the extensive grazing of cows and their calves or yearling animals on grasslands, a finishing stage in feedlots would be intensive.

6.2.3. Mixed Crop-livestock Production System

In the mixed crop-livestock systems of the Ethiopian highlands, livestock are subordinate but economically complementary to crop production in providing draft power, the main agricultural activity. In this ecological zone, livestock, especially cattle, provide traction, which is a vital contribution to the overall farm labor requirement. Livestock also provide meat, milk, cash income and manure, and serve as a capital asset against risk. Cattle are kept for multipurpose. However, purposes vary with production system. Traction (males) ranked highest, followed by milk (females) and reproduction/breeding (males and females) in both crop-livestock and agro pastoral systems. Manure production also considered important by most crop/livestock and agro pastoralist farmers, but as secondary rather than a primary purpose.

Crop-livestock integration is production system in which there are interaction between crop production and livestock production within a farm where both crops and livestock are managed by the same economic unit (i.e household) in which part of the land is used for feed production, including grazing animals. The integration of livestock and crop has a potential and intensification of the system is the only viable options for maintaining the economic livelihood and sustaining the natural resources.

6.2.4. Semi- intensive Livestock Production Systems

This production system is considered to have some characteristics in between the extensive and intensive systems in animal number, inputs used, outputs obtained, technology utilized and capital used, market access, market integration, management practices and other parameters. It is assumed as a transitional system from the extensive to the intensive one.

6.2.5. Intensive Systems

Production systems in this category are characterized by high inputs. The production systems are market-oriented and farmers adopted improved technology to optimize productivity. These systems are increasingly popular in eastern and southern Africa. Producers usually own less than 10 cows and about 2-4 ha of land with intensive crop -livestock production. In these systems farmers adapt/or adapt available production technology. Large-scale livestock keeping in peri-urban areas is highly

commercialized: it is oriented to the demand of urban consumers and depends on high level of purchased feeds, including by-products from agro processing industries. In contrast, small- scale livestock keeping by poorer urban dwellers offers a supplementary source of income, as well as source of animal protein which the families could otherwise not afford to buy. In peri-urban production systems herds are located within a 40-60 km radius of major cities. The system is located near highly populated urban centers where the producers have adequate resource and have access to credit to acquire inputs such as feed supplements, veterinary inputs and improved genotypes. In many cases marketing in organized around co-operative societies. Urban livestock are also fed crop residues brought in from surrounding areas, and the manure is transported to gardens inside the city and crop land further way. Some animals kept in cities may wander freely to seek their own forage.

7. Poultry Production and Management

7.1 Introduction to Poultry Production

Poultry occupies a unique position in terms of its contribution to the provision of high quality protein food to rural smallholder farming families in Africa and particularly in Ethiopia. There are only few alternative animal protein sources available. There are also few cultural or religious taboos that stand against the consumption of eggs and poultry meat in most countries. Both poultry meat and eggs enrich and contribute to a well balanced diet to satisfy human needs. Over the last decade, the consumption of poultry products in developing countries has grown by 5.8% per annum, and has created a great increase in demand. Village poultry could be particularly important in improving the diet of young children in Sub-Saharan Africa.

In Ethiopian condition, Village poultry significantly contributed to the livelihoods of poor households: economically as starter capital, as a means to recover from disasters, as an accessible protein source and for income and exchange purposes, and socio-culturally for mystical (spiritual) functions, hospitality and exchange of gifts to strengthen social relationships. Distance to markets influenced flock sizes and poultry marketing organization. Religious festival days were associated with increased poultry consumption and sales, and fasting periods with decreased consumption.

7.2 Definitions and terminologies in poultry production

Poultry: The word poultry is used to collectively indicates those species of birds that have been

domesticated to reproduce and grow under human care for the products of high food and economic value.

Egg: It is a body produced by females of birds, insects, etc. and capable of developing in to a new individual **(Pocket oxford dictionary)**. It is the behavior of reproduction of birds and it is also an excellent source of nutrients. It is also a nutritional standard by which other foods are judged.

Egg type (layers): those chickens that serve mainly for egg production. Eg. White leg horn.

Broiler: those birds (chicken) which mainly serve for meat production. Eg. Cornish

Dual purpose breeds:- those chickens which serve for both meat and egg production purposes.

e.g. New Hampshire, Light Sussex, Rhode Island Red

Ranching (free ranging): this is the traditional system of poultry husbandry in which chicken are moving around the home stead and fields through the whole day in search of feed, and gather at night into the basic shelter.

Cage system of poultry production: this is one part of modern poultry husbandry by which chicken are kept in ***a framework of wires or bars***, especially for the purpose of commercial egg production.

Deep litter system of production: this is also part of modern poultry husbandry in well designed housing of concrete floor with deep litter as bedding materials. This system is mainly suitable for broiler production relatively than cage system.

7.3 Origin, domestication and zoological classification of poultry

The term poultry applies to chicken, turkeys, ducks, geese, guinea fowl, pigeons, ostriches, pheasants (long-tailed game-bird), Quail and other game birds. Zoologically the fowl belongs to the genus Gallus and the family phasianidae. The domestic fowl is called simply *Gallus domestics*. The ancestor of the domestic chicken is originated in Southeast Asia: and has been subjected to extensive breeding for size, colour patterns, conformation and egg laying ability during long history. The very presence of comb distinguishes it from other birds. Fowls are having a relatively high breathing and pulse rate, and body temperature ranges from 105°F to 109°F (40.5 ^{o}C to 42.8^{o}C),which is higher than that of other domestic animals. $^{o}F = (1.8 \times {}^{o}C) + 32$.

