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# EVALUATION OF CHICKEN PRODUCTION SYSTEMS AND EFFECTS OF HOMEMADE RATION ON GROWTH AND CARCASS CHARACTERISTICS OF COBB500 BROILER CHICKEN IN BISHOFTU, ETHIOPIA

PhD Dissertation

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**Department of Animal Production Studies**
**PhD Program in Animal Production**

**June 2019**
**BISHOFTU, ETHIOPIA**

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A Dissertation Submitted to the College of Veterinary Medicine and Agriculture of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in Animal Production

By

**Yared Alemayehu Ebsa**

**June 2019**

**Bishoftu**

**Addis Ababa University**

**College of Veterinary Medicine and Agriculture**

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As members of the Examining Board of the final Ph.D open defense, we certify that we have read and evaluated the Dissertation prepared by Yared Alemayehu Ebsa titled: "**Evaluation of Chicken Production Systems and Effects of Homemade Ration on Growth and Carcass Characteristics of Cobb500 Broiler Chicken in Bishoftu, Ethiopia"**, and recommend that it be accepted as fulfilling the dissertation requirement for the degree of **Doctor of Philosophy in Animal Production**.

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We hereby certify that we have read the revised version of this dissertation prepared under our direction and recommend that it be accepted as fulfilling the dissertation requirement.

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# EVALUATION OF CHICKEN PRODUCTION SYSTEMS AND EFFECTS OF HOMEMADE RATION ON GROWTH AND CARCASS CHARACTERISTICS OF COBB500 BROILER CHICKEN IN BISHOFTU, ETHIOPIA

Yared Alemayehu Ebsa

Ph.D. Dissertation

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## ABSTRACT

*A survey was conducted to assess chicken production systems in urban and rural areas of Bishoftu then after a feeding experiment was conducted to evaluate homemade ration on growth and carcass characteristics of Cobb500 broiler chicken in Bishoftu, Ethiopia. The study indicated that the major chicken production system in the urban areas was small-scale chicken production system which account for 96.2% of the production system whereas the traditional chicken production system was the major chicken production system in the rural areas which account for 98.1% of the production system. The socioeconomic status of chicken producers indicated that majority of chicken producers in urban (69.2%); and rural (50.6%) areas were males. The average age of chicken producers in urban (33 years) was lower as compared to rural (37 years). Higher percentages of chicken producers in urban (53.8%); and rural (69.2%) were married. Almost all chicken producers in urban (90.4%) had attended formal education while more than 50% in rural (57.1%) were illiterates. In urban (98.0%) of chicken producers used deep litter house whereas higher percentages in rural (61.5%) left their chickens on perches. Larger percentages of chicken producers in urban (94.2%) provide supplementary feed. The major supplementary feed utilized in urban (82.7%) was commercial ration. Most chicken producers in urban (38.5%) fed their chicken any time. Higher percentages of chicken producers in rural (32.1%) fed their chickens twice per day. Maize, wheat and wheat bran were the major feeds utilized in rural other than*

*scavenging feed sources. In urban 95.5% of chicken producers did not incubate their eggs. Majority of chicken producers in rural areas practiced hatching of chicks. Disease was the first and major constraint of chicken production in urban and rural followed by high cost of commercial ration in urban; and predators in rural. In urban 92.8% chicken producers treated their chickens using veterinary drugs. Similarly, higher percentages of chicken producers in rural (40.6%) used veterinary drugs. The experimental rations used during the feeding experiment were commercial ration ($T_1$) and homemade ration ($T_2$). The feed ingredients included in the mix in case of homemade ration were maize grain, wheat middlings, soybean meal, noug seed cake, vitamin premix, calcium carbonate and salt. The result obtained from the experiment indicated that the feed intake of birds fed homemade ration during the starter (20.97 g) and entire phase (70.06 g) was the lowest ($P<0.01$) as compared to birds fed commercial ration. Lower body weight gain ($P<0.01$) and feed conversion ratio ($P<0.05$) was recorded in birds fed homemade ration only during the starter phase (122.7 g and 1.9), respectively. According to partial budget analysis higher net income was obtained in broilers fed homemade ration, although there is no significant difference in the carcass characteristics between the treatments. Therefore, homemade ration can improve the net income without much impact on the body weight and carcass characteristics at the final* day.

***Key Terms**: Chicken production systems, Homemade ration, Cobb500 broiler, Bishoftu,*

## STATEMENT OF THE AUTHOR

First, I declare that this dissertation is my *bonafide* work and that all sources of material used for this dissertation have been duly acknowledged. This dissertation has been submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Animal Production at Addis Ababa University, College of Veterinary Medicine and Agriculture and is deposited at the College library to be made available to borrowers under rules of the Library. I solemnly declare that this dissertation is not submitted to any other institution anywhere for the award of an academic degree, diploma, or certificate.

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## BIOGRAPHICAL SKETCH

The author was born in Oromia region, Illubabor Zone, Matu District on June 1, 1984 from his father Ato Alemayehu Ebsa and his mother W/ro Elsabex Takele. He obtained his elementary education from 1993 to 2000 from different schools in Bale Zone and did his high School Education from Goba Batu-Terara Secondary School between 2001 and 2004. Then, in 2005-2008, he joined Haramaya University and graduated with Bachelors of Science Degree in Animal Science. In 2008-2009, he joined Ministry of Agriculture and served as an agricultural expert in Gindhir District. In 2009-2012, he joined the School of Graduate Studies of Haramaya University, School of Animal and Range Science and graduated with Master of Science Degree in Animal Nutrition. From 2012-2015, he served Woldia University as a lecturer, researcher, higher diploma program tutor and also served the community jointly with NGOs and Wollo University in dissemination of push-pull technology until he sponsored and joined Addis Ababa University, College of Veterinary Medicine and Agriculture, Department of Animal Production Studies for Ph.D. Program in Animal Production. He has published three papers, including one from this PhD dissertation.

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## DEDICATION

*This dissertation paper is dedicated to my wife W/ro Etaferahu Gizaw and my daughter Emanda Yared for their unreserved partnership in the success of my life*

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| A.O.A.C | Association of Official Analytical Chemistry |
| CBMG | Cobb Broiler Management Guide |
| CF | Crude Fiber |
| CP | Crude Protein |
| CSA | Central Statistical Authority |
| DM | Dry Matter |
| EE | Ether Extract |
| EIAR | Ethiopian Institute of Agricultural Research |
| ESAP | Ethiopian Society of Animal Production |
| FAO | Food and Agricultural Organization |
| GDP | Gross Domestic Product |
| ME | Metabolizable Energy |
| NDF | Neutral Detergent Fiber |
| NRC | National Research Council |
| SPSS | Statistical Package for Social Science |

# 1. INTRODUCTION

The poultry sector in Ethiopia can be characterized into three major production systems based on some selected parameters such as breed, flock size, housing, feed, health, technology and biosecurity (Alemu and Tadelle, 1997; Bush, 2006). These are village or backyard poultry production system, small scale poultry production system and commercial poultry production system. Alternatively, FAO classifies poultry production systems into four sectors, depending on the level of bio-security (FAO, 2007). Based on this system of classification, Ethiopia has three poultry production systems: large commercial poultry production with "moderate to high biosecurity" (sector 2), small commercial poultry production with "low to minimal" biosecurity (sector 3) and village or backyard production with "minimal biosecurity" (sector 4) The poultry sector in Ethiopia thus lacks sector 1 of the FAO classification, which is industrial and integrated system with high level of biosecurity and birds/products marketed for export and urban use (Nzietchueng, 2008).

Village poultry production in Ethiopia represents a significant part of the national economy in general and the rural economy in particular, and contributes 99.2% of the national chicken meat production (AACMC, 1984), with an annual output of 72,300 metric tons of meat (ILCA, 1993). Village chicken production systems are characterized as mostly an indigenous integral part of the farming system. Local breeds of chicken are those chicken characterized by low input output system. These breeds require small initial capital and traditional management practices. Exotic chicken are characterized by high input output system of production. These breed require relatively higher amount of initial capital as compared to the local ones. These are disease sensitive breeds as compared to the local chicken breeds (Dawit *et al*., 2008). They also play a significant role in the socio-cultural and religious lives of mainly the rural community in Ethiopia (ESAP, 2009). Rushton and Ngongi (1998) classify smallholder chicken systems on the basis of management and degree of commercialization as scavenge based, free range, and semi-commercial. It is a broadly accepted rule of thumb, confirmed in numerous studies that about 60 to 80 percent of rural households in developing countries keep poultry in

either scavenge-based or free-range systems. The two systems are also referred to as "village poultry", although the production system is also wide spread in peri-urban areas (Tilahun, 2013a).

Scavenge-based chicken production system is the form of production that characterized by low inputs, with birds allowed to wander freely and scavenge for all or most of their food. In some areas, supplementary feeding is practiced subject to the seasonal availability of surplus grain. Housing is generally not provided, but the birds may be housed in the family dwelling at night. The production levels of scavenging birds are usually considered to be poor, especially when compared with those of commercial chickens. The size and the composition of flocks vary widely. They normally produce an average of 10 to 12 eggs about three times a year with an average hatchability rate of 80%. Chick mortality rates are characteristically high and an estimated 70% of chicks die before they reach the age of six weeks owing to combination of disease, predation and scant feed resources. Furthermore, off take rates are low in this system, and the principal market for the produce is the household consumption and for sale is common in Ethiopia. Flock sizes are small with an average of five to ten birds, and little investment is made in terms of time, management or money. In general, these systems have poor access to markets (Kryger *et al*., 2010).

Free-range chicken production system is provided with feed, night-time housing and, occasionally, water. They are expected to scavenge for a large proportion of their feed. Most of the feed used is produced at home. Night time shelter is often ineffective as protection against predators such as snakes. While the mortality rate in this system is lower than in the scavenge-based system, there are still considerable losses, mainly owing to poor nutrition, poor access to water, and disease. However, predation is less of a problem than in the scavenge-based system and off take rates are higher. Producers of free range chicken have reasonable access to markets and the sale of eggs and birds is common. The main input purchased is feed, with veterinary care as a minor input. Flock sizes are similar to those of the scavenge-based systems, but some capital investment is

made in terms of housing and human investment to manage the feeding and off take (Tilahun, 2013b).

The semi-commercial chicken production system is provided with feed and water. They are kept in fenced areas that have some type of shelter. Many producers have specialized in meat or egg production and hence have an interest in improved chicken. In addition, mortality and loss rates are relatively low compared with other systems, since the risks of predation, theft and loss caused by poor nutrition are much lower strains. When chicken production intensifies, it moves from being a small scale activity to medium scale, women's involvement decreases while that of men increases (Mathias, 2004).

Intensive chicken production system has comparative advantage to contribute towards poverty alleviation of most small holder farmers (Jebessa, 2008). Intensive chicken production started in Ethiopia about 30 years ago in colleges and research stations. The activities of these institutions focused on the introduction of exotic breeds and their distribution to farmers along with appropriate management, feeding, housing and health care packages. Though the contribution of the commercial intensive chicken farms to the national GDP is insignificant, their role from the point of introducing the exotic breeds in the country could be very high (Tadelle *et al*., 2003).

Chickens provide the following benefits: production of eggs for hatching, sale and home consumption, and production of birds for sale, sacrifice, replacement and home consumption (Tadelle *et al*., 2007). They also provide cheap source of animal protein due to their short generation interval, and higher feed conversion efficiency. Besides, chicken meat is the most palatable and easily digestible animal meat and contains essential amino acids required for human beings, and eggs are richly endowed with nutrients (Lahkotia, 2002). Chicken production stimulates local economic development of urban centers through the development of related micro-enterprises wholly or partly responsible for the provision of inputs and processing, packaging and marketing of outputs as well as the provision of services to the sector (LMAC, 2013). In addition, it may contribute to

poverty alleviation and socioeconomic inclusion of vulnerable groups and the unemployed to provide them with a decent livelihood (Gororo and Mabel, 2016).

According to preliminary survey conducted in urban and rural areas of Bishoftu, small scale chicken producers are constrained by poor access to markets, goods and services; they also have weak institutions and lack skills, knowledge and appropriate technologies (Sonaiya and Swan, 2004). They are also complaining over the high cost of commercially available broiler rations that is also addressed by EIAR (2016); and the cost of commercially available broiler rations are increasing from time to time even when the price of the major feed ingredients is decreasing. Feed processors and producers are not considering seasonal and regional variation in the price of feed ingredients, and also attention is not given to the least cost formulation of broiler rations (Tadelle *et al*., 2007). However, adapted exotic broiler breeds like Cobb500 chickens, local feed resources and appropriate vaccines are available, along with proven technologies that can substantially improve productivity and income generation (Sonaiya and Swan, 2004). Alternatively, the use of homemade ration prepared from readily available, local and cheap feed ingredients have great potential to increase broiler production (Lukuyu *et al*., 2011). Hence, evaluation of chicken production systems and effect of homemade ration on growth and carcass characteristics of Cobb500 broiler chicken in Bishoftu was conducted to achieve the above mentioned problems with the following specific objectives:

- To assess chicken production systems in urban and rural areas of Bishoftu
- To evaluate the effect of homemade ration on growth and carcass characteristics of Cobb500 broiler chicken.
- To evaluate the effect of homemade ration on the economics of Cobb500 broiler chicken through employing partial budget analysis.

# 2. REVIEW OF LITERATURE

## 2.1. Chicken Production Systems

Chickens can be reared in different management and production systems. Based on chicken breed type, input and output level, mortality rate, type of producer, purpose of production, length of broodiness, growth rate and number of chicken reared. These are free-range production system, semi-intensive production system and intensive production system (Yenesew *et al*., 2015)

### 2.1.1. Free-range chicken production system

This chicken production system is practiced in most rural areas of the country and objectives of production are for household consumption and as source of additional income for the household. It covers 95-98% of the chicken production system of the country and it is not profitable since it is not market oriented. It contains small flock sizes (5-20 chickens per household) which are indigenous breed types mostly depend on locally available feed material as supplement with low health services and other management practices. The chicken does not have their own constructed chicken house rather maintained in the main house with the family. Chicken brooding and rearing is only the care they obtain form their mother/hen. Because of these there is high mortality of chicken and long broody periods and there is risk of exposure for different chicken diseases and predators. The major feed sources for chicken are worms obtained from free scavenging, legumes, cereals and sometimes there is supplemental feed during feed shortage. The amount given is small and do not fulfill their nutrient requirement. Because of this their productivity is low. Indigenous poultry breed in this system of production does not produce more than 60 eggs per hen per year (Tadelle, 1996; Alemu and Tadelle, 1997).

The advantages of free-range chicken production system include, the chickens are healthy since they exercise in the open air freely, there is minimal infection with parasites if

enough space is available, there is little or no labour input, the chickens in this type of production system help to limit the amount of rubbish in a productive way and the direct costs of the system are low. In contrast, free-range chicken production system is difficult to control and manage the chicken especially the young chicks are easily exposed for predators and unfavorable weather conditions, the chickens eat sown seed when looking for feed, a large percentage of the eggs can be lost as the laying hens are not accustomed to laying nests, high diseases transmission and occurrence of high death, chickens are less productive (Yenesew *et al*., 2015).

### 2.1.2. Semi-intensive chicken production system

This type of chicken production system is better than free ranging production system since it uses inputs like supplemental feed, water and vaccine. They are kept in fenced areas that have some type of shelter. The fence can be made from mesh wire or other materials and will not allow the chicken to escape above on it. The fenced area should be always clean and dry. It has a small house which accommodate laying nest and feeders which serves as chicken house for night time. The house has one or two side open door for easy movement of the chicken to the fenced area during the day time. Many producers have specialized in meat or egg production and hence have an interest in improved chicken. In addition, mortality and loss rates are relatively low compared with other systems, since the risks of predation, theft and loss caused by poor nutrition are much lower strains. Since the feeds the chickens obtain from the scavenging is very low, they should be supplemented with energy and protein feeds. Since the main objective of the production is to get profit, they should get better health management practice like vaccination against Newcastle disease than free scavenging system. They are more productive than the chicken in free scavenging system. When chicken production intensifies, it moves from being a small scale activity to medium scale, women's involvement decreases while that of men increases (Mathias, 2004).

The advantage of this system include, complete control over operation, useful for record purposes, operational throughout the year, economic use of land (free range) and there is

better protection during winter while the disadvantage of this system is the high cost in fencing, danger of over stocking and exposure for different disease if the compass is not clean and dry.

### 2.1.3. Intensive chicken production system

This type of chicken production system use more inputs (feeds and feeding, breed, health, housing and other inputs) than the above two chicken production systems. It is market oriented and the main objective of production is to get better profit. The number of chickens involved are relatively high (more than 200 chicken). The chicken breed used is specialized improved breeds (layer or broiler). They should provide the expected product within that time. There are three types of intensive chicken production systems which include deep litter system, cage system and full slated rearing (Yenesew *et al*., 2015).

Deep litter system involves rearing of chickens on a floor littered by 5-10 cm thickness litter. The litter can be made from locally available material such as dry hay, teff straw, coffee pulp and sow dust. The litter should be dry at any time otherwise it can cause occurrence of different disease. In addition to provision of comfort for the chicken, the litter absorbs any waste material excreted from the chicken and makes the house dry. It is possible to place the feeders and drinkers in the house on the litter. But it is advisable to hang them as the age of the chickens increase. It is also important to place laying nest in the house. In this way it is possible to rear either layer or broiler. At least once a week, the litter should be sprayed with disinfectant chemicals. Deep litter is recommended for both meat birds and layers (Yenesew *et al*., 2015).

The advantages of the system included proper accommodation, prompt culling of unproductive birds, proper control of diseases and predators, good record keeping and high egg production. It has also advantageous in that land requirement is minimum, easy and economic management, scientific feeding and management, high degree of supervision, minimum labour, automation is possible and manure value is increased. Deep litter is a good insulation. It protects chickens from cold weather, and during hot

seasons they can nestle into it and reach the cool floor below. Studies show that when all other factors are equal, layers produce more eggs on deep litter than in cage systems. Chickens can be brooded and kept through their productive lives in the same house. Deep litter allows the bird to dust itself against lice and other parasites. On the other hand, the disadvantages of this intensive system of chicken production include high capital investment, problem of cannibalism and diseases outbreak. If the management is bad, liberation and accumulation of ammonia, wet litter problem dirty eggs, disease problems may result. There is a greater chance of worm and tick infestation and coccidiosis (internal protozoan parasites) than with cages or raised floor systems. The deep-litter system is inappropriate for very humid areas (80-90% humidity) damp litter spreads diseases. The litter must be turned often, particularly in damp weather, and this requires more labour than other systems. Sometimes adequate litter is difficult to obtain (Yenesew et al., 2015).

### 2.2. Cobb500 Broiler Chickens

The Cobb500 broiler chickens are known to be flexible broilers that will respond with accelerated growth and breast yield using high amino acid level. The worldwide success of Cobb has provided considerable experience of the breeds in a wide range of situations such as hot and cold climates, controlled environment and open housing (CBMG, 2015). The historical development of the Cobb industry, and the feeding periods and nutrient requirements of Cobb500 broiler birds will be discussed in the following sub-headings.

### 2.3. Feed intake and Feeding periods of Cobb500 broiler chickens

The feed intake of birds can be affected by age, reproductive stage, ambient temperature, metabolic energy, energy to protein ratio, a feed structure, feeding space, the health of the chicks, water quantity and quality and housing system (Leeson and Summers, 2001). It is necessary to adjust the protein content of the feed in relation to changing the energy level (Leeson and Summers, 2001). Accordingly, broilers are fast growing and are efficient in

converting feed into meat, and they need both high energy and protein feeds for efficient utilization of nutrients (Ma'aza, 1981).

The feeding period of Cobb500 broiler is classified based on nutrient requirement into starter (0-10 days), grower (11-22 days), finisher[1] (23-42 days) and finisher[2] (43-60 days). The recommended feed structure during the starter phase is crumb; while pelleted feed is provided during the grower and finisher phases. The CP requirement of Cobb500 broiler ranges from 21-22%, 19-20%, 18-19%, and 17-18% while the ME requirement is 3008, 3086, 3167 and 3191 kcal/kg during the starter, grower, finisher[1] and finisher[2], respectively (CBMG, 2015).

### 2.5. Nutrient Requirement of Broilers

#### 2.5.1. Energy Requirement of Cobb500 Chickens

Energy is not a nutrient but a property of energy-yielding nutrients when they are oxidized during metabolism (NRC, 1994). Energy is produced when the feed is digested in the gastrointestinal tract. The energy is then either released as heat or is trapped chemically and absorbed into the body for metabolic purposes. It can be derived from protein, fat or carbohydrate in the diet. In general, cereals and fats provide most of the energy in the diet. Energy in excess of the requirement is converted to fat and stored in the body. The provision of energy accounts for the greatest percentage of feed costs. More accurate measures of useful energy contained in feedstuffs are ME (Robert, 2008).

The daily energy requirements of growing birds are highly variable depending on the variation of body weight of birds, environmental temperature, amounts of bird's activity, the prevalence of stress, the age of the bird and amount of feather cover. The only compensating fact in overcoming the above variation is that each bird is able to govern its feed intake according to energy need (North, 1984).

### 2.5.2. Protein and amino acid requirements

Protein is one of the most expensive nutrients in chicken's ration. The variation in protein requirements may be due to differences in breed, environmental conditions and also due to differences in age, body size and egg weight among birds and energy contents of the diets (Leeson and Summers, 2001). Nevertheless, the quantity of feed consumed is essentially controlled by energy concentration and the requirement of chicks for protein to achieve maximum growth increases as the density of dietary energy increases. If energy is limiting, the dietary protein was used inefficiently since it was used as another source of energy instead of being converted into body protein (Miller, 2004). Alternatively, it could adopt a compromise by changing the size, number and composition of the egg laid (Adnan, 1988). Therefore, it is necessary to provide adequate protein and amino acids for normal growth to physiological maturity in order to provide with health and tissue reserves needed for maximum production through the subsequent stages of productive life (Leeson and Summers, 2001).

### 2.5.3. Vitamin requirements

Vitamins play a vital role in enzyme systems and natural diseases resistance of chicken. They are needed in very small quantities, but very essential to sustain life. Vitamin deficiency can lead to serious body disorders of chicks. Natural vitamins are found in young and green plants, seeds and insects. In commercial chicken production, most vitamins can be purchased in a synthetic form and added to feed as a premix. Without extra vitamins, rations cannot be balanced enough to support high productivity of chicks (Wiseman, 1994).

Vitamins A, D and E supplements will prevent the deficiency diseases, reduce stress and mortality rate (Sahin *et al*., 2001; Swain and Johri, 2000; Wijtten *et al*., 2010). Supplementation of protein and vitamins A, D and E with other feed increases feed intake, total digestibility and feed conversion ratio resulting an increase in daily weight

gain as well as significantly increase growth rate of broiler which helps early gain of marketing age that is very important for profitable farming (Odunsi *et al*., 1999).

### 2.5.4. Mineral requirements

Minerals make up a small portion of an animal's diet; however, they play an important role in health, growth, and reproduction. The minerals, calcium, and phosphorus are the major mineral constituents of bone. Animals' calcium requirements cannot be considered independently of phosphorus. Calcium plays an important role in muscle function, whereas phosphorus is key to major metabolic functions throughout the body in terms of carbohydrate, protein and fat metabolism, and nerve and muscle function (Ward and Lardy, 2005). Both calcium and phosphorus are primarily added to the structure and maintenance of the chicken bones and eggshell. The skeleton accounts for about 99% of the calcium and 80% of the phosphorus in the body. The two minerals interact with each other, both before and after their absorption from the digestive tract (McAinsh and Riise, 2005).

Calcium and phosphorus requirements in birds are influenced by the amount of vitamin D in the diet and increased as the level of vitamin D decreased and vice versa. For growing birds, the ratio of calcium and phosphorus should be between 1:1 and 2:1 (Sonaiya and Swan, 2004). On the other hand, sodium and chloride work together to maintain cellular volume, pH and osmolarity balance of body fluids. Sodium chloride promotes water intake (Ward and Lardy, 2005).

## 2.6. The Common Chicken Feed Ingredients in Bishoftu

### 2.6.1. Maize (*Zea mays*) grain

Maize is the popular cereal used in combination with soybean meal, noug seed cake and wheat short to formulate compounded chicken feed. It is a cheap form of starch and is a major energy source for animal feed (Macrae *et al.*, 1993). Maize is the most preferred

energy source due to its high energy, low fiber, better palatability, the presence of pigments and essential fatty acids. However, the protein content of the traditional maize grain is low compared to other cereals (NRC, 1994). On the other hand, one of the benefits of using yellow maize in chicken diets is that birds are attracted to the yellow color of the grain. It should be ground medium to medium-fine for use in mash diets and fine for inclusion in pelleted diets. The grain should be mixed into feed immediately after grinding since it is likely to become rancid during storage (Blair, 2008). Maize grain according to Wubu (2011) is composed of 86.4% DM, 8.9% CP, 1.6% CF, 1.8% Ash, 5.4% EE, 0.05% Ca and 0.33% P and 4024.2% kcal/kg DM. According to Brazilian Tables for chicken and swine maize grain can be included in the ration of starter and grower with optimum inclusion level up to a value of 65% (Rostagno *et al.*, 2005).

### 2.6.2. Noug seed (*Guizotia abyssinica*) cake

Noug seed cake is a by-product of oil processing from noug seed which is commonly grown in Ethiopia. The total land coverage of noug seed cultivation in Ethiopia is about 358,828 hectares. From these hectares about 84,802.3 tons of noug seed is produced and an estimated amount of 19,000 tons of noug seed cake is produced annually (Moghaddam, 2005). The supplementary feed value of noug seed cake depends on the oil contents of the cake and is therefore influenced by the degree of oil extraction technology and efficiency (Alemu, 1981).

Noug seed cake is good sources of quality protein supplement that contribute greatly to the improvements of animal performances (Zewdu, 2005). According to Wubu (2011), noug seed cake is composed of 92.9% DM, 31.6% CP, 14.7% CF, 10.2% Ash, 6.7% Ca, 0.83% P and 2596 kcal/kg ME.

### 2.6.3. Soybean (*Glycine max*) meal

Soybean meal is perhaps the only common protein supplement that is typically included in chicken rations with no limitation as to the quantity used. When properly toasted to

denature the trypsin inhibitors, there are no anti-nutritive factors to consider when formulating diets. With the single exception of methionine, soybean meal is an almost ideal protein supplement for all types of chicken. When blended with maize or grain sorghum, soybean meal provides a good balance of all the essential amino acids needed by chicken except for methionine. Soybean meal dominates the market for protein supplements for chicken. There are a number of reasons for this, including its consistency in nutrient content, its ready availability year-round, and its high content of CP. Because chicken producers desire high-energy diets, soybean meal is a superior value because no other common plant protein feedstuff exceeds soybean meal in CP content. Soybean meal matches or exceeds all other common plant proteins in both total and digestible amino acid content (Waldroup, 2002). Soybean under Ethiopian condition is reported to contain 94.4% DM, 36.7% CP, 5.6% CF, 6.1% Ash, 18.2% EE, 0.25% Ca, 0.74% P and 4193 kcal/kg ME per DM (Wubu, 2011). According to Brazilian Tables for chicken and swine soybean meal (48%) can be included in the ration of starter, grower and layer with a value of 35% for starter and grower; and 30% for layers (Rostagno *et al.*, 2005).

### 2.6.4. Wheat middlings

Wheat middlings consists of fine particles of wheat bran, wheat shorts, wheat germ, wheat flour and some of the offal from the ‘tail of the mill’. This mixture of shorts and germ is the most common by-product of flour mills. It must be obtained in the usual process of commercial milling and must contain less than or equals to 95 g/kg CF. The name "middlings" derives from the fact that this by-product is somewhere in the middle of flour on one hand and bran on the other. This by-product is known as pollards in Europe and Australia. The composition and quality of middlings vary greatly due to the proportions of fractions included, and also the number of screenings added and the fineness of grind. On average wheat middlings are composed of 896 g/kg DM, 162 g/kg CP, 1.2 g/kg Ca, 9.7 g/kg P and 369 g/kg NDF; and 6.6 g/kg lysine, 1.9 g/kg tryptophan, 5.4 g/kg threonine, 2.5 g/kg methionine, 3.4 g/kg cystine, 5.0 g/kg isoleucine, 7.3 g/kg valine and 0.53 mg/kg selenium  The variation in nutrient composition was especially high for Ca (0.8–3.0 g/kg) and selenium (0.05–1.07 mg/ kg). Heavy middlings with a

higher bulk density greater than or equals to 335 g/liter had a greater proportion of flour attached to the bran and is lower in CP, lysine, P, and NDF than light middlings which is less than or equals to 310 g/liter (Blair, 2008).

Wheat middlings is used commonly in chicken diets in countries such as Australia, as a partial replacement for grain and protein supplement in diets for laying and breeding stock when it can be included at levels up to 450 g/kg (Bai *et al.*, 1992). However, lower levels are more usual. Wheat middlings could be included at up to 430 g/kg in the diet of White Leghorn laying hens without effect on productivity (Patterson *et al.*, 1988). However, at that level of dietary inclusion feed intake was higher and feed conversion efficiency lower than in hens fed a control diet, unless the diet was supplemented with 50 g/kg fat. Dietary inclusion of 250 g/kg middlings resulted in egg production and feed intake similar to those from hens given a conventional diet. According to Brazilian Tables for chicken and swine wheat bran-middlings can be included in the ration of starter (from 3 to 10), grower (from 5 to 15) and layer (from 6 to 15) (Rostagno *et al.*, 2005).

# 3. MATERIALS AND METHODS

## 3.1. Description of the Study Area

The study had two phases. These were survey and feeding experiment. The survey was undertaken in urban and rural areas of Bishoftu from May to July, 2018; while the feeding experiment was conducted in the chicken house located at Bishoftu college of Veterinary Medicine and Agriculture from July to August, 2018. The study area is located in the central highlands of Ethiopia, 9° North latitude and 40° East longitude. The town is located in tepid to cool sub-moist mid highland with moderate weather condition. It is located about 47 km southeast of Addis Ababa. The area has an altitude of about 1800 m.a.s.l., with an average annual rainfall of 1152 mm of which 85% falls down during the long rainy season that extends from June to September and short rainy season from March to May with an average rainfall of 800 mm. The average minimum and maximum temperature range from 8.5 to 30.7 ºC. The average relative humidity is 61.3% (CSA, 2004).