Zoological classification of fowl

Kingdom- Animalia

Phylum- Chordata

Class- Aves

Family- phasianidae

Genus- Gallus

Species- Gallus domesticus

Common name-fowl

Fowl may be classified on the basis of **utility** and economic value and these include

1. Meat type
2. Egg type
3. Dual purpose

7.4 Economic importance of poultry production

Advantage of poultry keeping:-

1. Supply of nutritive food: - it is evident from the composition of egg and poultry meat that, the products contain essential amino acids, and hence supply protinacious food to human beings.
2. It can be started with little initial investment, i.e. it requires low cost to purchase the animals and their feed and also require low space.
3. Stock number can easily be increased due to fast reproductive rate and high prolificacy. This makes poultry very important economically.
4. Provides more food at low cost. e.g, 2kg BW of broiler is obtained from 4 kg of balanced feed within 7-8 weeks.
5. have better feed conversion efficiency
6. Poultry meat and egg has no religious and taboo restriction
7. Provides quick return eg. Broiler of 1kg can be easily obtained in 4 weeks.
8. Income in poultry farming is round the year.
9. Expansion of poultry enterprise is easy.
10. Provides self-employment to unemployed educated youth.

11. Utilization of all type of labor (retired persons, women, and children) is possible.
12. Provides good organic manure.
13. Feed for ruminants.
14. Poultry enterprises require relatively less space, capital and labor.

Limitation of poultry production

- Susceptible to disease and parasite, i.e. High problem in disease and parasites infection.
- Competent to human food (cereal grain)
- Requires high level of management and skill especially at higher level of poultry production. The common management activities include feeding, watering, health care, housing, and breeding.
- Risk of high death loss because of predators and sudden crush (trampling) by larger animals.
- High risk of theft because of their portable (small) size and etc.
- Local breeds are low genetic potential

7.4 poultry Reproduction system

Reproduction in hen is accomplished by the eggs. Laying of eggs can occur without the intervention of the cock. For the eggs to be fertile, a cock must copulate the laying hen. The hen's egg only produces a chick if it has been fertilized, and on condition that it has been kept for 21 days incubation, for commercial egg production it is not economical to use a cock.

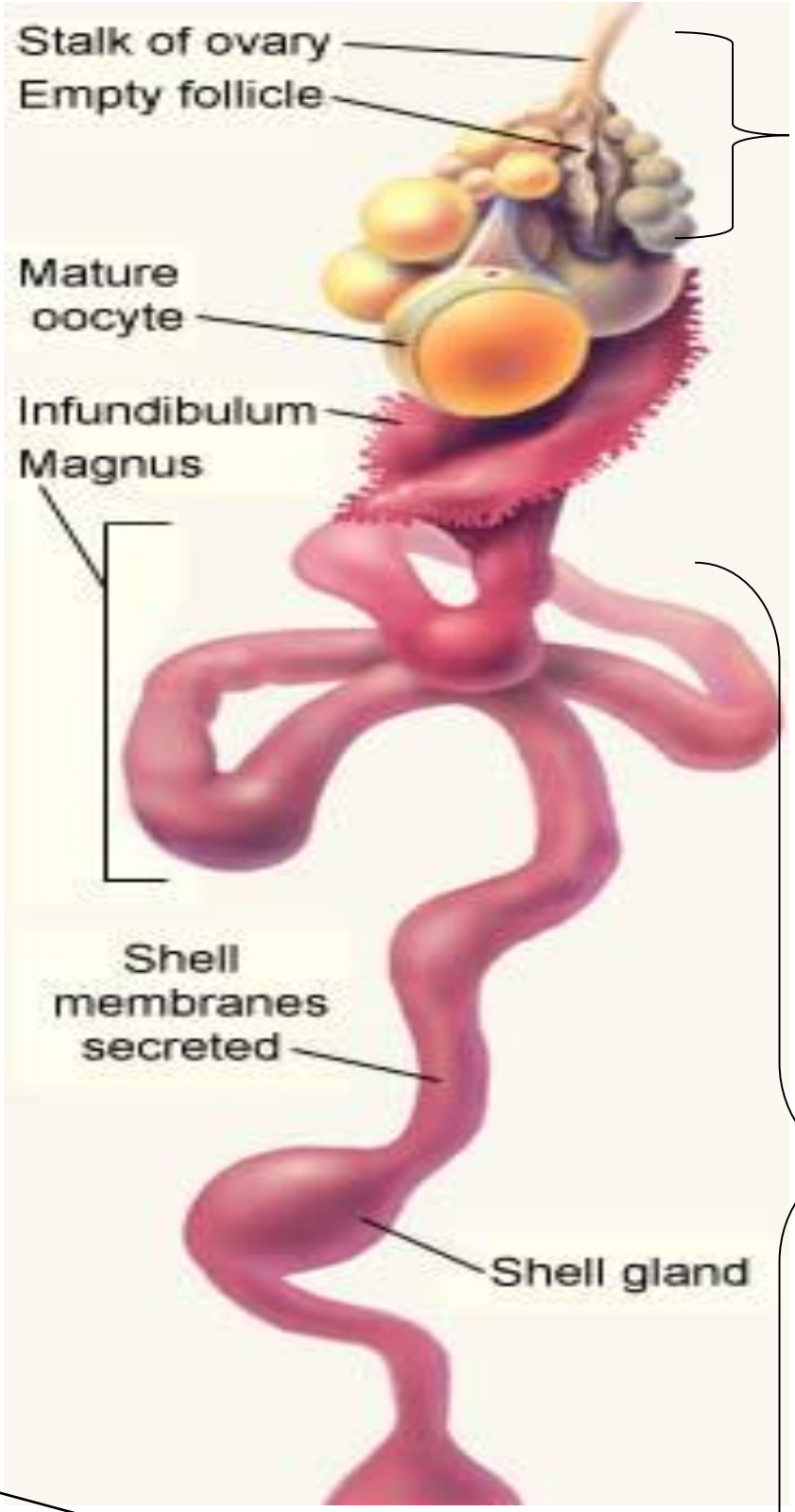
7.4.1. Female reproductive system

Female reproductive organ consists of two ovary (primary organ) and oviduct (accessory organ) in embryonic development, but the only left side one develops completely and remains functional, where as the right side one becomes rudimentary and remains non functional.

Ovary: At hatching time the female chick has two ovaries and two oviducts. The functioning ovary appears as a ***cluster of many spheres***, each of which is independently attached by a very slender stalk. Each sphere is a more or less developed ovum or yolk enclosed in a thin membrane or follicle. Each yolk contains a ***germinal disc*** from which the embryo develops. A hen in a laying condition has as many as 900 to over 3600 ova have been counted.

Oviduct: - the oviduct in the female corresponds to the ***vas deferens*** in the male. The oviduct is divided into five defined regions.

1. The funnel or ***infundibulum***, which receives the yolk from the ovary, and it is the site of fertilization.
2. The ***magnum***, which secretes the **albumen or egg white**. Its wall is thicker than infundibulum.
3. The ***isthumus***, which secretes the ***shell membranes*** (inner and outer shell membranes).
4. The ***uterus*** (shell gland), which secretes mainly the ***shell and the shell pigment***
5. The vagina which ***holds the egg*** until it is laid.



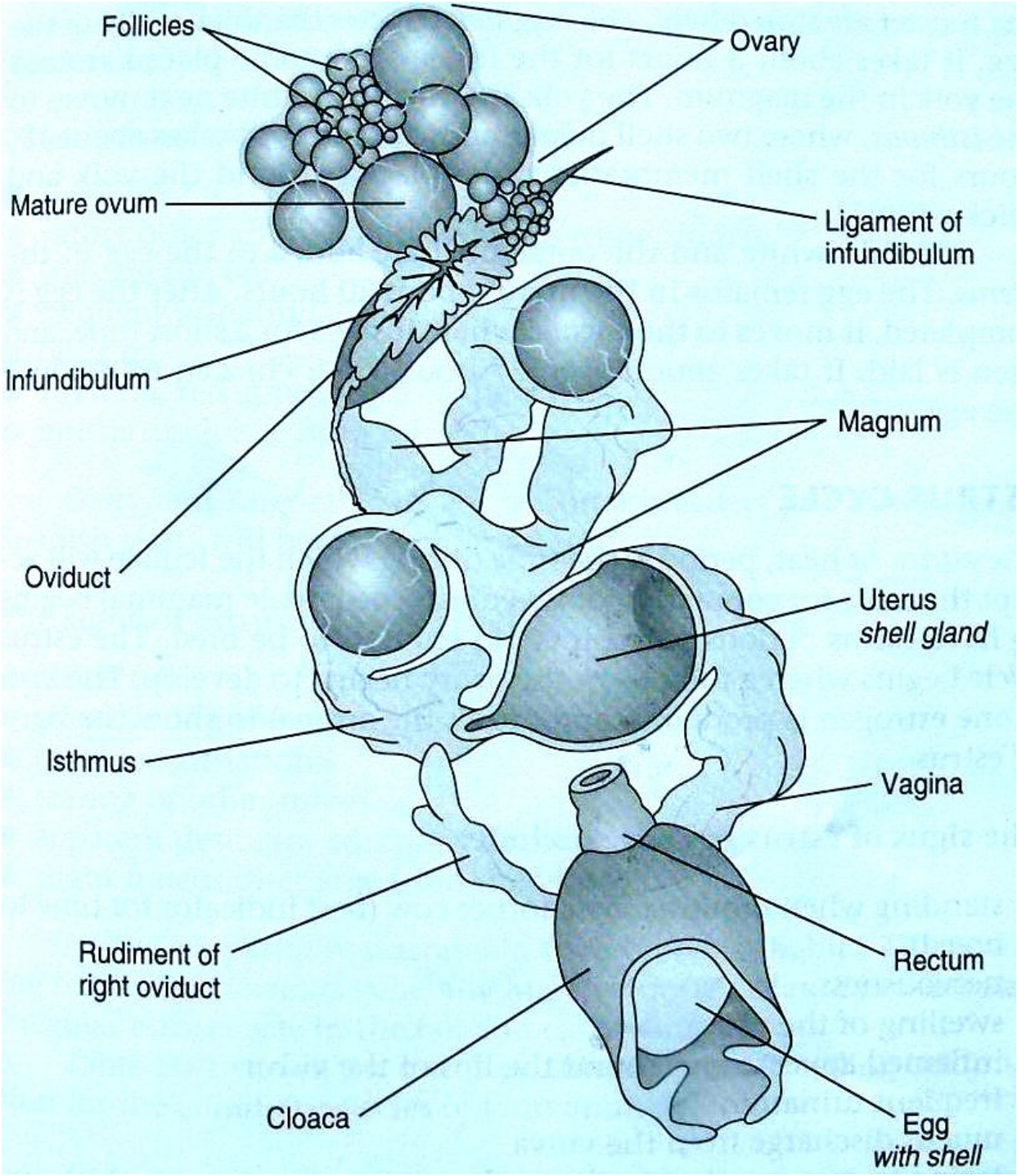
Left ovary

Isthumus oviduct

Left

7.4.2. Egg formation in the fowl

With or without a cock the hen can always lay eggs. Eggs layed with cock are ***fertile***, otherwise, they are ***sterile***. The egg has different parts: the yolk, albumen (egg white), the two membranes and the shell. The shape of the egg is irregular ovoid and it can be divided into three main parts. The white constitutes approximately ***60%*** of the weight of the egg, the ***yolk 30%*** and the ***shell and membranes 10%.*** The weight of the hen's egg varies according to the breed of the layers and their feeding.