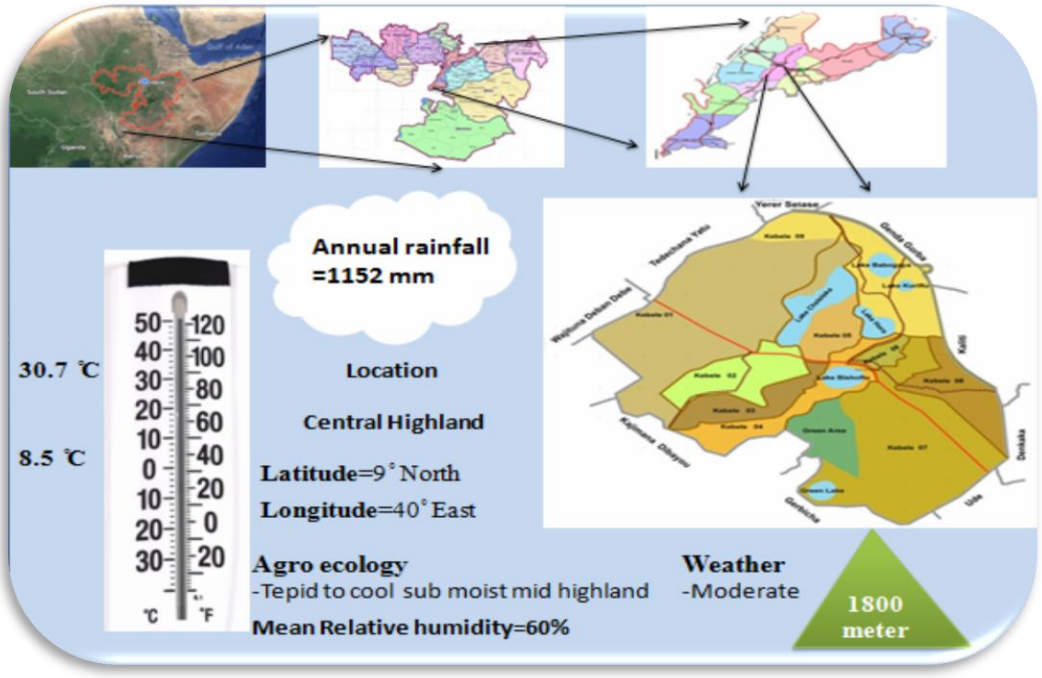


Figure 1. Geographical location of the study area

### 3.2. Data Collection Procedures

The survey was conducted considering all chicken producers in urban (Kebele 01, 03, 05, 07 and 09) and rural (Gorba, Gote and Kaliti) areas of Bishoftu. The total households included in the study were determined using the formula: $N=0.25/SE^2$; Where, N= Sample size, SE= Standard error (Arsham, 2002). A total of 312 chicken producers each 156 sample respondents were selected from urban and rural areas of Bishoftu, respectively. Both qualitative and quantitative data about chicken farmers were collected. The qualitative data include sex, educational level, marital status, chicken ownership status, chicken production systems, feed availability and utilization, disease prevention and control methods, egg incubation practices and chicken production constraints. On the other hand, quantitative data includes age, family size, flock size and egg production. The above-mentioned data were collected formally by means of pre-tested semi-structured open-ended and close-ended questionnaires. Based on availability, accessibility, quality and marketing price, local feeds were selected, analyzed chemically and ration was formulated.

### 3.3. Chemical Composition of the Feed Ingredients of Homemade Ration

The chemical composition of the feed ingredients of homemade ration is presented in Table 1. The feed ingredients included in the mix were maize grain, wheat middlings, soybean meal, noug seed cake, vitamin premix, calcium carbonate and salt. Before ration formulation the two feed ingredients namely maize grain and noug seed cake were hammer milled to 5 mm sieve size.

Table 1. Chemical composition of the feed ingredients of homemade ration

| Parameters | DM | CP (%DM) | CF (%DM) | EE (%DM) | Ash (%DM) | Ca (%DM) | ME * |
|---|---|---|---|---|---|---|---|
| Maize grain | 90.2 | 8.8 | 4.7 | 6.1 | 4.8 | 0.1 | 3479.7 |
| Soybean meal | 90.1 | 39.4 | 5.6 | 7.8 | 6.8 | 0.3 | 3481.8 |
| Wheat middlings | 90.4 | 16.3 | 7.9 | 4.4 | 4.7 | 0.2 | 3320.0 |
| Noug seed cake | 89.4 | 29.5 | 16.8 | 8.3 | 9.3 | 0.4 | 2059.0 |

DM=Dry Matter; CP=Crude Protein; CF=Crude Fiber; EE=Ether Extract; Ca=Calcium; ME=Metabolizable Energy; *=Given in Kcal/kg DM

### 3.4. Experimental design and treatments

A total of 120-day old Cobb500 broiler birds were purchased from Alema farm and randomly distributed to each replicate making up 15 per replicate and a total of 60-day-old chicks per treatment (Table 2).

Table 2. The arrangement of treatments on a completely randomized design

| Broiler strain | Treatments | Replications | | | |
|---|---|---|---|---|---|
| | | $R_1$ | $R_2$ | $R_3$ | $R_4$ |
| Cobb500 | $T_1$, commercial ration | $T_1R_1$ | $T_1R_2$ | $T_1R_3$ | $T_1R_4$ |
| | $T_2$, Homemade ration | $T_2R_1$ | $T_2R_2$ | $T_2R_3$ | $T_2R_4$ |

### 3.5. Chemical analysis of experimental feeds and ration

Before conducting the actual experiment and formulating experimental rations representative samples were taken from each of the feed ingredients. Then, the samples were subjected to the proximate method of A.O.A.C (1990) to determine DM, CP, CF, EE, and Mineral content. The nitrogen was determined by using Kjeldhal procedure and CP was computed by multiplying the nitrogen content by 6.25. Chemical analysis of the feed was made in duplicate. The ME value was determined indirectly following the method given by Wiseman (1987) as follow:

$$\text{ME (Kcal|kg DM)} = 3951 + 54.4\,\text{EE} - 88.7\text{CF} - 40.8\,\text{Ash}$$

The chemical composition of experimental rations is given in Table 3. The experimental rations were formulated based on nutrient requirement of Cobb500 with ME content of 3008 kcal/kg DM and CP content of 22% for the starter phase (1-10 days), ME content of 3086 kcal/kg DM and CP content of 19% for grower phase (11-22 days) and ME content of 3191 kcal/kg DM and CP content of 18% for the finisher phase (23-42 days) (WPSA, 1989).

Table 3. Chemical composition of experimental rations

| Parameters | DM | CP (%DM) | CF (%DM) | EE (%DM) | Ash (%DM) | Ca (%DM) | ME * |
|---|---|---|---|---|---|---|---|
| Homemade ration | | | | | | | |
| Starter | 90.6 | 22.0 | 8.2 | 6.9 | 6.8 | 0.5 | 3000.0 |
| Grower | 90.8 | 19.0 | 7.8 | 6.2 | 5.8 | 0.4 | 3085.0 |
| Finisher | 90.7 | 18.0 | 7.2 | 6 | 5.5 | 0.4 | 3166.8 |
| Commercial ration | | | | | | | |
| Starter | 90.8 | 22.0 | 5.9 | 7.2 | 6.9 | 0.9 | 3000.0 |
| Grower | 90.6 | 20.0 | 5.5 | 6.1 | 4.8 | 0.8 | 3150.0 |
| Finisher | 90.5 | 18.0 | 5.4 | 5.8 | 5.8 | 0.7 | 3250.0 |

DM=Dry Matter; CP=Crude Protein; CF=Crude Fiber; EE=Ether Extract; Ca=Calcium; ME=Metabolizable Energy; *=Given in Kcal/kg DM

### 3.6. Preparation of experimental house and equipment

In the beginning, the deep litter house and its compartments namely the roof, the wall, the floor and the pens were thoroughly cleaned using a broom and plenty of water. Grasses and herbaceous materials grew around the house were removed using the mower. After one day, the house was disinfected with locally available disinfectant called (Hi-7 "*alkyl-di-methyl-benzyl-ammonium-chloride, di-dectyl-di-methyl-ammonium-chloride, glyoxal, glutaraldehyde, formaldehyde, isopropanol and pine oil*"). The feeding materials and drinkers were also carefully cleaned and disinfected. The chicks were vaccinated against Newcastle (Thermostable, HB1) at day 2 and at day 7 (Lasota a booster dose) and

Infectious Bursa disease at the age of 10 days. The required brooding temperature was maintained using 200-watt electric bulbs/pen. Each pen was equipped with feeders, drinkers and covered with clean and disinfected dry teff straw to a depth of 5cm. Water was available to the birds all the times. Turning of litter and changing extremely wet litter with clean and dry teff straw was carried out whenever required.

### 3.7. Measurements and Observations

#### 3.7.1. Feed intake

The measured amount of feed was offered twice a day at 08:00 AM and 05:00 PM hours on *ad libitum* base throughout the experimental period. Feed refused from each pen was collected the next morning before the daily offer is given. The feed offered and refused was recorded for each pen. The amount of feed consumed was determined as the difference between the feed offered and refused. The difference between the daily feed offered and refused was divided by the number of birds' present and experimental period to calculate the mean daily feed intake of each bird.

$$\text{Average daily feed intake (g)} = \frac{\text{Daily feed offered (g)} - \text{Daily feed refused(g)}}{\text{Number of birds present} \times \text{Experimental days}}$$

#### 3.7.2. Body weight measurements

The chicks were weighed per replicate on the first day after being randomly assigned to respective pens by sensitive balance and the weight per chick was calculated as the mean weights of chicks in the pen and recorded to form the initial body weight. Final body weight was taken at the end of the experiment and recorded. Body weight gain per pen per chick was determined as the difference between the final and initial body weight. Average daily body weight gain per chick for each pen was computed by dividing total body weight gain per pen to the number of experimental days.

$$\text{Average daily body weight gain (g)} = \frac{\text{Total body weight gain per pen (g)}}{\text{No of experimental days (42 days)}}$$

### 3.7.3. Feed conversion ratio

The feed conversion ratio (FCR) was determined by dividing average daily feed intake with average daily body weight gain.

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Average daily feed intake (g)}}{\text{Average daily body weight gain (g)}}$$

### 3.7.4. Carcass measurements

At the end of the experiment, 2 randomly selected birds per pen were starved for eight hours, weighed immediately before slaughter and the blood exsanguinated by severing their neck. After slaughtering, the birds were de-feathered by hand plucking and all inedible (viscera, head and shank) body parts were removed and the carcass was weighed. The carcass percentage was determined using the following equation:

$$\text{Carcass percentage (\%)} = \frac{\text{Carcass weight (g)}}{\text{Slaughter weight (g)}} \times 100$$

### 3.7.5. Measurements of proportion of body cuts

The percentage of a particular body cuts breast, back, leg, keel, wing, neck, gizzard, heart, liver and skin were separated from inedible body parts and weighed individually, and their percentage was determined by dividing their respective weight by carcass weight multiplied by 100.

$$\text{Body cuts (\%)} = \frac{\text{Weight of individual body cuts (g)}}{\text{Carcass weight (g)}} \times 100$$

### 3.7.6. Ranking of chicken production constraints

Chicken production constraints were ranked using the formula adopted from Kosgey (2004) and the variable with the highest index value is the highest economically important.

**Index**

$$= \frac{\sum[(\text{n} \times \text{no of p 1st}) + (\text{n} - 1 \times \text{no of p 2nd}) + \cdots + (1 \times \text{no of p last})]}{\sum[(\text{n} \times \text{no of p 1st}) + (\text{n} - 1 \times \text{no of p 2nd}) + \cdots + (1 \times \text{no of p last})] \text{ for all factors}}$$

Where p=problem n=value given for the least ranked factor; no=number

### 3.7.7. Partial budget analysis

The partial budget analysis of feeding homemade ration was determined by employing partial budget analysis. Partial budgeting is a method of organizing experimental data and information about the cost and benefits from some change in the technologies being used on the farm. The aim is to estimate the change that will occur in farm profit or loss from some change in the farm plan (ESAP, 2002).

The profitability of feeding homemade ration was determined based on costs incurred during processing the ration, the purchasing price of commercial ration and market price of Cobb500 broiler. The costs incurred during processing homemade ration and purchasing price of commercial ration were the total variable costs and the selling price of broilers was the total return. The net income (NI) was calculated by subtracting the total variable cost from the total return (Upton, 1979):

$$\text{NI} = \text{Total income} - \text{Total variable cost}$$

The change in net income ($\Delta\text{NI}$) was calculated as the difference between the change in total income and the change in total variable cost (Upton, 1979):

$$\Delta NI = \text{Change in total income} - \text{Change in total variable cost}$$

The marginal rate of return (MRR) which measures the increase in net return associated with each additional unit of expenditure was computed using the equation developed by (Upton, 1979):

$$MRR = \frac{\text{Change in net income } (\Delta NI)}{\text{Change in total variable cost } (\Delta TVC)}$$

### 3.8. Statistical Analysis

The data collected during the study were subjected to statistical analysis using statistical package for social science (SPSS, 2015). During data analysis, qualitative data were analyzed using statistical package for social sciences and quantitative data were analyzed using statistical analysis software. The effect of homemade ration on Cobb500 broiler was evaluated using independent samples t-test procedure. The independent samples t-test compares the means of two groups with a constant while the t-test algorithm was used to test for equality of means. The model used was:

$$Y_{ij}=\mu+T_i+e_{ij}$$

Where: Yij = the response variable; Ti = Treatment effect;

μ = Over all mean; eij =Random error

# 4. RESULTS

## 4.1. Evaluation of Chicken Production Systems in the study areas

The chicken production systems in urban and rural areas of Bishoftu are presented in Table 4. The present findings indicated the major chicken production system in urban areas is dominated by small scale private chicken production system whereas traditional chicken production system was practiced under the rural areas accounting for 96.2% and 98.1% of the production system, respectively.

Table 4. Chicken production systems in urban and rural areas of Bishoftu

| Chicken production systems | Urban<br>N (%) | Rural<br>N (%) |
|---|---|---|
| Large scale chicken production system | 6 (3.8) | - |
| Small scale chicken production system | 150 (96.2) | 3 (1.9) |
| Traditional chicken production system | - | 153 (98.1) |

### 4.1.1. Socioeconomic status of chicken producers

The socioeconomic status of chicken producers in urban and rural areas of Bishoftu is presented in Table 5. In urban areas of Bishoftu, larger percentages of chicken producers were males (69.2%), slightly more than half (53.8%) were married, and considerably higher percentages (90.6%) had attended primary, secondary and tertiary education; whereas in rural areas of Bishoftu to some extent more than half (50.6%) of chicken producers were males, 69.2% were married, and slightly more than half (57.0%) were illiterates. On the other hand, the average age of chicken producers in urban areas of Bishoftu was 33.2±11.0 years, ranging from 16 up to 65 years; whereas in rural areas was 37.1±1.033 years, ranging from 17 to 68 years.

Table 5. Socioeconomic status of chicken producers in urban and rural areas of Bishoftu

| Parameters | Urban N (%) | Rural N (%) |
|---|---|---|
| Age (in years) | | |
| Average | 33.2 | 37.1 |
| Range | 16-65 | 17-68 |
| Sex | | |
| Female | 48 (30.8) | 77 (49.4) |
| Male | 108 (69.2) | 79 (50.6) |
| Marital status | | |
| Married | 84 (53.8) | 108 (69.2) |
| Single | 72 (46.2) | 48 (30.8) |
| Education Levels | | |
| Illiterate | 15 (9.6) | 89 (57.1) |
| Primary school | 21 (13.5) | 44 (28.2) |
| Secondary school | 36 (23.1) | 17 (10.9) |
| Tertiary education | 84 (53.8) | 6 (3.8) |
| Overall literates | 141 (90.4) | 67 (42.9) |

### 4.1.2. Average flock size of chicken producers

The average flock size of chicken producers in urban and rural areas of Bishoftu is presented in Table 6. In urban the highest average flock size was recorded by hens which was 2380.9±1077.5 followed by pullets, chicks, cockerels and cocks, respectively. In rural areas of Bishoftu on average chicken producers kept 8.24±3.003 pullets.

Table 6. Average flock size of chicken producers in urban and rural Bishoftu

| Types of flocks | Urban (Mean±SD) | Rural (Mean±SD) |
|---|---|---|
| Chicks | 1293.5±655.4 | 3.92±0.485 |
| Cockerels | 1160.7±490.5 | 2.79±0.901 |
| Pullets | 2132.6±1052.3 | 8.24±3.003 |
| Hens | 2380.7±1077.5 | 5.40±0.311 |
| Cocks | 4.0±1.4 | 0.92±0.136 |

SD=Standard deviation

### 4.1.3. Chicken breeds, housing types and feed resource utilization

The types of chicken breeds in urban and rural areas of Bishoftu are presented in Table 7. In urban areas of Bishoftu, the most widely distributed layer breeds are Lowman's (37.2%) and Bovan's (19.2%). On the other hand, the major broiler breeds were Cobb500 (17.9%) and Ross308 (10.9%). In rural areas of Bishoftu Horro (98.7%) were the dominant chicken breeds.