Follicles
Ovary
Mature ovum
Ligament of infundibulum
Infundibulum
Magnum
Oviduct
Uterus
shell gland
Isthmus
Vagina
Rudiment of right oviduct
Rectum
Cloaca
Egg
with shell

Yolk formation

The yolk has been produced in the ***liver and then transported to the ovary by the blood***. The yolk is formed in the ovary, not in the oviduct. The yolk color is determined by the presence or absence of ***xanthophylls***. The color of the yolk is influenced to a large degree by ***nutrition*** and yellow yolk can be produced by feeding laying birds on ***grass meal or alfalfa meal***. Yolk is rich in ***nutritious*** materials required for nourishment and growth of embryo during incubation. The function of yolk is as a ***food reserve***, and when the chick hatches it is absorbed within the chick's body. The presence of this food reserve enables the chicks to ***survive without food and water*** for several days after hatching. This long survival time means that newly hatched chicks can be ***transported over long distances***. On the surface of the yolk there is the ***blastoderm***, which is the site of embryonic development. However, the blastoderm is present in all eggs and therefore it is ***not an indication*** that the egg is fertile or not.

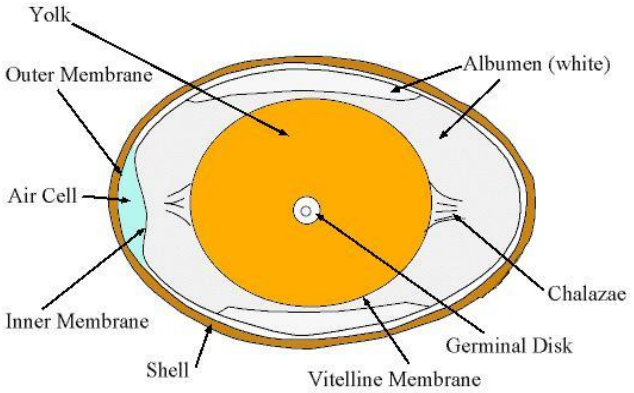


Fig : Chicken egg structure and its different parts

Albumen (egg white) formation

The funnel of infundibulum: it receives (engulfs) the yolk from the ovary and it is ***site for fertilization***. The egg stays ***15-30 minutes*** in this region. In the **magnum** secretion of albumen or egg white and deposition around the yolk is takes place. The egg stays for about ***3 hrs*** until the albumen deposition finalized.

The albumen located within the shell membranes is made up different distinct layers. The thick white make up about half of the volume of the albumen and has layers of thin white either side of

it. The relative proportion of thin and thick white is not constant and they are for example affected by ***disease***, ***genotype of the bird and age of the egg***. The longer the egg has been stored the greater the proportion of thin white. The albumen acts as a ***source of moisture and protein*** for the developing embryo, it also ***absorbs waste products*** excreted by the embryo and as it is composed largely of water. It has high specific heat, and it therefore protects the embryo from large fluctuations of temperature.

Chalaza is made up of ***coils of thick albumen***, twisted in opposite directions. The function of chalazae is to keep the yolk located in the center of the egg.

Shell membrane formation

It is synthesized in isthmus. In the **isthmus,** the egg stays for about ***1.5 hrs*** in which the inner and outer shell membrane formation is takes place. As soon as the egg enters the isthmus, the shell membranes begin to be deposited on the forward end. ***By the time it is fully emerged in isthmus***, the egg is already enclosed in thin, tight fitted ***inner membrane*** (composed of fine fibers), and takes its ***normal shape***. The outer membrane is formed when ***egg passes in isthmus for short while***. The outer membrane is made up of coarser, more loosely interwoven fibers.

The egg shell formation

At the junction of Isthmus and uterus called ***isthmus-uterine junction*** the ***shell started*** to be synthesized. The ***uterus (shell gland)*** secrets the ***shell and the shell pigment***. About ***95%of eggshell deposition*** is takes place here. ***Cuticle formation*** to cover pores on egg shell in order to protect entrance of micro organisms in to the inside. Egg stays here for about ***18-22 hrs***, but ***not less than 18 hrs***. This ***time gap*** is mainly depend up on the ***management applied***. Finally, the egg is stayed in the vagina until it is laid.

For the normal egg to be formed, the time (duration) **from ovulation to egg laying** takes about ***24-26 hrs***, but adequate management shortens the duration. The interval between egg laying and last ovulation is ***half an hour***.

7.4.3. Male reproductive system

The male reproductive system produces male reproductive cells (spermatozoa), which introduces into the oviduct of the female for fertilization of the egg. It also produces ***androgen***, which is responsible for development of secondary sexual characteristics and spermatogenesis.

Generally the male reproductive system consists of

- Paired testes (two small ovoid organs)
- Epididymis
- Vas deferential (for convoying of spermatozoa and seminal fluid from the tests to the cloacae).
- Rudimentary-penis (rudimentary copulatory organ)

The tests of birds are ***retained in the body cavity*** and never descend in to scrotum, i.e. they ***do not have scrotum***

8. Apiculture

8.1. Beekeeping in Ethiopia

Definitions

- **Apiculture**: one of the important agricultural sectors that enables utilize natural resources that otherwise would be wasted and contributes to the national food products through **pollination**. Apiculture is A **science** based industry which uses bees as micromanipulators to harvest plant foods from environmental resources. ***''Apis''*** **Latin** word for **Bee**, and **apiculture** is the **science** and practice of bee keeping.
- **Beekeeping:** Formally known as *apiculture*, beekeeping is thought to have been practiced as early as 13,000 BC.
- It Means managing honeybee colonies in such a way as to: (obtain a large (or maximum) adult colony population to coincide with the major honey (nectar) flows in the area, and to utilize this population to the beekeeper's greatest advantage for storing honey and/or pollinating crops, maintenance of honey bee colonies, commonly in hives, by humans.

  In general the words '**apiculture**' and '**beekeeping**' tend to be applied loosely and used synonymously: in some parts of the world,

Honey, the natural food of the honeybee, has many times been described as man's sweetest food Until the refining of sugar cane developed in the 19th century, honey was the only sweetening agent widely available.

Why people keep honeybee colonies?

General advantages

Bee keeping plays an important role:

- In meeting the beverage requirements of the urban population
- As income generating activity among the rural community
- As a means of balancing diets through the use of honey which has high nutritional value
- In the national food production through pollination of (fruits vegetables, legumes and other seed crops)

Relative advantages of beekeeping

- Compared to other agricultural activities, beekeeping has its own relative advantages over others:-

  - unlike cultivation of crops and animal husbandry, beekeeping does not disturb the. Ecological balances of an area. Instead, it is an environmentally friendly activity.
  - Beekeeping does not compete for resources with other agricultural activities. Hence, it can be integrated with annual and perennial crop production, animal husbandry and. Conservation of natural resources.
  - Since beekeeping is light work, it can be done by women, aged men and persons with Disabilities. Moreover, since it is less labor intensive, it can be done as part time and side line activity.
  - Beekeeping assists to utilize resources like pollen and nectar which other wise are wasted. Man can not utilize these resources in the absence of bees.
  - Beekeeping can be run in areas which are not suitable for cultivation of crops and animal husbandry such as hills and escarpments.
  - Bee products like honey and beeswax are not perishable and can be transported and stored for long periods and their prices do not fluctuate very much over seasons.

- Beekeeping can be run with little or no land, because bees can forage in any place around their foraging distances and it is useful for intensification of land and also in areas where there is shortage of land.
- Beekeeping is useful in improving the quality and quantity of crop yields and Contributes for maintaining biodiversity through efficient pollination services Honeybees.

8.2. Types of bee castes

Honeybees are social insects that live together in groups, cooperate in caring for young and foraging tasks. A colony is a group of honeybees living together and working in group according to their division of labour. Each colony contains one queen bee who is the female parent of the colony; a few hundred drone bees (males), and thousands of worker bees. At a time of a year a colony also consists of developing broods (i.e.-eggs, larvae, & pupae).

The three (3) castes in a honeybee colony are:

1. **The queen-** is a fully fertile female specialized for producing eggs. The queen affects the colony by producing chemicals called "Pheromones" that regulate the behaviors of other bees.
2. **The worker bees**-are reproductively underdeveloped females that do all the work of the colony. A colony may have 10,000---80,000 worker bees. The only difference between workers and queens is the quality of the larvae diet i.e.- a special food called "Royal jelly".
3. **Drone** is a male honey bees and Produced from unfertilized eggs

Queen

- The queen in HB colony is the only fully competent sexual female present; under normal conditions is the mother of all other individuals in the colony.
- A queen HB is readily distinguished from both worker and drown.
- Her wings are much shorter in proportion to her body length.

- Because of her long tapering abdomen she appears wasp like than the drone and worker.
- her curved sting used only in battles against the rivals queen(when there is more than one queen in the colony)
- Her movement is slow under normal condition and deliberate through when necessary.

The queen's proboscis is shorter than that of the worker bees. She lacks the following glands and substances:

1-pollen basket (corbiculae),

2-hypo pharyngeal gland that is useful in production of royal jelly in worker bees

3-wax gland that is used to secret wax in worker honeybees.

4-Nasonov glands, that is useful for production of pheromones that is used in communication in worker honeybees.

But the queen has well-developed glands for queen's substance (pheromones) production particularly the large mandibular- glands.

The mandibular- glands secret pheromones that have the following functions;

i.e-1) Inhibits ovarian development in worker bees,

-2) Inhibits queen cell production in the colony,

-3) for queen recognition by the members of colony, and

-4) for attracting the drones to the mating area (congregation area).

The queen ovaries contain a numerous overalls (egg laying sacs) compared to the worker bees.

*each of her two ovary consists of 150-180 ovarioles where as worker ovary has only 2-12 ovarioles

*the ovarioles can produce unlimited number of eggs often as many as million or more during her life time.

- Queen has well developed spermatheca which holds sperm from drone; which have mated with queen early her life time.
- HBS rear queen only under three conditions.

1. When they are about to swarm.

2. When a colony is about to replace an old or filing a queen/supersede/

3. When the colony becomes quenelles/through accident or natural causes/

Drone

- is a male honey bees
- Produced from unfertilized eggs
- Designed only for significant function i.e. mating.
- Performs no works for the colony and is fed by the worker, even they can't suck honey from the comb.
- The drone work related structures are reduced/absent
- Drone has very short proboscis
- Drone has large compound eyes
- Drone large muscles and broad muscles.
- Drone has no wax glands hypo pharyngeal gland pollen basket.
- In contrast, orientation flight muscles and relating structures are highly developed.
- Drones mate only once in his life time and die soon since much of endophallus break off from drone is left in the queen during copulation

Worker and its duties

- They are female honeybees and obtained from fertilized eggs.

- As the name worker itself indicates workers perform almost all the tasks in the colony, only reproduction that is beyond their task.
- The activities that worker honey bees on this perform are rented with their age hosed two groups.
- 1/ Nurse bees / House bees/
- are those workers bees who spent most of their time by performing activities inside the hive
- This starts from the first day of emergency up to 21 days.

2/ forager bees/Field bees/

- These are honeybees which perform their activities outside the hive. This high labor worker honeybee has an effect on their age and the age of WHBs is shorter than queen and drone.
- The maximum age of worker bees is 42 days. But they can live up to 60, 90 days even up to 10 months. These are exception/
- The age of worker bees is determined by the activities they perform. Some activities performed by nurse bees are the following:-
    a. Cleaning activities

1/ body cleaning 2/ nest cleaning

The first task of worker bees immediately after emergency is cleaning of her own body besides to this nurse bee's also clean body of other worker bees, queen and drone. A bee that needs to be cleaned performs a grooming invitation dance during which it rapidly stamps its legs and shale's its body from side to side. This usually results in a near by bee cleaning it, in the wing bases and in the constriction b/n the thorax and abdomen where a bee is unable to clean it self.