Table 7. Types of chicken breeds in urban and rural areas of Bishoftu

| Types of chicken breeds | Urban N (%) | Rural N (%) |
|---|---|---|
| Lowman's brown | 58 (37.2) | - |
| Bovans brown | 30 (19.2) | - |
| Cobb500 | 28 (17.9) | - |
| Ross 308 | 17 (10.9) | - |
| Brown. Nick | 4 (2.6) | - |
| Rhode Island Red | 2 (1.3) | - |
| Horro (red, black or white) | 17 (10.9) | 154 (98.7) |
| Dominant Sussex | - | 2 (1.3) |

### 4.1.4. Housing and feed resource utilization of chicken producers

The housing and feed resource utilization of chicken producers is presented in Table 8. In urban areas of Bishoftu almost all chicken producers (98.0%) used a house confined with deep litter system whereas higher percentages of chicken producers (61.5%) in rural used perches. Larger percentages of chicken producers (94.2%) in urban provide supplementary feed to their chicken. Higher percentages of chicken producers (82.7%) in urban feed their chicken commercially available ration and only (17.3%) supplement homemade ration. Most of chicken producers (38.5%) in urban feed their chicken any time depending on the amount of feed available on the feeding trough, 36.5% feed their chicken three times per day, 25.0% feed their chicken two times per day. Higher percentages of chicken producers (32.1%) in rural areas feed their chickens twice per day while lower percentages (7.0%) feed their chickens once per day. Maize, wheat, wheat bran and scavenging feed sources were the major feed resources utilized in rural Bishoftu. Other feed resources utilized in rural areas were commercial feeds, chickpea, barley, *atela*, *enkuro*, *injera*.

Table 8. Housing and feed utilization among chicken producers in urban and rural Bishoftu

| Parameters | Urban N (%) | Rural N (%) |
|---|---|---|
| Housing system | | |
| Deep litter house | 153 (98.0) | 9 (5.8) |
| Cage house | 3 (2.0) | - |
| Kitchen | - | 25 (16.0) |
| Perches | - | 96 (61.5) |
| Separate house | - | 26 (16.7) |
| Feed resources | | |
| Scavenging | - | 36 (23.1) |
| Supplement | 147 (94.2) | 15 (9.6) |
| Commercial ration | 129 (82.7) | - |
| Homemade ration | 27 (17.3) | - |
| Feeding frequency | | |
| Once per day | - | 11 (7) |
| Twice per days | 39 (25.0) | 50 (32.1) |
| Thrice per day | 57 (36.5) | 37 (23.7) |
| Any time | 60 (38.5) | 22 (14.1) |

### 4.1.5. Egg incubation practices in urban and rural Bishoftu

Egg incubation practices in urban and rural Bishoftu is presented in Table 9. In urban Bishoftu larger percentages of chicken producers (95.5%) did not incubate their eggs. Majority of chicken producers (71.3%) in rural area of Bishoftu practiced hatching of chicks, out of which 61.7% practices natural incubation while 9.6% uses artificial incubation. Larger percentages (63.5%) of chicken producers in rural store their eggs for incubation for 15 days and incubation is mostly practiced during the dry season through natural means (86.5%).

Table 9. Egg incubation practices in rural areas of Bishoftu

| Parameters | Urban N (%) | Rural N (%) |
|---|---|---|
| Egg incubation status | | |
| Yes | 7 (4.5) | 114 (73.1) |
| No | 149 (95.5) | 42 (26.9) |
| Method of egg incubation | | |
| Natural | - | 135 (86.5) |
| Artificial | 7 (4.5) | 21 (13.5) |
| Selecting egg for incubation | | |
| Yes | 156 (100) | 99 (63.5) |
| No | - | 57 (36.5) |

The average number of eggs set for incubation, eggs hatched, chicks grew and dead in rural are presented in Table 10. On average in rural chicken producers set approximately 13.35 eggs for incubation and out of this value 10.27 chicks hatched and only 6.66 of the chicks grew and the other 3.61 chicks left dead.

Table 10. Average number of eggs incubated, hatched, chicks grew and died in urban and rural areas of Bishoftu

| Parameters | Urban (Mean±SE) | Rural (Mean±SE) |
|---|---|---|
| No of eggs incubated | - | 13.37±0.17 |
| No of eggs hatched | - | 10.27±0.251 |
| No of chicks grew | - | 6.66±0.257 |
| No of chicks dead | - | 3.61±0.211 |

SE=Standard error of the mean

### 4.1.6. Major constraints of chicken producers in urban and rural Bishoftu

The major constraints of chicken production in urban and rural Bishoftu are presented in Table 11 and 12. The major constraints of chicken producers in the present study area were sudden disease outbreak ($1^{st}$), high cost of commercial feed ($2^{nd}$), unavailability of day-old-chicks on demand ($3^{rd}$), market instability and poor sales ($4^{th}$), poor supply and quality of vaccine ($5^{th}$), cold season ($6^{th}$), unavailability of pullets on demand ($7^{th}$), labor cost ($8^{th}$), poor quality commercial feed ($9^{th}$), cost of rental house ($10^{th}$), poor supply of feed ingredients ($11^{th}$), interruption of electric supply ($12^{th}$), poor quality of day-old-chicks ($13^{th}$), suffocation during transportation ($14^{th}$), high cost of transportation ($15^{th}$), lack of rental house ($16^{th}$), rats ($17^{th}$), raccoons ($18^{th}$), snakes ($19^{th}$) and lack of water ($20^{th}$).

Table 11. Major constraints of chicken producers in urban Bishoftu

| Constraints | 1st | 2nd | 3rd | 4th | 5th | 6th | Index | Rank |
|---|---|---|---|---|---|---|---|---|
| Disease outbreak | 72 | 21 | 9 | 3 | 3 | - | 0.180 | 1 |
| High cost of commercial ration | 30 | 48 | 12 | 12 | 12 | 6 | 0.164 | 2 |
| Unavailability of day old chicks on demand | 15 | 9 | 39 | 9 | 3 | - | 0.099 | 3 |
| Market instability and poor sales | 12 | 9 | 12 | 24 | 18 | 6 | 0.085 | 4 |
| Poor supply and quality of vaccine | 3 | 3 | 9 | 21 | 33 | 27 | 0.069 | 5 |
| Cold season | 6 | 18 | 6 | 18 | 3 | - | 0.064 | 6 |
| Unavailability of pullets on demand | - | - | 30 | 15 | 9 | 3 | 0.057 | 7 |
| High cost of labor and management | - | 3 | 9 | 15 | 27 | 15 | 0.051 | 8 |
| Poor quality of commercial ration | 6 | 12 | 3 | 12 | 3 | 3 | 0.047 | 9 |
| High cost of rental house | 6 | 12 | 6 | 9 | - | 3 | 0.046 | 10 |
| Poor supply of feed ingredients | - | 9 | 12 | 9 | 3 | 3 | 0.040 | 11 |
| Interruption of electric supply | 6 | - | 6 | - | 3 | 3 | 0.017 | 12 |
| Poor quality of day-old chicks | - | 6 | - | 9 | - | - | 0.017 | 13 |
| Suffocation | - | 6 | - | - | - | 21 | 0.016 | 14 |
| High cost of transportation | - | - | - | - | 21 | 3 | 0.014 | 15 |
| Lack of rental house | - | - | - | - | 15 | - | 0.009 | 16 |
| Rats | - | - | - | - | 3 | 24 | 0.009 | 17 |
| Raccoons | - | - | 3 | - | - | 12 | 0.007 | 18 |
| Snakes | - | - | - | - | - | 21 | 0.006 | 19 |
| Lack of water | - | - | - | - | - | 6 | 0.002 | 20 |

Note: Values are given in number

The major constraints of chicken producers in the rural areas of Bishoftu are presented in Table 12. In rural, disease (1st), cats (2nd) and birds (3rd) were the three major constraints of chicken production.

Table 12. Major constraints of chicken production in rural Bishoftu

| Constraints | 1st | 2nd | 3rd | Index | Rank |
|---|---|---|---|---|---|
| Disease | 133 | 9 | 7 | 0.453 | 1 |
| Birds | 8 | 71 | 56 | 0.237 | 2 |
| Cats | - | 41 | 63 | 0.155 | 3 |
| Cold | 10 | 21 | 5 | 0.082 | 4 |
| Feed cost | 5 | 4 | - | 0.025 | 5 |
| Raccoons | - | 4 | 25 | 0.035 | 6 |
| Predators | - | 6 | - | 0.013 | 7 |

Note: Values are given in number

### 4.1.7. Disease prevention and control methods in urban and rural Bishoftu

The disease prevention and control methods in urban and rural Bishoftu are presented in Table 13. In urban Bishoftu almost all (92.8%) of chicken producers treated their chickens using veterinary drugs and 40.6% in rural Bishoftu used veterinary drugs.

Table 13. Disease prevention and control methods in urban and rural Bishoftu

| Methods applied | Urban<br>N (%) | Rural<br>N (%) |
|---|---|---|
| Veterinary drugs | 145 (92.8) | 63 (40.6) |
| Traditional medicine | 11 (7.2) | 52 (32.9) |
| Left their chickens untreated | - | 41 (26.5) |

## 4.2. Measurements and Observations

### 4.2.1. Feed intake

The feed intake of Cobb500 broiler fed commercial and homemade broiler ration is presented in Table 14. There is no significant difference (P>0.05) in the feed intake of

birds during the grower and finisher phases. However, significantly lower (P<0.01) feed intake was recorded in birds fed homemade ration during the starter (20.97 g) and entire phases (70.06 g), respectively.

Table 14. Feed intake of Cobb500 broiler during the different stages of growth

| Parameters | Commercial | Homemade | SEM | P-value | Sign. |
|---|---|---|---|---|---|
| Feed intake (g/bird) | | | | | |
| Starter | 23.03 | 20.97 | 0.478 | 0.005 | ** |
| Grower | 48.53 | 44.83 | 2.412 | 0.176 | ns |
| Finisher | 117.75 | 112.35 | 4.050 | 0.231 | ns |
| Entire | 76.73 | 70.06 | 1.734 | 0.008 | ** |

SEM=Standard Error of Mean; P=Probability; ns=non-significant at P>0.05; **=Significant at P<0.01; g=gram

### 4.2.2. Body weight gain

The body weight gain of Cobb500 broiler fed commercial and homemade broiler ration is presented in Table 15. There is no significant difference (P>0.05) in the initial and final body weight of birds between the treatments. Significantly lower (P<0.01) body weight was recorded in birds fed homemade ration during the starter phase, however, there is no significant difference (P>0.05) on average body weight during the grower, finisher and entire phase.

Table 15. Body weight gain of Cobb500 broiler during the different growth stages

| Body weight parameters | Commercial | Homemade | SEM | P-value | Sign. |
|---|---|---|---|---|---|
| IBW (g/bird/day) | 43.2 | 43.3 | 0.804 | 0.387 | ns |
| ABW (g/bird/day) | | | | | |
| Starter | 135.7 | 122.7 | 2.266 | 0.001 | ** |
| Grower | 611.2 | 582.3 | 14.312 | 0.09 | ns |
| Finisher | 1718.4 | 1599.6 | 93.314 | 0.25 | ns |
| Entire | 1025.2 | 957.3 | 47.681 | 0.204 | ns |
| FBW (g/bird/day) | 2877.0 | 2689.6 | 336.588 | 0.598 | ns |

IBW=Initial Body Weight; ABW=Average Body Weight; FBW=Final Body Weight; g=gram; SEM=Standard Error of Mean; P=Probability; ns=non-significant at P>0.05; **=Significant at P<0.01

### 4.2.3. Feed conversion ratio

The feed conversion ratio of Cobb500 broiler fed commercial and homemade ration is presented in Table 16. According to the findings of the present study, there is no significant difference (P>0.05) in the feed conversion ratio between birds fed commercial and homemade ration during the grower, finisher and entire phases. However, significantly lower (P<0.05) feed conversion ratio was obtained in birds fed homemade ration during the starter phase.

Table 16. Feed conversion ratio of Cobb500 broiler during the different growth stages

| Parameters | Commercial | Homemade | SEM | P-value | Sign. |
|---|---|---|---|---|---|
| FCR | | | | | |
| Starter | 1.7 | 1.9 | 0.045 | 0.013 | * |
| Grower | 1.4 | 0.9 | 0.226 | 0.076 | ns |
| Finisher | 1.6 | 1.5 | 0.069 | 0.158 | ns |
| Entire | 1.6 | 1.4 | 0.099 | 0.172 | ns |

FCR=Feed conversion ratio; SEM=Standard error of mean; P=Probability; *=Significant at P>0.05; ns=non-significant at P>0.05

### 4.2.4. Carcass measurements

The carcass measurements of Cobb500 broiler fed commercial and homemade ration is presented in Table 17. According to the findings of the present study, there is no significant difference (P>0.05) on the slaughter weight, carcass weight and weight of individual carcass cuts of Cobb500 broiler fed commercial and homemade ration.

Table 17. Carcass characteristics of Cobb500 broiler birds at the age of 42 days

| Parameters | Commercial g (%) | Homemade g (%) | SEM | P-value | Sign. |
|---|---|---|---|---|---|
| Slaughter weight | 2404.4 (100) | 2283.9 (100) | 94.5 | 0.249 | ns |
| Carcass weight | 1849.0 ( 76.9) | 1765.5 (77.3) | 0.333 | 0.248 | ns |
| Wing | 91.0 (4.9) | 90.7 (5.1) | 1.941 | 0.895 | ns |
| Back | 179.7 (9.7) | 171.6 (9.7) | 6.396 | 0.251 | ns |
| Neck | 62.0 (3.4) | 58.8 (3.3) | 2.442 | 0.249 | ns |
| Leg | 428.1 (23.2) | 415.4 (23.5) | 10.356 | 0.266 | ns |
| Breast | 461.1 (24.9) | 434.3 (24.6) | 19.978 | 0.229 | ns |
| Gizzard | 74.5 (4.0) | 70.1 (4.0) | 3.242 | 0.228 | ns |
| Liver | 66.2 (3.6) | 63.2 (3.6) | 2.393 | 0.248 | ns |
| Heart | 14.5 (0.8) | 13.9 (0.8) | 0.397 | 0.146 | ns |
| Keel | 216.5 (11.7) | 205.7 (11.6) | 8.57 | 0.256 | ns |
| Skin | 255.2 (13.8) | 241.9 (13.7) | 0.057 | 0.216 | ns |
| Fat | 20.3 (1.1) | 15.9 (0.9) | 0.07 | 0.08 | ns |

NB: Values in brackets are in percentage; SEM=Standard error of mean; P=Probability; Sign. Significant; ns=Non-Significant at P>0.05

### 4.2.5. Partial budget analysis

The partial budget analysis of Cobb500 broiler fed commercial and homemade rations are presented in Table 18. The partial budget analysis indicated that the feed costs incurred in Cobb500 broiler chickens fed homemade ration is the cheapest (3035.4 birr) as compared to those fed commercial ration (5065.2 birr). The total and net income obtained in Cobb500 broiler birds fed homemade ration is higher as compared to those birds fed commercial ration

Table 18. The economics of Cobb500 broiler chickens fed the commercial and homemade ration at 42 days of age

| Parameters | Unit | Commercial | | | Homemade | | |
|---|---|---|---|---|---|---|---|
| | | Quantity | Unit cost | Total cost | Quantity | Unit cost | Total cost |
| Number of birds | No | 60 | - | - | 60 | - | - |
| Total cost | | | | | | | |
| Feed cost | Kg | 375.2 | 13.5 | 5065.2 | 348.9 | 8.7 | 3035.4 |
| Variable costs | Birr | - | - | 6354.0 | - | - | 6354.0 |
| Fixed costs | Birr | - | - | 5350.0 | - | - | 5350.0 |
| Total | Birr | - | - | 16769.2 | - | - | 14739.4 |
| Total income | | | | | | | |
| Broiler sale | No | 57.0 | 120.0 | 6840.0 | 58.0 | 120.0 | 6960.0 |
| Bag sale | No | 4.0 | 2.5 | 10.0 | 5.0 | 5.0 | 25.0 |
| Litter sale | Pack | 5.3 | 100.0 | 530.0 | 5.5 | 100.0 | 550.0 |
| Total | Birr | | | 7380.0 | | | 7535.0 |
| Net income | Birr | | | -10529.2 | | | -7204.4 |
| ΔTC | Birr | - | - | - | - | - | -2029.8 |
| ΔTI | Birr | - | - | - | - | - | 3324.8 |
| ΔNI | Birr | - | - | - | - | - | 3324.8 |
| MRR | Birr | - | - | - | - | - | 1.6 |

ΔTC =Change in Total cost; ΔTI =Change in Total income; ΔNI =Change in Net income; MRR=Marginal rate of return

# 5. DISCUSSION

## 5.1. Evaluation of Chicken Production Systems in Bishoftu

Small-scale private commercial chicken farms are the major chicken production system dominated in the urban areas of Bishoftu. The major reason in the expansion of this production system is due to suitability of the study area in that the presence of large-scale intensive private commercial farms like that of Alema, Genesis, Elfora and Friendship private limited agro industries. The other reason in the expansion of this type of chicken production system is due to availability and accessibility of commercial day-old chicks and pullets; and commercial feeds in the nearby area. On the other hand, the presence of agricultural institutions such as College of Veterinary Medicine and Agriculture (CVMA), Debrezeit Agricultural Research Center (DARC) and National Veterinary Institution (NVI). The other factor in the growth of such type of chicken production system is due to relocation of chicken producers from the Capital City, Addis Ababa. However, there is no as such expansion of small scale private farms in the rural areas of Bishoftu in that the major chicken production system in the study area is traditional chicken production system.