2/ Cleaning nest

- The cleaning of the nest includes:-

- Cleaning the cell from which blood were hatched.
- Removing the remains of cocoons and larval excreta.
- Removing moldy pollen from the cell
- Removing dead larvae, dead bees
- Removing of only foreign materials which found inside the hive.
- For example, if bees found dead spider or ants inside their cell, they remove out of their hive with the help of their mandible. But for a bigger foreign materials such as lizard snake this material is heavier for the bees to remove, and then they fix with the wall of their hive by the use of propels. In doing this, they try to avoid bad smell due to this foreign materials.

Brood feeding

- The major activity associated with brood feeding is nursing, in which the workers with developed hypo pharyngeal and mandible glands feed brood food to larvae.
- Therefore, bees which attain the age (usually b/n 6 and 16 days old) used to feed
- larvae of queen
- larvae of worker
- larvae drone
- - In addition to this the adult queen is also fed by nurse bees unless and other wise the queen is caged where the workers are not able to feed her.
- Nurse bees continuously supply tiny larvae with for more food than can be consumed so that larvae appear to float in the milky white food.
- - Nurse bees visit individual larvae an average of about 1300 visits per day, ore than 7200 visits(1140 feeding visits at all. That is until larvae finish and become pupa.
- A Single nurse bee rears the equivalent of two to three larvae during its nursing life.

Queen Tending /Taking attention for queens/

- Workers attend the queen at about the same time they are participating in brood- nursing activities. A circle of six to ten attendant workers is usually formed around the queen:

with the individual attendants rotating frequently, a typical visit lasts lees than one minute.

- The workers are examining the queen with their antennae and fore legs, licking her with their tongues, and feeding her brood food secretions by dark mouth- to mouth food exchange

Comb construction

- Comb is a back to back arrangement of series hexagonal cells made of bees wax to hold brood, pollen or honey
- Comb construction and brood rearing fulfill fundamental biological needs for shelter and reproduction
- Beeswax, the material used by the HBS in construction of the comb is secreted by worker bees (8-17 days old)
- Worker bees involved in wax secretion form a cluster in order to increase their body temperature, because wax-secreting worker requires high amount of energy.
- In order to gain this high energy, worker bees feed with large quantity of honey or sometime sugar/nectar

Cell capping.

- The young worker of 2-3 days old usually engages in cell capping activity.
- Older workers are producing wax and place wax secretion on the rims of the cells, which need to be capped, so that the copious wax production by the younger capper is not necessary.
- Cell capping can proceed more quickly, however, smith (1959) noted that capping time of only 20 minutes for one cell by a single worker.

Orientation Flight

- The mean age at which orientation flight is performed is usually about one day before the mean foraging age.

- This is the age of 21-24 days old.
- The purpose of orientation flight is, as the name implies to orient to the nest location before workers take trips to the field to forage.
- These flights tend to take place own arm, windless, sunny afternoon, and the synchronous emergence of many young workers from the nest inspired German researchers to call these " Play flights'
- The gradually increasing circles in the air which are perforated during orientation flights serve to familiarize workers with land marks around the nest and with the location of the entrance.
- A single orientation flight generally lasts less than 5 min. and successive flights appear to increase in duration and distance from the colony.

Colony Defense

This stage is traditional b/n nursing activity and field activity. All nurse bees are not involved in the guarding activity, because the number of involved bees is related with pay biology of worker and number of enemies in the areas. By physiology it means do these. Worker bees have well developed stinging apparatus.

Those who do guard the nest perform this activity most frequently b/n the ages of 12 and 25 days, and they usually guard for only a few hours or days before foraging commences. Guard workers can be recognized by their characteristics posture entrance, where they stand on their four hind legs with antennae held for ward and for legs lifted.

Four hind legs means those legs found behind the fore legs that is it includes the middle and hind leg.

- Each guard patrols limited areas around the hive, inspecting incoming workers with the antennae and determine their odor and behavior whether they are colony members or not.
- More workers assume guarding duties when the colony has been under attack or during periods of forage dearth, when robbing is more likely.

Defensive Mechanisms

- The defensive can be done in the following ways
    1. By stinging. E.g. Man, cattle
    2. By biting with theism mandibles. E.g. Ants.
    3. By fanning their wings. E.g. ants
    4. By kicking with legs. E.g. Ants

GNest Homeostasis/ Thermoregulation

- One of the great advantages and challenges of insect social organization is colony homeostasis, or maintenance of hive temperature and other environmental factors at relatively constant levels regardless of external conditions.
- The advantages of homeostasis are many, including rearing of brood under stable conditions, survival of populous colonies through cold and hot, early initiation of brood rearing and flight warming of foragers.
- Bees require temperature about 34 ^{o}**c** to 35 ^{o}**c** inside the brood nest temp.
- To maintain the above temp. Bees use different methods for regulating hive temp.

8.3. Beekeeping systems

A. Traditional beekeeping

- ✓ an occupation in which local methods are passed on from generation to generation
- ✓ requires a full commitment to bees and beekeeping.
- ✓ the oldest and the richest practice which has been carried out by the people for thousands of years in Ethiopia.
- ✓ This practice is extensive and closely tied to swarm management
- ✓ beehives are hung up in trees to catch swarms and are then transferred and placed in the backyards with some kinds of hive sheds that protects them from the hot temperature and rain.

- ✓ Old and invaluable information of traditional beekeeping has started to disappear due to the reasons such as:
- ✓ migration of young population to bigger cities
- ✓ traditional beehives not being suitable for intervention into, thus providing less efficiency.
- ✓ change in the global climate
- ✓ Traditional beehives (30-40 cm across and 1 m long) are crafted by creating a tube shaped structure using branches, straw, cow dung and clay.
- ✓ But, sometimes hives can be made from soft logs of a cactus tree.
- ✓ Hence, several millions of bee colonies are managed in these kinds of hives and traditional beekeeping methods in almost all parts of the country.

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However, traditional beehives in this system have their own disadvantages on colony management and honey harvesting activities including:

- ❖ difficulty in colony inspection for brood diseases,
- ❖ difficult to work with open hives in the night,
- ❖ not appropriate for artificial queen rearing,
- ❖ higher chance for a number of bees and a queen to be killed during operations,
- ❖ very difficult yield and behavior targeting selection.

B. Transitional /the top bar hive

Here the langstroth frame is replaced by a simple modification of the top bar of the langstroth frame, and the bees build their combs hanging down from the center of the bar. Since the combs are not supported in all the four sides of the frame they can easily be broken. There are three type of top bars used.

- It has been speculated to be started in Ethiopia since 1976
- a type of beekeeping which is intermediate approach between traditional and modern beekeeping.

- some qualities of traditional beekeeping are retained and some qualities of modern beekeeping are visible.
- Transitional (intermediate) beekeeping practice has different advantages over traditional system. These include:
    - hives can be opened easily and quickly,
    - the bees are guided to building parallel combs following individual top bars,
    - top bars are easily removable and this enables beekeepers to work fast,
    - top bars are also easier to construct,
    - beehives can be suspended with wires or ropes and this gives protection against pests.

However, transitional beekeeping has its own disadvantages such as:

- top bar hives are relatively more expensive than traditional beehives,
- combs suspended from the top bars are more apt to break off.
- Thus, the types of beehives used more frequently in this system are Kenyan top-bar hives (KTBH), Tanzania top-bar hives (TTBH) and KTBH is widely known and commonly used in many parts of the country

Generally, a top-bar hive is a single story long box with slopping sidewalls inward toward the bottom (forming an angle of 115o with the floor) and covered with top bars of fixed width, 32 mm for east African honeybees.

C. Frame hive beekeeping

The main purpose of frame hive beekeeping method is to obtain the maximum honey crop, season after season, without harming bees.

Accordingly, it uses different types of frame hives :

- Zander
- Langstroth hives being common in the country,
- Dadant, Modified Zander, and foam hives are also found).

However, these hives basically differ in the number and size of frames.

Generally, frame hive consists of a precisely constructed rectangular boxes (hive bodies) superimposed one above the other in a tier.

Similarly the number of boxes (suppers used) varies with season, population size and activities of bees.

As reported by, HBRC (1997) these box hives have an advantage over the others in the volume and quality of honey harvested (averagely 15-20 kg/year and in potential areas up to 50-60 kg harvested).

Moreover, the hives allows swarm control through supering and colony management,

- it is easy to transport and allows the use of higher level technologies. However, equipment in this beekeeping system are relatively expensive, require skilled manpower, very less wax production only 1-2% of the honey yield needs very specific precaution.
- Modern beekeeping came into existence as a result of the invention of the following equipments:
    - Modern frame hives with the correct bee space by Langstroth
    - Foundation sheet by Johonson Mering
    - Centrifugal honey extractor
    - Queen excluder
    - Smoker

8.4. Bee products and their uses

1. HONEY

Honey is elaborated from the nectar of numerous plant species but may also be produced from honeydew excretions of aphids and scale insects). Nectars vary considerably in quality and quantity, depending on the floral source. Similarly, honeys vary; some honey is nearly colorless (like water), with a light, pleasing aroma, and some is as dark as crankcase oil, with a heavy-bodied aroma. Honey from most floral sources falls between these extremes. Bees convert nectar to honey by drying it down to moisture content of 15 to 20 percent and by adding a salivary enzyme that changes sucrose (long-chain sugar) into glucose and fructose (two short-chain

sugars); honey is composed of sugars, mainly fructose and glucose. Honey also contains trace amounts of minerals, enzymes, vitamins, and colloids. Other biologically active constituents (such as hydrogen peroxide and gluconic acid) inhibit some microbial development but accelerate yeast growth. A limited number of plant sources yield nectar with toxic elements, but fortunately bees either recognize and avoid these or are able to nullify their effects. (Beekeepers avoid areas with such noxious plants.) Honey is used as a sweetener (1 part honey 1.67 parts sugar) and in baking, baby foods, confectioneries, cosmetics, meat packing, pharmaceuticals, and syrups, and for curing tobacco. Honey is often used to maintain moisture as well. In times past, it was believed to be a powerful aphrodisiac. It is served in liquid or granulated (spread) form and in the comb; limited quantities of dried honey are now available. But for bees, honey is the all-purpose food, essential for stores of body fat, for flight, and in the production of heat, humidity, and wax. Honey is defined as: the sweetest substance produced by the bees from the nectar of the blossoms or from the secretions of the living parts of the plants, which they collect, transform and combine with specific substances, and store in honey combs. Honey of the world show great variability. Flavor and aroma of the honey differs because of the differences plant sources. Therefore, honey is classified by the source from which the bees gathered the nectar. The source influences the honeys flavor, color and viscosity. We can see this from the following simple table.

Plant	Color	Viscosity
Orange	Light, yellowish	High
Coconut	Dark	Moderate

However, the main constituent in all honey is the same. There is very high concentration of sugar dissolved in water. As a result, honey is safe from spoilage by microorganisms when properly stored even for a longer period. Honey shall not have objectionable flavor, aroma or taint absorbed from foreign matter during its processing and storage. Natural plant toxins (hazardous to health) should not also be available in honey.

USES OF HONEY

- As human food.
- In certain alcoholic beverages.
- Sugar substitute in cooking and baking
- In child feeding, adult feeding
- For athletic and strenuous activities
- Diabetics
- As an ingredient in the drugs
- For animal feeding
- In veterinary medicine
- In cosmetics
- Industrial uses-in manufacture of some alcoholic drinks, chocolates, and caramel

2. BEES WAX

For making beeswax, each worker bee has four pairs of wax glands on the underside of its r abdomen; these function best in 12- to 18-day-old bees, according to the needs of the colony. Both protein (pollen) and carbohydrates (honey) are required to produce beeswax; 1 lb beeswax, which contains about 450,000 wax scales, will provide enough wax to make 35,000 hexagonal cells that can store 10 kg (22 lb) honey. Thus bees consume part of their food (pollen and honey) for the purpose of converting it into nest structure -specifically cells for food storage and brood rearing. It takes 2.7 to 4.5 kg (6 to 10 lb) honey to produce 0.45 kg (1 lb) wax. Beeswax has many uses worldwide, including the production of candles, cosmetics (the largest user-industry), electronics, lubricants, leather and fabric preservatives, polishes, inks and paints, models for dentistry, and beer. A large portion of the beeswax produced is recycled to the bee industry where it is used to produce the foundation for new honeycomb and queen cell cups. World production of beeswax exceeds 9072 t (10,000 tons) annually.