In agreement with the present findings in urban and rural areas, a study conducted on the socioeconomic characteristics of chicken producers in Bangui larger percentages of chicken production systems were possessed by males (Keita, 1999). In contrast, Desalew *et al*. (2013), Gueye (1998), Khandait *et al*. (2011) and Muchadeyi *et al*. (2007) found that approximately 80% of the chicken flocks in a number of African countries were owned and largely controlled by women. Unlikely, Halima (2007) also reported that rural women in North-West Ethiopia are more responsible for chicken rearing in both male and female headed households, while men are responsible for crop cultivation and other off-farm activities.

The average age of chicken producers (35 years) reported by a study conducted in Rwanda (Mbuza *et al*., 2016) was slightly higher than average age of 33 years recorded

in urban and lower than average age of 37 years recorded in rural. Contrary to the present result ages ranging from 20-40 years and 31-50 years were reported by Adebayo and Adeola (2005) and Bamiro *et al*. (2013), respectively. In the same way, ages ranging slightly lower than the study conducted in urban and rural areas were also reported by Mbuza *et al*. (2016).

According to the report of (Nebiyu *et al*., 2016) higher percentages of chicken producers under small scale intensive chicken production system in the study area were married which was in accordance with the present study conducted in the urban areas. Similarly, in line with the present study conducted in the rural areas majority of village chicken owners in Bure district were married (Fisseha *et al*., 2010). In contrast to the work done by Nebiyu *et al*. (2016) majority of chicken producers in the urban areas had attended primary, secondary and tertiary education. More than 50% of the chicken producers in the rural areas of the present study were illiterates which is supported by the study of Aschalew *et al*. (2014) who stated most of (58%) of the respondents in North Gonder were illiterates.

Majority of chicken producers in urban areas of Bishoftu had attended primary, secondary and tertiary education whereas Nebiyu *et al*. (2016) stated that highest number of poultry farmers were attended secondary education followed by those who did not attend formal education. In agreement with the current study in the urban areas, Wondu *et al*. (2013) stated that in Northern Gonder (Ethiopia) majority of flocks were dominated by chicks (47.0%). Similar to the present findings chicks and hens were the dominant flocks in Arbegona district. The relatively higher proportion of laying hens per chicken producers in the study area might be because of the interest of the farmers for increased egg production and using laying hens as parent-stocks for hatching as the sources of replacement. The number of cocks and cockerels were few which might indicate that all farmers don't rear cocks as they share a cock for breeding among neighbors (Feleke *et al*., 2015) or it may be because males are either sold in the market or consumed at home (Tadelle, 1996).

According to the report of Adebayo and Adeola (2005) broiler chicken ranging from 1000-3000 (2000) were recorded that was slightly lower than average flock size of 2380.9 hens obtained in urban areas of Bishoftu. The minimum flock size recorded under intensive chicken production system in Ethiopia were approximately 2500 specialized breeds (FAO, 2007). In contrast to the findings of Mbuza *et al*. (2016) in Rwanda and Feleke *et al*. (2015) in Arbegona on average chicken producers in urban areas kept approximately 8 pullets.

Deep litter house is the major housing system used under large and small scale intensive private commercial chicken production system in the urban areas. The system is inexpensive but labour intensive. On the other hand, in the rural areas larger percentages of chicken producers kept their chicken on perches that was during the night time. In contrast, Salo *et al*. (2016) who stated that 23.3% of chicken producers were reported using separate houses. Accordingly, housing systems in backyard system is rudimentary and mostly built with locally available materials (Solomon, 2007). In line with the present study in the rural areas, Moges *et al*. (2010) reported that in Bure district, North West Ethiopia, 77.9% of the village chicken owners provide only night shelter. On the contrary, another study by Mengesha *et al*. (2011) in Jamma district, South Wollo reported that 41.3% of chicken owners share the same room.

Commercial feeds were the major feed resources utilized in urban areas which was in agreement with the findings of Tadesse *et al*. (2017) who conducted his research in intensive chicken farms in Tigray (Ethiopia). With regard to feeding frequency, in contrast to the present study conducted in urban and rural areas majority of farmers (69.2%) provide feed to their chicken three times per day (Tadesse *et al*., 2017).

According to the report of Hassen *et al*. (2012), the most common cereal supplement used during the dry periods in Metema other than scavenging feed resources was entirely sorghum; on the other hand, in the rural areas the major feed resources utilized as a supplement under village chicken production system were maize grain, wheat grain and wheat bran whereas commercial feeds, chickpea, barley, *atela*, *enkuro*, *injera* were

supplementary feed resources other than the major ones. Similar to the present finding none of the respondents in Metema were aware of the nutritional requirements of chicken at a balanced level.

In the urban areas incubation is mostly practiced by large scale chicken producers, namely Alema, Genesis, Elfora, Elele, Friendship and Ethio private limited agro industries. This time the major private chicken farm known in providing day-old-chicks is Alema Farm. Samson and Endalewu (2010) reported that productive hens lay on average 10-18 eggs per clutch and 7-15 eggs were incubated using a broody hen from the incubated eggs 5-10 chicks hatched per clutch that was comparable with present study conducted in the rural areas. In line with the present study most chicken keepers in Eastern Gojjam (Ethiopia) had experience of selecting and incubating eggs for hatching using broody hens as a sole means of natural incubation (Melese and Melkamu, 2014). A study conducted in Jigjiga (Ethiopia) more than 60% of the house hold store eggs in cold environment until utilization which is in agreement with the present study in the rural areas (Abdo *et al*., 2016). According to the report of Samson and Endalewu (2010) in the majority of chicken producers in mid-rift valley of Oromia (Ethiopia) incubate their eggs not only during the dry season but also any time of the season which is disagreed with the current study conducted in the rural areas where incubation is practiced only during the dry season. In line with the present study dry season was the most preferred season for egg incubation (Ermias *et al*., 2015). The average number of eggs set for incubation, eggs hatched, chicks grew and dead in the rural areas were in accordance with the report of Melese and Melkamu (2014) where the average number of eggs set for incubation was 13 per broody hen, from which 83.0% were hatched and 67.0% were grown well.

The major constraints of chicken production in urban areas of Bishoftu namely high price of feed, unavailability of pullets on demand, feed quality, shortage of water, unavailability of feed in the nearby area, marketing difficulties during selling of chicken products and health constraint were also reported by Nebiyu *et al.* (2016) whereas shortage of land, high cost of pullets, lack of access to credit and inadequate training were not reported in the present study conducted in the urban areas. The first major

constraint, the sudden disease outbreak reported by chicken producers in the urban areas might be due to the poor quality of day-old-chicks. They are provided to the customers without being vaccinated. The other factors mentioned were the poor supply and quality of vaccine particularly Gumboro vaccine was reported to be one of the factor causing death to broiler chickens in the study areas. Poor disease prevention and control and the lack of knowledge, management skills and provision of feed, water and housing were identified as the major constraints of chicken production in the majority of chicken rearing regions of Ethiopia. The main causes of losses were identified as disease and predators (Meskerem, 2017; Reta, 2009). Transportation can also reduce the quality of day-old-chicks because of suffocation. Cut off or interruption of electricity supply especially in the morning and mid-night or during cold season were mentioned as a factor causing reduction in immunity of chickens and finally to the death of chickens. Lack of water in the urban areas was identified as a factor in reduced water intake of chickens causing dehydration and death. Lack of rental chicken houses followed by its expensiveness and unavailability of day-old-chicks or pullets on demand was the other major factors preventing sustainability of chicken production in the study areas.

The second major constraint, the high cost of commercial feeds is associated with the poor supply of feed ingredients in case of large scale intensive private commercial farms. The third major constraint, unavailability of day-old-chicks on demand is related with the high cost of labor management in case of large scale intensive private commercial farms. Among the private commercial feed manufacturers, Alema farm accounted for a largest share in the supply of formulated commercial broiler and layer feeds In line with the present study in urban areas according to the report of Nebiyu *et al.* (2016), the price of formulated commercial chicken feed was increasing from time to time due to the increment of ingredients purchasing price. Owing to the high price incurred in formulated feed, its quality and unavailability in the nearby area is becoming the main constraint faced by most of chicken producers of the study area. Nzietchueng (2008) also reported that most small-scale chicken farms obtain their feed from large scale intensive commercial farms. Similarly, Badubi and Ravindran (2004) reported that although there was considerable interest, on-farm mixing of feeds was not practiced owing to the

scarcity of raw materials and the lack of knowledge on proper feed formulation in the small scale layer production.

On the other hand, the major constraints of chicken production under an intensive system in Tigray (Ethiopia) collectively were lack of knowledge to prepare homemade ration, the price of homemade ration, unavailability of commercial feed in nearby area and unavailability and cost of feed ingredients (Nebiyu *et al*., 2016). In the rural areas of Benishangul Gumuz (Ethiopia) according to the report of Mekonnen *et al*. (2016), the major constraints of chicken producers were health constraint, shortage of feed, shelter, poor extension services, marketing constraints and predators. According to the report of Melese and Melkamu (2014) seasonal disease outbreak (100%) followed by predators (89%) was considered the largest threat to chicken production in Eastern Gojjam (Ethiopia) which was in agreement with the major constraints of chicken production traditional management system in rural areas of Bishoftu.

## 5.2. Effects of Homemade Ration on Growth and Carcass Characteristics of Cobb500 Broiler Chicken in Bishoftu

Significantly lower feed ($P<0.01$) intake obtained in broiler chickens fed homemade ration during the starter and entire phase might be associated with high inclusion level of noug seed cake in the diet making it unsuitable for chicken feeding which was in agreement with the findings of Aberra *et al*. (2018) although the inclusion level was within safe maximum. Cobb500 broiler were also reported to display a color preference for feed especially in the first few days of life (Graham, 2012), which might be in agreement with the present findings. Similarly, Ferket and Gernat (2006) reported that so many factors can influence feed intake, it is often difficult to correct a constraint of poor feed intake unless a complete review of feed is made.

Significantly lower ($P<0.01$) body weight recorded in broilers fed homemade ration during the starter and entire phase might be due to significantly lower feed intake recorded in these phases. Feed intake as the major factor that influence the body weight gain of broiler chicken was reported by Ferket and Gernat (2006).

Significantly lower ($P<0.05$) feed conversion ratio obtained in broiler chickens fed homemade ration during the starter phase is directly associated with the ratio between lower feed intake and higher body weight gain recorded in this phase. In contrast to the present study the average feed conversion ratio for growing chicks was varies from 2.03 to 2.28 (Pathak *et al*., 2015; Raman *et al*., 2010).

The partial budget analysis indicated that the higher income obtained in Cobb500 broiler chickens fed homemade ration in the present study was primarily due to the least price of feed ingredients used during ration formulation and also due to least cost formulation of ration. Vieira *et al*. (2012) also stated that economic returns will depend primarily on ingredient costs, the product mix being produced, and the price of products being sold. In the present study soybean meal is expensive as compared to other feed ingredients in the ration. According to the nutrient requirements of Cobb500 broiler birds so as to minimize the CP and ME content; and the cost of homemade ration, the cheapest feed ingredient or wheat middlings are replacing maize grain, soybean meal, and noug seed cake throughout the three growth stages, namely during the starter, grower and finisher phases. The result indicated that the price of 1 kg homemade ration is the cheapest as compared to commercial ration during the starter (10.10 birr), grower (8.87 birr) and finisher (8.67 birr) phases. There is 4.79 birr, 5.01 birr and 4.76 birr difference between homemade and commercial ration during the starter, grower and finisher phases, respectively.

# 6. CONCLUSIONS AND RECOMMENDATIONS

## 6.1. Conclusions

In the first phase of the study, the chicken production systems in urban and rural areas of Bishoftu were conducted beginning from May to July, 2018. During the study the major chicken production system identified in the urban areas was small-scale chicken production system whereas the major chicken production system in the rural areas was traditional chicken production system. A study on the socioeconomic characteristics of chicken producers indicated that majority of chicken producers were males and married in both urban and periurban areas. The average age of chicken producers in case of urban areas was approximately 33 years while in the rural areas was about 37 years. The age range was higher in case of rural areas as compared to urban. Majority of chicken producers in the urban areas were literates while most of the chicken producers in the rural were illiterates.

The highest average flock size in the urban areas was represented by hens while pullets the rural areas. Majority of small scale chicken production systems in the urban areas used deep litter houses for both broiler and layer production whereas in the rural areas chickens kept on perches during the night. Commercial feeds were the major supplementary feeds utilized in the urban areas while maize grain in the rural areas. Most of the chicken producers in urban areas fed their chicken any time but it depends on the amount of feed available on the feeding material whereas in the rural areas they fed twice on daily basis.

Egg incubation in the urban areas was mostly practiced by large scale intensive private commercial farms particularly Alema farm. Majority of chicken producers in the rural areas store eggs for incubation naturally using broody hens usually during the dry seasons. On average in the rural chicken producers set approximately 13 eggs for incubation and only about 7 chicks survive and grew into adult.

Disease outbreak is the major constraint reported by chicken producers in the urban and rural areas. The high cost of commercial feeds and unavailability of day-old chicks on demand were the second and third constraints reported by chicken producers in the urban areas. Predators such as cats and birds, on the other hand, were the other major constraints in the rural areas. In urban and rural areas chicken producers treat infected chickens using veterinary drugs.

In the second phase of the study effects of homemade ration on growth and carcass characteristics of Cobb500 broiler chicken was conducted in the chicken house located in the College of Veterinary Medicine and Agriculture beginning from July to August, 2018. Based on the results obtained from the feeding experiment significantly lower feed intake was recorded in broilers fed homemade ration during the starter and entire phase, respectively. Significantly lower body weight and feed conversion ratio was recorded in broilers fed homemade ration during the starter phase. The result also indicated that the feed costs incurred in broilers fed homemade ration is the cheapest as compared to those fed commercial ration. According to the partial budget analysis the net income obtained in broilers fed homemade ration is better than those fed commercial ration. Higher net income was obtained in broilers fed homemade ration, although there is no significant difference in the carcass characteristics between the treatments. Therefore, it can be concluded that homemade ration improved the net income without much impact on the body weight and carcass characteristics at the final day.

### 6.2. Recommendations

- Therefore, the author recommends chicken producers to use homemade ration in order to minimize feed cost and also to improve the net income and marginal rate of return without much impact on feed intake, body weight, feed conversion ratio and carcass characteristics at the finisher phase.

- Further research is needed on the effect of homemade ration formulated from locally available non-conventional feed ingredients on the growth and carcass

characteristics of broiler chickens and also on growth, egg production, quality, fertility and hatchability of layer chickens considering multiple breed effects and partial budget analysis.

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# 8. APPENDICES

## Appendix A. Published paper

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# Assessment of Chicken Production Status in Selected Periurban Areas of Bishoftu, Ethiopia

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**Abstract:** This survey was conducted to study assessment of chicken production status in selected periurban areas of Bishoftu, Ethiopia. 156 selected poultry producers were involved in the study from three randomly selected periurbans namely, Gorba, Gote and Kaliti. Except in Gorba and Gote, 76.9% of poultry producers in Kaliti were females. The mean age of poultry producers was 37.1±1.033 years while the mean family size was 2.4±0.213 children. On average 50.6%, 69.2% and 57.0% of poultry producers in periurban Bishoftu were males, married and illiterates. Maize, wheat and Frushika were the major feed resources in the three periurban areas followed by scavenging feed resources. Disease was the major cause to the death of chickens and cats and birds to the death of chicks.

**Key words:** Poultry · Chicken · Feed · Availability · Utilization · Bishoftu · Periurban · Ethiopia

## INTRODUCTION

Ethiopia is endowed with many livestock species with an estimated population of 56.7 million cattle, 29.33 million sheep, 29.11 goats, 56.87 million poultry, 2.03 million horses, 7.43 million donkeys, 0.4 million mules and 1.16 million camels [1]. Poultry or chickens in Ethiopia provide the following benefits: Production of eggs for hatching, sale and home consumption and production of birds for sale, sacrifice, replacement and home consumption [2]. Chickens have short generation interval and higher feed conversion efficiency, thus provide cheap source of animal protein and also chicken meat is the most palatable and easily digestible animal meat and contains essential amino acids required for human beings and eggs are richly endowed with nutrients [3]. They have also socio-cultural and religious role mainly in the rural community of Ethiopia [4]. However, the per capita consumption of chicken egg and meat (57 eggs and 2.85 kg meat) in Ethiopia is one of the lowest in the world. This is directly associated with social and religious taboos, for example according to the report of Mitiku [5] chickens are consumed mostly during holiday times after a long period of fasting. The productivity of poultry has been limited by scarcity and consequent high prices of the conventional protein and energy sources in Ethiopia. Poultry producers in Ethiopia are always complaining over the high cost and quality of poultry feed on the market. This necessitates investigations for conventional and non-conventional feed resources that are cheaper, locally available and have better nutritional value [6]. The price of raw materials varies according to source of supply and region. Little attention is given to the least cost formulation of rations. In many instances, the cost of mixed feed does not seem to follow reductions in ingredient cost. Prices of mixed feed remains unduly high even at times when the price of the major component of mixed rations fall by more than fifty percent [7]. Thus, the use of cheap and readily available local feed resources has great potential to increase poultry productivity [8].

## MATERIALS AND METHODS

**Description of the Study Areas:** The study was conducted in randomly selected periurban areas of Bishoftu. Bishoftu is found in the central highlands of Ethiopia, 8°45'N latitude and 38°59'E longitude. It is located about 45 km southeast of Addis Ababa. The area

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has an altitude of about 1900 meter above sea level, with average annual rainfall of 686.9 mm. The average minimum and maximum temperature ranges from 10.9 to 27.0°C with a mean value of 18.9°C. The average relative humidity is 60.0% [9].

**Design and Sampling Procedure:** The survey was conducted in periurban areas of Bishoftu and a total of 156 poultry producers were selected randomly from each periurbans, namely Gorba, Kaliti and Gote. The areas were selected randomly based on nearness to Bishoftu city. During the study, poultry producers who were willing to participate were considered.

**Methods of Data Collection:** Qualitative and quantitative data were collected and recorded using pre-tested semi-structured questionnaire with open-ended and close-ended questions.

**Data Analysis:** Data were analyzed using SPSS version 21 [10] while figures were organized using Microsoft Excel spreadsheet of window 10's edition.

## RESULTS AND DISCUSSION

**Socio-Economic Status of Chicken Producers:** The socio-economic status of poultry producers is presented in Table 1. On average, 50.6% of poultry producers in periurban Bishoftu were males was due to higher percentages of male poultry producers in Gorba and Gote. In contrast, Weyuma *et al*. [11] reported that 56.0% in Filtino, 57.5% in Dalota and 55.0% in Gote were females. However, 76.9% of poultry producers in Kaliti were females. The mean age of poultry producers was 37.1±1.033 (μ±SE), ranging from 17 to 68 years. In Rwanda, an average of 35 ± 11.2 years ranging from 17 to 52 years was reported by Mbuza *et al.* [12] that was a slightly lower than the present finding. On average, 69.2% of poultry producers in periurban were married that was because of higher percentages of married poultry producers in Gote and Gorba. Conversely, 55.8% of poultry producers in Kaliti were single. Higher percentages (57.0%) of poultry producers in periurban were illiterates followed by those who attended primary, secondary and tertiary school. Higher percentages (88.5%) of poultry producers in Kaliti were illiterates as compared to Gote and Gorba. Similarly, Aschalew *et al*. [13] stated that most (58.02%) of the respondents in North Gondar (Ethiopia) were illiterates. On the other hand, 38.5%, 21.2% and 11.5% of poultry producers in Gorba, Gote and Gorba were attended primary, secondary and tertiary school, respectively. The result also indicated that poultry producers in Kaliti were not attending secondary and tertiary education whereas in Gote they were not attending tertiary education.

**Livestock and Chicken Composition and Size:** Higher percentages (35.3%) of poultry producers in periurban did not kept livestock. However, 26.3%, 12.2% and 8.3% kept combination of cattle, sheep and donkeys, cattle and donkeys or cattle only; and small percentages were keeping combination of cattle and goats, cattle, goats and donkeys, cattle, sheep and goats, sheep and donkeys or cattle, sheep, goats and donkeys.

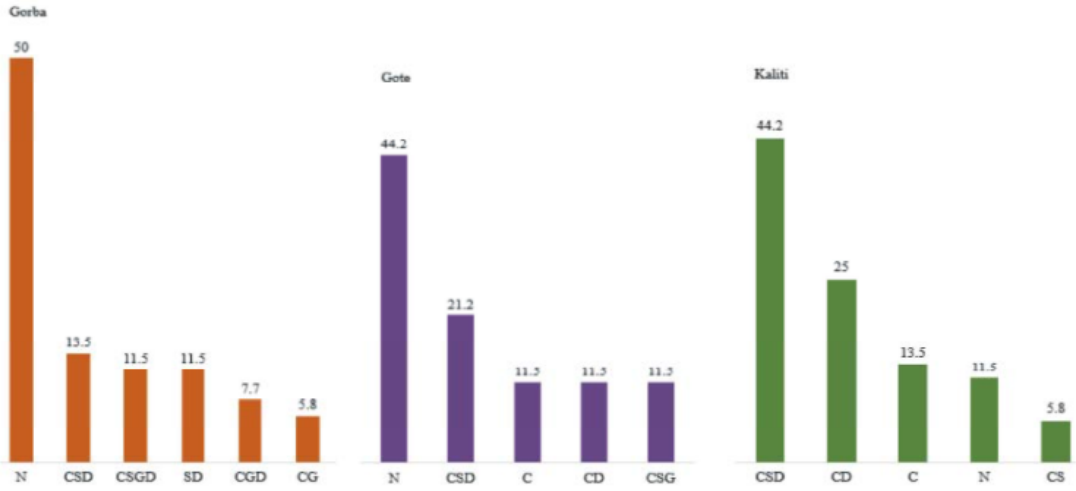
Poultry producers in Gorba (19.2%) and Gote (34.6%) dominantly kept chicks and hens while in Kaliti (57.7%) kept hens. Similarly, in Arbegona woreda, the dominant flocks were hens (42.4%), pullets (19.1%) and chicks (15.5%), followed by cocks and cockerels. The relatively higher proportion of laying hens per household in the study area might be because of the interest of the farmers for increased egg production and using laying hens as parent stocks for hatching as the sources of replacement. The number of cocks and cockerels were few which might indicate that all farmers don't rear cocks as they share cock for breeding among neighbors [14] or it may be because males are either sold in the market or consumed at home [15].

An average flock size of 41.92±9.420 was recorded in Gorba, which was greater than average flock size recorded in Gote and Kaliti. Considerably higher average flock size recorded and establishment of deep litter systems in Gorba showed significant improvement in poultry production system. Average flock size of 8.00 chickens [12] and 7.93 chickens [14] were reported in Rwanda and Arbegona, respectively.

**Poultry Housing, Feeding Methods and Frequency:** Housing, feeding methods and frequencies are presented in Table 1. Larger percentages of poultry producers, 75.0% in Gote, 65.4% in Kaliti, 44.5% in Gorba and 61.5% on average kept their chickens on perches and only 17.3% in Gorba kept their chickens in deep litter house. On average 16.7% of poultry producers in Gorba, Gote and Kaliti kept their chickens in a separately constructed poultry house while 23.3% of poultry producers were reported to kept their chickens in a separate house [16]. Larger percentages (96.2%) in Gote, 92.3% in Kaliti, 82.7% in Gorba and 90.4% on average allowed their chickens to scavenge. Similarly, in Lemo (Ethiopia), 90.0% of poultry

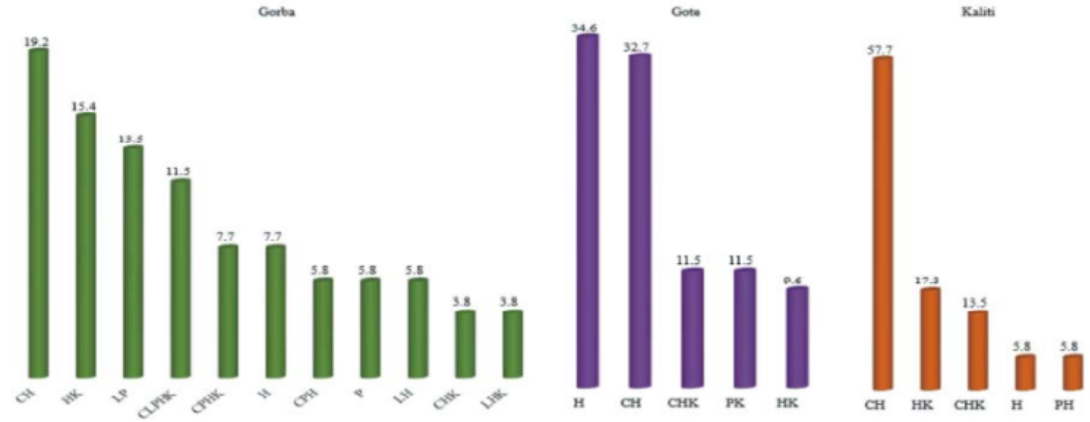
Table 1: Socio-economic status of poultry producers

| Parameters | Study areas | | | |
|---|---|---|---|---|
| | Gorba | Gote | Kaliti | Total |
| Sex (%) | | | | |
| Female | 38.5 | 32.7 | 76.9 | 49.4 |
| Male | 61.5 | 67.3 | 23.1 | 50.6 |
| Age (μ±SE) | 37.3±1.606 | 38.6±1.723 | 35.4±1.980 | 37.1±1.03 |
| Marital status (%) | | | | |
| Married | 75.0 | 88.5 | 44.2 | 69.2 |
| Single | 25.0 | 11.5 | 55.8 | 30.8 |
| Educational level (%) | | | | |
| Illiterate | 38.5 | 44.2 | 88.5 | 57.0 |
| Primary school | 38.5 | 34.6 | 11.0 | 28.2 |
| Secondary school | 11.5 | 21.2 | - | 10.9 |
| Tertiary school | 11.5 | - | - | 3.8 |
| Family size (μ±SE) | 2.0±0.310 | 3.4±0.296 | 1.9±0.446 | 2.4±0.213 |




where, C=Cattle; S=Sheep; G=Goats; and D=Donkeys

Fig. 1: Livestock composition and size of poultry producers (in %)




where, C=Chicks; L=Cockerels; P=Pullets; H=Hens; and K=Cocks

Fig. 2: Chicken composition and size of poultry producers (in %)

Table 2: Livestock and chicken structure (μ ± SE) in periurban areas of Bishoftu

| Types of Animals | Gorba (μ ± SE) | Gote (μ ± SE) | Kaliti (μ ± SE) | Total (μ ± SE) |
|---|---|---|---|---|
| Livestock | | | | |
| Cattle | 1.69±0.450 | 1.77±0.248 | 2.92±0.263 | 2.13±0.196 |
| Sheep | 0.96±0.205 | 1.75±0.360 | 1.92±0.306 | 1.54±0.174 |
| Goats | 0.38±0.110 | 0.23±0.098 | - | 0.21±0.50 |
| Donkeys | 0.92±0.194 | 1.92±0.534 | 1.40±0.176 | 1.42±0.200 |
| Total | 3.96±0.764 | 9.02±1.070 | 6.25±0.557 | 6.38±0.5060.506 |
| Chicken | | | | |
| Chicks | 3.60±0.848 | 4.60±1.091 | 3.56±0.474 | 3.92±0.485 |
| Cockerels | 8.37±2.546 | - | - | 2.79±0.901 |
| Pullets | 24.02±8.650 | 0.58±0.227 | 0.12±0.065 | 8.24±3.003 |
| Hens | 4.90±0.554 | 5.08±0.554 | 6.21±0.500 | 5.40±0.311 |
| Cocks | 1.04±0.207 | 0.67±0.182 | 1.06±0.303 | 0.92±0.136 |
| Total | 41.92±9.420 | 10.92±1.435 | 10.94±0.925 | 21.23±3.219 |

producers allow their chickens to scavenge and 95.6%, higher than the present finding, provide supplemental feed to their chickens [16]. Higher percentages (32.1%) of poultry producers fed their chickens twice per day while lower percentages (7.0%) fed their chickens once per day. However, according to the report of Tadesse *et al*. [17] under intensive poultry production system higher percentages (21.9%) of poultry producers provide supplemental feeds three times on daily basis whereas lower percentages (10%) fed their chickens twice per day.

Egg incubation status, methods, season and selection habit is presented in Table 1. All poultry producers in periurban Bishoftu store their eggs for incubation and incubate their eggs during the dry season through natural means using broody hens. In contrast, 54% of poultry producers in mid rift valley of Oromia incubate chicken egg at any time [19]. Larger percentages (13.5%) of poultry producers in Gorba, 29.5% in Gote, 20.5% in Kaliti and 63.5% on average select eggs for incubation. Similarly, Samson and Endalew [19] stated that more than half (61%) of the respondents in mid rift valley of Oromia (Ethiopia) identify spoiled eggs during incubation by sun candling (39%), shaking (33%) and putting in water (28%).

**Egg Incubation Practice:** Egg incubation status, methods, season and selection habit is presented in Table 1. All poultry producers in periurban Bishoftu store their eggs for incubation and incubate their eggs during the dry season through natural means using broody hens. Larger percentages of poultry producers in Gorba (13.5%), Gote (29.5%), Kaliti (20.5%) and on average (63.5%) select eggs for incubation.

Average number of eggs set for incubation, eggs hatched, chicks grew and dead is presented in Table 2. On average in periurban Bishoftu poultry producers set approximately 13.35 eggs for incubation and out of this value (76.9%) chicks hatched and only (64.8%) of the chicks grew and the other (35.2%) chicks left dead. Similarly, in Eastern Gojjam (Ethiopia), according to the report of Melese and Melkamu [20], the average number of eggs set for incubation was 13 per broody hen, from which relatively fair number (83.0%) of chicks were hatched and (67.0%) were grown well.