Generally, Bess wax:

- Is very poor conductor of heat
- Has an insulating effect.
- Has a characteristic odor and a melting point of about 63 oC.

- Insoluble in water and alcohol.
- But completely soluble in cold chloroform and ether and benzene.

COMMON USES OF BEES WAX

- As an ingredient in medicines.
- As soldering wax for repairing kitchen utensils.
- Modern electronic industry uses it in computers.
- Used in tanneries for treating hides and skins.
- It is cooperated in to cosmetics.

3 PROPOLIS

Propolis is used in the attachment of combs to the top and sides of the hive, as well as for filling cracks, reducing the size of the hive entrance, and embalming intruders. It is composed of plant resins gathered by worker bees, beeswax (30 to 60 percent), balm (perhaps a glandular secretion of bees or a product of honey bee digestion), as well as pollen and hive debris. In times past, varnishes responsible for the tonal quality of violins and the finishes ori other fine woods contained refined propolis.

*Propolis is an aromatic resinous substance collected by bees from trees and plants

Color - yellowish-red to dark brown with a green tinge.

- Bees use it to:

- Seal any cracks or crevices.

- To encase and seal any unwanted object.

- "Bee glue"

Propolis is the latest hive product to have been commercialized.

The material has many properties that the bees use and humans can make use of the material.

- Draught proofing
- Vibration reduction
- Hole filling
- Aromatic barrier
- Antibiotic properties

Uses:

Local anesthetic, reducing spasms, healing gastric ulcers and strengthening capillaries

4 Pollen

The human nutritional value of pollen and queen (royal) and worker jelly has been of great interest throughout the world. However, there is much doubt as to their real worth. These jellies, larval food synthesized from the digestion of pollen and secreted by the brood food glands of worker bees, have, like pollen, no proven attributes except as bee food. Nevertheless, both are used in various cosmetics, lotions, and dietary supplements.

. Source of protein

. A colony may use up to 50 kg. a year

. Composition of bee-collected pollen varies according to plant source

. Obtained by placing pollen trap over a hive entrance. This consists of grids through which bees have to pass.

- Free ingress and egress to the bees but fine enough to knock off the pollen from the legs of the pollen foragers.

. Pollen trap should be placed at the hive entrance only for some hours of a day because the pollen requirement of the bees should also be fulfilled.

. Composition of pollen: Vitamins, minerals, proteins, fats and oils, carbohydrates, amino acids, over 5000 enzymes and coenzymes, hormones, peptones, peptones, polypeptides and globulins, high concentration of nucleic acids RNA & DNA, and a variety of antibiotic substances.

Commercial uses of bee-collected pollen:

- Feeding to bees when plant source of pollen are lacking
- As dietary supplement for domestic animals
- For human consumption
    - Expensive packaged pharmaceutical preparations as nutritional and therapeutic dietary supplements.

5 ROYAL JELLY

- "Thick milky" substance produced by worker bees.
- It is the royal jelly that makes a queen a queen.
- It is highly nitrogenous
- Productivity of royal jelly is affected by keeping colonies in a queenless state
- When taken by man it has Effects on eye mal functions and On general health

9. Fishery

9.1. Fishery resources

The recent estimate of world fishery production is about 76,000,000 tones/year; out of this, Closer to 90% of the world's fishery catches come from marine (oceans and seas), and the rest 10% come from fresh water environment. Fish production in Ethiopia is a recent practice and it is concentrated only on rift valley lakes; about 99% of the total captured fishes directly come from the natural water bodies such as lakes, rivers and streams. However, in certain lakes and rivers there is a problem of over exploitation which there must be reduced fishing or exploitation

so as to attain sustainable production, Whereas in some there is a problem of under-exploitation which requires development of the fishery activities.

However, with the real importance of fish as high quality food, and food shortage due to the increased population pressure, intense fish production not only in the natural water bodies such as lakes and rivers, but also in the artificially fish cultured ponds, dams and reservoirs is very essential.

The major problems of fishery production in Ethiopia are:

- Problems of transportation(spoilage problem) b/c fish are highly perishable food item
- Management problems- e.g fishing should be avoided during breeding period
- Food habit of the people – some people don't eat fish and others are less interested to consume fish

Definitions of terminologies

- Fisheries - The industry or occupation devoted to the catching, processing, research or selling of aquatic animals (fish, invertebrates, or mammals). The majority of animals that is used for fisheries practice are fish. There are more than 30,000 species of fish, more or less evenly distributed between fresh water and sea water, and of these some 1,500 are of interest to the aquarist.
    - ✓ *The major invertebrates are mollusks and crustacean*
    - ✓ *Mammals which are used for fisheries-whales , dolphin,etc*
- Fish – is an aquatic vertebrate, cold-blooded animal that breathes oxygen by means of gills and moves and keeps its balance by fins, reproduce by laying eggs, and its body is covered with scales, two chambered heart (one auricle and one ventricle) circulate deoxygenated blood only.
- Aquaculture- Rearing aquatic animals or cultivating aquatic plants for food
- Fresh water- The mean salinity of fresh water is around 2ppt, or approximately 2 g salts/liter. e.g rivers, ponds, lakes or springs
- Marine water- The mean salinity of marine water is around 35ppt, or approximately 35 g salts/liter. e.g sea and oceans.

- Brackish water- water body that contains less salinity than marine water