**Constraints of Chicken Production:** The constraint of chicken production is presented in Table 6. In Gorba, disease, cats, birds, feed cost, cold and raccoons were the first six constraints of chicken production. In Gote, disease, birds, cats, predators, cold, raccoons, dogs, transportation and feed cost are the first nine problems of chicken production while in Kaliti, disease, birds, cats, cold, raccoons, poor egg production, predators and dogs are the first nine constraints of chicken production. Disease was the first major problem in periurban Bishoftu. In Gorba, almost all (90.0%) used veterinary drugs to treat their chickens and some of them (10.0%) used miliya and hot pepper (*Capsicum frutescence*). In Gote, 30% of poultry producers treated their chickens using miliya, sensel and hot pepper and only 20% provided veterinary drugs to their chickens such as tetracycline while 50% of them do not treat their chickens. In Kaliti, 17.6% of poultry producers treated their chickens using miliya and hot pepper, 35.3% miliya, hot pepper and veterinary drugs, 5.9% treated their chickens using miliya, hot pepper, feto (Brassica species, *Lipdum sativum*) or ebecha, 11.8% treated their chickens using only veterinary drugs while 29.4% left their chickens untreated. In Gote and Kaliti, dogs were mentioned as a vector in transmission of poultry diseases. On the other hand, according to the report of Nega *et al*. [21] in periurban areas of Benishangul Gumuz the major constraints of poultry production were health problem, shortage of feed, shelter, poor extension services, marketing problems and predators.

Table 3: Poultry housing, feeding methods and frequency

| Parameters | Study Areas | | | Total |
|---|---|---|---|---|
| | Gorba | Gote | Kaliti | |
| Housing | | | | |
| Deep litter house | 17.3 | - | - | 5.8 |
| Kitchen | 23.1 | 19.2 | 5.8 | 16.0 |
| Perches | 44.2 | 75.0 | 65.4 | 61.5 |
| Portable/Separate house | 15.4 | 5.8 | 28.8 | 16.7 |
| Feeding resources | | | | [illegible] |
| Yes | 82.7 | 96.2 | 92.3 | 90.4 |
| No | 17.3 | 3.8 | 7.7 | 9.6 |
| Supplementation | | | | 0.0 |
| Yes | 80.8 | 71.2 | 78.8 | 76.9 |
| No | 19.2 | 28.8 | 21.2 | 23.1 |
| Feeding Frequency | | | | |
| Anytime | 11.5 | 9.6 | 21.2 | 14.1 |
| Once | 9.6 | - | 11.5 | 7.0 |
| Twice | 44.2 | 28.8 | 23.1 | 32.1 |
| Thrice | 15.4 | 32.7 | 23.1 | 23.7 |

Table 4: Available feed types and utilization

| Study areas | Feeds | 1st | 2nd | 3rd | 4th | 5th | Index | Rank |
|---|---|---|---|---|---|---|---|---|
| Gorba | Maize | 30 | 11 | - | - | - | 0.249 | 1 |
| | Wheat | 3 | 30 | 1 | 4 | 4 | 0.192 | 2 |
| | Frushika | - | - | 23 | 2 | - | 0.094 | 3 |
| | Scavenging | 10 | - | - | - | - | 0.064 | 4 |
| | Commercial ration | 9 | - | - | - | - | 0.058 | 5 |
| | Chickpea | - | 1 | 8 | 5 | 1 | 0.050 | 6 |
| | Barley | - | - | 1 | 12 | 6 | 0.042 | 7 |
| | Atela | - | - | 6 | 1 | 1 | 0.027 | 8 |
| | Enkuro | - | - | 2 | 5 | - | 0.021 | 9 |
| | Injera | - | - | 1 | 2 | 2 | 0.012 | 10 |
| | Sorghum | - | - | - | - | 2 | 0.003 | 11 |
| | Nougcake | - | - | - | - | 1 | 0.001 | 12 |
| Gote | Maize | 37 | 2 | - | - | - | 0.343 | 1 |
| | Wheat | - | 39 | 1 | 4 | - | 0.274 | 2 |
| | Frushika | - | - | 29 | 2 | - | 0.134 | 3 |
| | Scavenging | 15 | | | | - | 0.134 | 4 |
| | Chickpea | - | 1 | 4 | 5 | - | 0.036 | 5 |
| | Barley | - | - | 1 | 12 | - | 0.031 | 6 |
| | Atela | - | - | 4 | 1 | - | 0.020 | 7 |
| | Enkuro | - | - | 2 | 5 | - | 0.020 | 8 |
| | Injera | - | - | 1 | 2 | - | 0.009 | 9 |
| Kaliti | Maize | 33 | 8 | - | - | - | 0.336 | 1 |
| | Frushika | - | 16 | 29 | 2 | - | 0.233 | 2 |
| | Wheat | 8 | 20 | 1 | 4 | - | 0.211 | 3 |
| | Scavenging | 11 | - | - | - | - | 0.095 | 4 |
| | Barley | - | 3 | 1 | 12 | - | 0.050 | 5 |
| | Chickpea | - | - | 4 | 5 | - | 0.028 | 6 |
| | Atela | - | - | 4 | 1 | - | 0.019 | 7 |
| | Enkuro | - | - | 2 | 5 | - | 0.019 | 8 |
| | Injera | - | - | 1 | 2 | - | 0.009 | 9 |

Table 5: Egg incubation status, methods, season and selection habit

| Parameters | Gorba | Gote | Kaliti | Total |
|---|---|---|---|---|
| Egg incubation status | | | | |
| Yes | 8.3 | 33.3 | 31.4 | 73.1 |
| No | 25.0 | - | 1.9 | 26.9 |
| Method of egg incubation | | | | |
| Natural | 21.8 | 33.3 | 31.4 | 86.5 |
| Artificial | 11.5 | - | 1.9 | 13.5 |
| Season of egg incubation | | | | |
| Dry season | 21.8 | 33.3 | 31.4 | 86.5 |
| Rainy season | 11.5 | - | 1.9 | 13.5 |
| Selecting egg for incubation | | | | |
| Yes | 13.5 | 29.5 | 20.5 | 63.5 |
| No | 8.3 | 3.8 | 10.9 | 23.1 |

Table 6: Average number of eggs set for incubation, eggs hatched, chicks grew and dead

| Parameters | Gorba (μ±SE) | Gote (μ±SE) | Kaliti (μ±SE) | Total (μ±SE) |
|---|---|---|---|---|
| No of eggs set for incubation | 13.06±0.358 | 13.12±0.231 | 13.86±0.306 | 13.37±0.170 |
| No of eggs hatched | 9.71±0.548 | 10.23±0.234 | 10.71±0.519 | 10.27±0.251 |
| No of chicks grew | 6.00±0.552 | 7.27±0.374 | 6.47±0.435 | 6.66±0.257 |
| No of chicks dead | 3.77±0.482 | 2.96±0.226 | 4.24±0.390 | 3.61±0.211 |

Table 7: Major constraints of chicken production

| Study areas | Problems | 1st | 2nd | 3rd | Index | Rank |
|---|---|---|---|---|---|---|
| Gorba | Disease | 40 | 5 | | 0.417 | 1 |
| | Cats | | 25 | 11 | 0.196 | 2 |
| | Birds | | 14 | 19 | 0.151 | 3 |
| | Feed cost | 5 | 4 | | 0.074 | 4 |
| | Cold | 7 | | | 0.067 | 5 |
| Gote | Disease | 45 | 1 | 2 | 0.446 | 1 |
| | Birds | 5 | 29 | 14 | 0.279 | 2 |
| | Cats | | 13 | 20 | 0.147 | 3 |
| | Predators | | 6 | | 0.038 | 4 |
| | Cold | 2 | 2 | 1 | 0.035 | 5 |
| Kaliti | Disease | 48 | 3 | | 0.481 | 1 |
| | Birds | 1 | 28 | 13 | 0.231 | 2 |
| | Cats | | 3 | 19 | 0.080 | 3 |
| | Cold | | 11 | | 0.071 | 4 |
| | Raccoons | | 3 | 15 | 0.067 | 5 |
| | Poor production | 3 | | | 0.029 | 6 |
| | Predators | | 4 | | 0.026 | 7 |
| | Dogs | | | 4 | 0.013 | 8 |

## CONCLUSIONS

In general, the result indicated that most of the poultry producers in Kaliti were females, singles and illiterates; and some of them were not attending secondary and tertiary education while in Gote they were not attending tertiary education. On the other hand, relatively higher proportion of laying hens kept per household in Kaliti might be because of the interest of the farmers for increased egg production and using laying hens as parent stocks for hatching as the sources of replacement [14]. Considerably higher average flock size recorded and establishment of deep litter systems in Gorba showed significant improvement in poultry production and housing system. Higher percentages of poultry producers in Gote kept their chickens on perches. The result also indicated that advances in construction of separate poultry houses in the three periurban areas. In Gote, higher percentages of poultry producers allowed their chickens to scanvenge. Maize, wheat and frushika were the major feed resources utilized under the three periurban areas. Higher percentages of poultry producers in Gorba stored their eggs for incubation and incubate their eggs during the dry season through natural means

using broody hens. Disease was the first major problem in these periurban areas followed by birds and cats. In all periurban areas most of the time, poultry producers treated their chickens using miliya and hot pepper. Dogs were mentioned as a vector in transmission of poultry diseases in Gote and Kaliti.

**Recommendations:**

- In Gorba and Gote, female poultry producers should be encouraged to take part in poultry production.
- In addition to poultry production, poultry producers in Kaliti should be encouraged to attend both secondary and tertiary education whereas in Gote they should be encouraged to attend tertiary education
- Agricultural extension agents should train poultry producers in Gorba, Gote and Kaliti about poultry production system in terms of feed resource utilization, egg production and reproduction, disease prevention and control methods and in construction of safe and durable poultry houses or the different methods how to keep chickens.

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**Appendix B. Questioners Developed For Evaluation of Chicken Production System in Urban and Rural Areas of Bishoftu**

## I. Socio-economic characteristics of chicken producers

1. Name: _____ Date: _____ Place: _____
2. Sex: A) Male B) Female
3. Age: _____
4. Marital System: A) Single B) Married C) Other, please specify _____
5. Occupation: A) Private B) Governmental C) NGO's D) Other: _____
6. Education: a. Illiterate b. Read and Write c. $1^{st}$ and $8^{th}$ d. Other: _____
7. Family size: _____

## II. Chicken ownership System and other related questions

1. Do you owe livestock? A) Yes B) No
2. If your answer to question 2 is yes, how many livestock do you owe, respectively? Cattle: _____; Sheep: _____; Goats: ____; Equines: ____; Chicken: ____
3. If you owe chicken in question number 9, which classes of chickens are found? A) Chicks B) Pullets C) Roosters D) Hens E) Cocks F) Other: _____
4. What type of breed are the chickens? _____
5. What is the source of foundation? A) Gift B) Purchase C) Other: _____
6. How long has chicken been kept in the household? _____
7. What is the source of money to finance your chicken farming? A) Chicken sales B) Egg sales C) Crop sales D) Livestock sales E) other: _____
8. Do you feel the need to improve your chicken production? A) Yes B) No
9. If yes, what type of breed you prefer? A) Exotic B) Indigenous

**III. Feed resource availability and utilization**

1. Do your chickens scavenging? A) Yes B) No
2. Do you provide supplementary feed to your chickens? A) Yes B) No
3. If your answer to question number 2 is yes, what type of feed you provide to your chickens? A) Home-made feeds B) Commercial-made rations
4. If your answer to question no 2 is commercial ration, which type of ration you purchased?

   A) Layer type B) Broiler type C) Breeder type D) I don't know
5. If your answer to question number 3 is commercially made ration, what are the feed ingredients in the ration?

   1st _____ 2nd _____ 3rd _____ 4th _____ 5th _____; other, please specify: _____
6. If your answer to question number 3 is commercially made ration, do you know the exact nutritional content of the feed? A) Yes B) No
7. If your answer to question no 6 is yes, what is the nutritional composition of the ration? A) %DM: ____ B) %CP: ____ C) %ME: ____ D) %Ca: ____ E) %P _____ F) Other, please specify: _____
8. If your answer to question number 3 is commercially made ration, where do you purchased it? Including amount, price, and date? And also cost of transportation?

   1st _____ 2nd _____ 3rd _____ 4th _____ 5th _____; other, please specify: _____
9. If your answer to question no 3 is home-made feed, please specify the feeds you provide to your chickens? Including: amount, price, place and date?

   1st _____ 2nd _____ 3rd _____ 4th _____ 5th _____; other, please specify: _____
10. How frequently do you provide supplementary feed to your chickens?

A) Ones in the morning
B) Twice in the morning
C) Once in the afternoon
D) Twice in the afternoon
E) Other, please specify: _____

11. How do you provide supplementary feed to your chickens?
    A) In a feeding trough: i) Separately ii) In group
    B) On the bare ground: i) Separately ii) In group
    C) Other, please specify: _____
12. Why you give supplementary feed to your chickens? A) To increase egg yield
    B) To increase meat yield C) Other, please specify: _____
13. Indicate at which season you provide supplementary feed to your chickens?
    A) Short-rainy (Feb-March)
    B) Short-dry (Apr-May)
    C) Long-rainy (June-Sep)
    D) Long dry (Oct-Jan)
14. Which feed types are the most expensive according to season, price and place where it is purchased? 1st _____ 2nd _____ 3rd _____
15. If you provide home-made supplementary feed to your chickens do you mix feeds or provide individually? A) Mixing B) No
16. If your answer to question 8 is yes, what feeds are in the mix? 1st _____ 2nd _____ 3rd _____ 4th _____ 5th _____
17. If you do not give feed, reason out why not giving supplementary feeding?
    A) Lack of awareness about feed
    B) Unavailability
    C) Expensive
    D) Time shortage
    E) Other, please specify: _____
18. Do you give water to your chickens? A) Yes B) No
19. If yes, please specify the type of container you used to give water? _____
20. Where do you get the water source from? Please specify: _____

**IV. Egg production System**

1. If you have hens, do they lay eggs? A) Yes B) No
2. If your answer to question 1 is yes, how many eggs are produced?
   A) Per day B) Per clutch C) Per year

3. What do you think about the duration of clutch as the age of the chicken increases?
   A) Increases B) Decreases C) Constant
4. Where do you store eggs until sale? 1) Grain 2) Clay pots 3) Plastic materials
   4) Cartoons 5) Floor depression 6) others, please specify _____
5. Constraints of chicken production and productivity (Specify in order of their economic importance) 1st _____ 2nd_____ 3rd_____ 4th _____ 5th _____

## V. Egg Incubation Practices

1. Do you incubate your eggs? A) Yes B) No
2. If yes, by which means? A) Artificial B) Natural
3. If by Natural, at which season you practice incubating eggs? A) Dry B) Rainy
4. Do you select egg for incubation? 1) Yes 2) No
5. How long do you store eggs before incubation? _____
6. Where do you store eggs before incubation? _____
7. How many chicks hatch? _____
8. How many chicks grow? _____
9. When is the chicks death and at what time? a. First week b. Second week c. Third week d. Forth week e. Six –eight week of after hatching
10. What are the main causes of chicks' death? A) Disease B) Predators C) other: _____
11. If by Artificial, how many eggs are incubated?
12. How many eggs hatch? _____
13. How many chicks grow? _____
14. Approximate age of female sexual maturity (Hen (age at 1st egg) _____months?
15. Age of first mating male, Cock (age at 1st mate) _____ months?
16. The number of eggs in one clutch/chicken. a. Indigenous _____ b. exotics _____
17. How many times do you incubate eggs per year? _____

## VI. Disease prevention and control

1. Do you experience serious disease outbreaks? A) Yes B) No

2. What do you do when chickens fall to sick? A) Treat by yourself B) Call veterinarian C) Cull D) Slaughter immediately E) Sell
3. Describe the common diseases you experienced? 1st _____ 2nd _____ 3rd _____
4. How did the disease affect your flock and which disease type is more serious? A) Wiped out the whole flock B) Destroyed more than half
5. What do you think the source of infection? A) Own flock B) Incoming chickens C) Unknown D) Other: _____
6. Do you control free movement of flock? A) Yes B) No
7. If yes, why?
    1. To protect from predators
    2. To avoid risk of contagious diseases
    3. To protect mixing from neighboring chickens
    4. Other, please specify _____
8. Do you face mortality of chickens? 1) Yes 2) No
9. If your answer to question 8 is yes, how frequently does it occur? A) Daily B) Other, please specify _____
10. What classes of chickens face more death than the others, please specify according to their priority? 1st _____ 2nd _____ 3rd _____ 4th _____
11. What are the major causes of mortality of chickens?
    1. Diseases B) Parasites C) Accident D) Predators E) Suffocation F) Other _____
12. How do you control diseases and parasites? A) Vaccination B) Spray C) Drugs D) Hygiene E) Culling sick animals F) other, please specify _____

## VII. Challenges of chicken production

1. What are the problems relating to feeding?
2. What are the problems relating to chicken marketing in your experience?
    a) Unstable chicken price
    b) Poor sales
    c) Lack of market place
    d) Availability of substitute
    e) Poor infrastructure
    f) Others specify _____
3. What are other challenges in relation to chicken production? _____

Appendix Table 1. Costs incurred during conducting the research

| Costs incurred | Unit | Quantity | Unit cost (Birr) | Total (Birr) |
|---|---|---|---|---|
| Variable costs | | | | |
| Guard | Months | 2 | 1800 | 3600 |
| Clearing grasses and herbs | Days | 2 | 200 | 400 |
| Disinfecting chicken house | Days | 1 | 400 | 400 |
| Cleaning chicken house | Days | 2 | 250 | 500 |
| Electric installation | Days | 42 | 24 | 1008 |
| Hand gloves | Pack | 2 | 50 | 100 |
| Disinfectant | L | 1 | 200 | 200 |
| Vaccine | No | 4 | 100 | 400 |
| Teff straw | Pack | 5 | 50 | 250 |
| Charcoal | Pack | 1 | 300 | 300 |
| Day-old chicks | No | 120 | 28 | 3360 |
| Rental house (Allowance) | Months | 2 | 10000 | - |
| Electricity service (Allowance | Days | 42 | 50 | - |
| Water service (Allowance) | Days | 42 | 8 | - |
| Transportation | Trips | 14 | 156.43 | 2190.02 |
| Sub Total | | | | 12708.02 |
| Fixed costs | | | | |
| Plastic carpet | M | 30 | 50 | 1500 |
| Plastic feeders (Allowance) | No | 8 | 80 | - |
| Metal feeders (Allowance) | No | 8 | 500 | - |
| Water container (Allowance) | 150L | 1 | 700 | - |
| Drinkers (Allowance) | No | 8 | 200 | - |
| Wire | Pack | 1 | 100 | 100 |
| Wire mesh (Allowance) | $m^2$ | 36 | 100 | - |
| Electric wire | M | 100 | 15 | 1500 |
| Breaker | No | 2 | 100 | 200 |
| Electric bulbs | No | 16 | 250 | 4000 |
| Boots | No | 2 | 100 | 200 |
| Digital balance | No | 1 | 1500 | 1500 |
| Overcoat | No | 1 | 100 | 100 |
| Sub Total | | | | 10700 |
| Total cost | | | | 69509.02 |

Appendix Table 2. Formulation and price of feed ingredients and rations

| Parameters | Starter | Grower | Finisher | Price (birr/kg) |
|---|---|---|---|---|
| Feed ingredients (in %) | | | | |
| Maize grain | 43.00 | 40.00 | 40.00 | 8.80 |
| Soybean meal | 24.74 | 15.56 | 14.95 | 17.00 |
| Calcium carbonate | 1.00 | 1.00 | 1.00 | 0.70 |
| Vitamin premix | 1.00 | 1.00 | 1.00 | 0.35 |
| Wheat middlings | 2.35 | 22.90 | 30.00 | 6.00 |
| Noug seed cake | 27.41 | 19.04 | 12.54 | 8.00 |
| Salt | 0.50 | 0.50 | 0.50 | 10.00 |
| Rations (in birr) | | | | |
| Commercial ration | 14.80 | 13.88 | 13.43 | 42.11 |
| Homemade ration | 10.01 | 8.87 | 8.67 | 27.55 |
| Difference ($T_2$-$T_1$) | 4.79 | 5.01 | 4.76 | 14.56 |

Appendix Table 3. Standard body weight gain and feed consumption of Cobb500 broiler chicken

a) Starter phase (1-10 days)

| Age | Hatched | | Males | | Females | |
|---|---|---|---|---|---|---|
| (Days) | Weight (g) | DFC (g) | Weight (g) | DFC (g) | Weight (g) | DFC (g) |
| 0 | 42 | - | 42 | - | 42 | - |
| 1 | 56 | 13 | 56 | 13 | 56 | 13 |
| 2 | 72 | 17 | 72 | 17 | 72 | 17 |
| 3 | 89 | 21 | 89 | 21 | 89 | 21 |
| 4 | 109 | 23 | 109 | 23 | 109 | 23 |
| 5 | 131 | 27 | 131 | 27 | 130 | 27 |
| 6 | 157 | 31 | 157 | 31 | 156 | 31 |
| 7 | 185 | 35 | 186 | 35 | 184 | 35 |
| 8 | 215 | 39 | 217 | 39 | 214 | 37 |
| 9 | 247 | 44 | 250 | 44 | 244 | 44 |
| 10 | 283 | 48 | 286 | 49 | 280 | 47 |

DFC=Daily Feed Consumption; g=gram

b) Grower phase (11-22 days)

| Age | Hatched | | Males | | Females | |
|---|---|---|---|---|---|---|
| (Days) | Weight (g) | DFC (g) | Weight (g) | DFC (g) | Weight (g) | DFC (g) |
| 11 | 321 | 54 | 324 | 54 | 318 | 54 |
| 12 | 364 | 58 | 368 | 59 | 360 | 57 |
| 13 | 412 | 64 | 416 | 64 | 408 | 63 |
| 14 | 465 | 68 | 470 | 70 | 460 | 68 |
| 15 | 524 | 75 | 528 | 77 | 520 | 73 |
| 16 | 586 | 81 | 590 | 83 | 582 | 79 |
| 17 | 651 | 87 | 656 | 90 | 646 | 84 |
| 18 | 719 | 93 | 727 | 97 | 711 | 89 |
| 19 | 790 | 98 | 803 | 104 | 777 | 92 |
| 20 | 865 | 105 | 884 | 112 | 844 | 98 |
| 21 | 943 | 111 | 971 | 119 | 914 | 103 |
| 22 | 1023 | 117 | 1058 | 124 | 986 | 111 |

DFC=Daily Feed Consumption; g=gram

c) Finisher[1] (22-42 days)

| Age | Hatched | | Males | | Females | |
|---|---|---|---|---|---|---|
| (Days) | Weight (g) | DFC (g) | Weight (g) | DFC (g) | Weight (g) | DFC (g) |
| 23 | 1104 | 123 | 1145 | 130 | 1060 | 116 |
| 24 | 1186 | 130 | 1233 | 136 | 1136 | 124 |
| 25 | 1269 | 134 | 1321 | 142 | 1214 | 126 |
| 26 | 1353 | 141 | 1409 | 148 | 1294 | 134 |
| 27 | 1438 | 148 | 1497 | 154 | 1378 | 142 |
| 28 | 1524 | 152 | 1585 | 160 | 1463 | 144 |
| 29 | 1613 | 158 | 1677 | 165 | 1549 | 151 |
| 30 | 1705 | 163 | 1773 | 171 | 1636 | 155 |
| 31 | 1799 | 169 | 1873 | 177 | 1724 | 161 |
| 32 | 1895 | 174 | 1978 | 184 | 1813 | 163 |
| 33 | 1993 | 180 | 2085 | 192 | 1903 | 165 |
| 34 | 2092 | 182 | 2192 | 200 | 1993 | 167 |
| 35 | 2191 | 189 | 2299 | 209 | 2083 | 169 |
| 36 | 2289 | 193 | 2406 | 212 | 2172 | 175 |
| 37 | 2386 | 197 | 2513 | 215 | 2259 | 179 |
| 38 | 2482 | 201 | 2620 | 218 | 2344 | 184 |
| 39 | 2577 | 205 | 2726 | 221 | 2428 | 189 |
| 40 | 2671 | 209 | 2832 | 225 | 2510 | 193 |
| 41 | 2764 | 213 | 2938 | 229 | 2591 | 197 |
| 42 | 2857 | 216 | 3044 | 233 | 2671 | 199 |

DFC=Daily Feed Consumption; g=gram

d) Finisher[2] (43-60 days)

| Age | Hatched | | Males | | Females | |
|---|---|---|---|---|---|---|
| (Days) | Weight (g) | DFC (g) | Weight (g) | DFC (g) | Weight (g) | DFC (g) |
| 43 | 2950 | 220 | 3150 | 237 | 2751 | 203 |
| 44 | 3043 | 222 | 3256 | 241 | 2831 | 203 |
| 45 | 3136 | 225 | 3362 | 245 | 2910 | 205 |
| 46 | 3229 | 227 | 3468 | 250 | 2989 | 204 |
| 47 | 3322 | 231 | 3574 | 255 | 3068 | 207 |
| 48 | 3414 | 233 | 3680 | 265 | 3147 | 208 |
| 49 | 3506 | 235 | 3786 | 270 | 3226 | 209 |
| 50 | 3596 | 237 | 3891 | 265 | 3301 | 209 |
| 51 | 3685 | 239 | 3994 | 265 | 3376 | 213 |
| 52 | 3773 | 240 | 4095 | 265 | 3451 | 215 |
| 53 | 3859 | 242 | 4194 | 265 | 3524 | 219 |
| 54 | 3944 | 243 | 4291 | 265 | 3597 | 221 |
| 55 | 4028 | 245 | 4386 | 265 | 3670 | 225 |
| 56 | 4111 | 245 | 4481 | 265 | 3741 | 225 |
| 57 | 4192 | 245 | 4573 | 265 | 3812 | 225 |
| 58 | 4272 | 245 | 4662 | 265 | 3883 | 225 |
| 59 | 4350 | 245 | 4748 | 265 | 3953 | 225 |
| 60 | 4427 | 245 | 4831 | 265 | 4023 | 225 |
| 61 | 4502 | 245 | 4912 | 265 | 4093 | 225 |
| 62 | 4576 | 245 | 4990 | 265 | 4162 | 225 |
| 63 | 4649 | 245 | 5068 | 265 | 4230 | 225 |

DFC=Daily Feed Consumption; g=gram

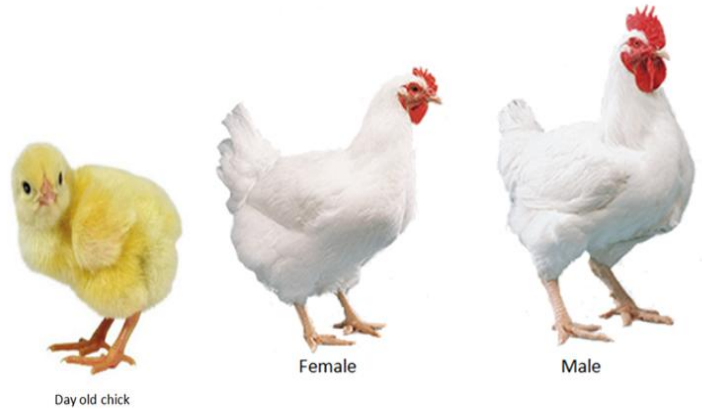
**Appendix C. Photos taken while conducting the survey**

Appendix Figure 1. Deep litter houses at different places in Bishoftu

Appendix Figure 2. Broiler chicks confined in deep litter system in Bishoftu

**Appendix D. Photos taken before conducting the feeding experiment**

Appendix Figure 3. The experimental house inside (right) and outside (left)




Appendix Figure 4. Cobb500 broiler chickens

Appendix Figure 5. Preparation of homemade ration for all stages of growth

Appendix Figure 6. Day-old Cobb500 broiler chicks purchased from Alema Farm

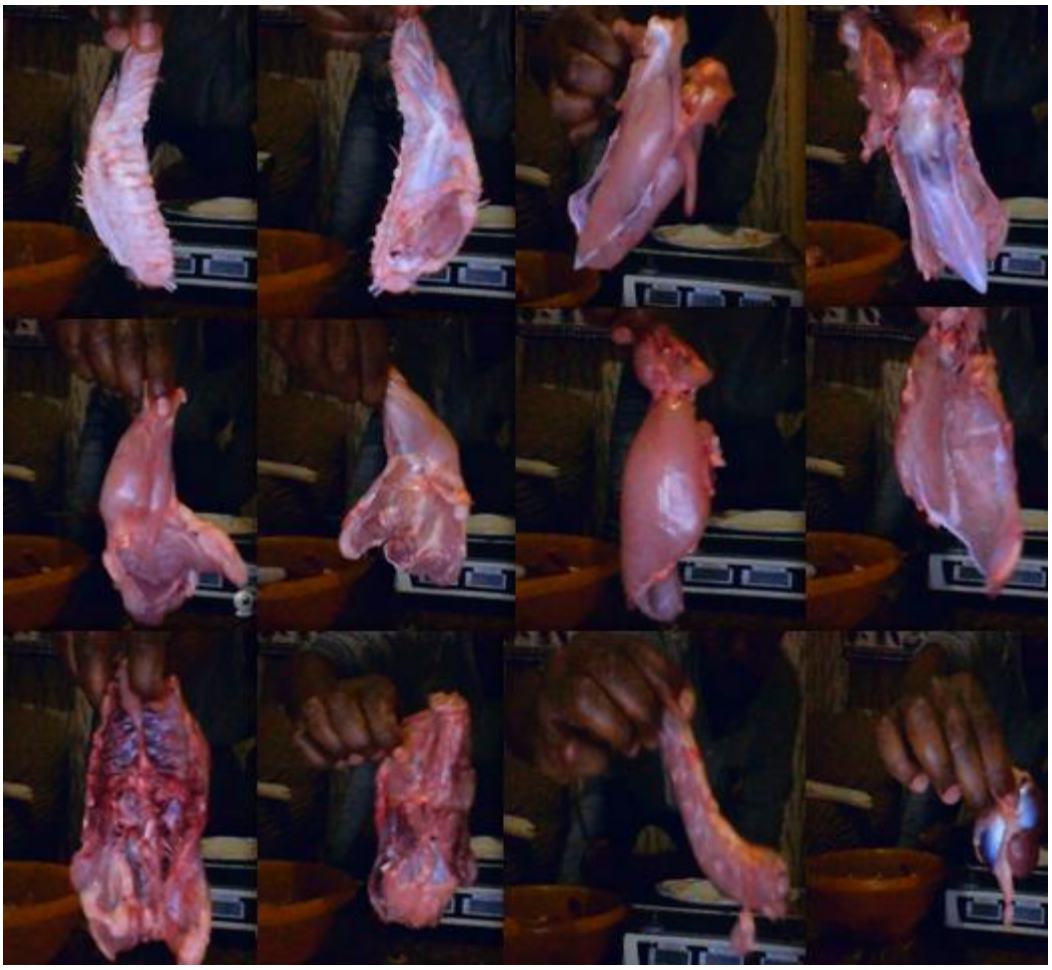
**Appendix E. Photos taken while conducting the feeding experiment**

Appendix Figure 7. Digital balance (left) and drinkers (right)

Appendix Figure 8. Measurement of feed offered and refusal

Appendix Figure 9. Provision of water and feed to the birds

Appendix Figure 10. Cobb500 broiler birds at different stages of growth



Appendix Figure 11. Measurement of carcass cuts of Cobb500 fed homemade ration