**Thesis Ref No……..**

**ADDIS ABABA UNIVERSITY**
**COLLEGE OF VETERINARY MEDICINE AND AGRICULTURE**
**DEPARTMENT OF ANIMAL PRODUCTION STUDIES**
**MSC PROGRAM IN ANIMAL PRODUCTION**

# MORPHOLOGICAL CHARACTERIZATION OF INDIGENOUS CHICKEN AND THEIR PRODUCTION SYSTEM IN SILTE, DALOCHA AND WULBAREG WOREDAS OF SILT'E ZONE, SOUTH REGION, ETHIOPIA

**MSC THESIS**

**BY**
**EYOB TAGESSE HABDOLLO**

**JUNE 2019**

**BISHOFTU, ETHIOPIA**

# MORPHOLOGICAL CHARACTERIZATION OF INDIGENOUS CHICKEN AND THEIR PRODUCTION SYSTEM IN SILTE, DALOCHA AND WULBAREG WOREDAS OF SILT'E ZONE, SOUTH REGION, ETHIOPIA

**MSC THESIS**

**A Thesis submitted to the College of Veterinary Medicine and Agriculture of Addis Ababa University in partial fulfillment of the requirements for the degree of Master of Science in Animal Production**

**By**

**Eyob Tagesse Habdollo**

**Advisor: Dr.Gebeyehu Goshu (Associate Professor)**

**June 2019**

**Bishoftu, Ethiopia**

**APPROVAL AND SIGNATURE SHEET**

Addis Ababa University

College of Veterinary Medicine and Agriculture

Department of Animal Production Studies

---

As members of the Examining Board of the final MSc open defense, we certify that we have read and evaluated the thesis prepared by **Eyob Tagesse** entitled ‘‘**Morphological Characterization of Indigenous Chicken and their Production System in Silte, Dalocha and Wulbareg Woredas of Silt'e Zone, South Region, Ethiopia**’’ and recommend that it be accepted as fulfilling the thesis requirement for the degree of Masters of Science in Animal Production

| | | |
|---|---|---|
| _____ | _____ | _____ |
| Chairman | Signature | Date |
| Prof. Harpal Singh (Professor) | _____ | _____ |
| Internal Examiner | Signature | Date |
| Dr. Wondmeneh Esatu (Associate Professor) | _____ | _____ |
| External Examiner | Signature | Date |

I hereby certify that I have read the revised version of this thesis prepared under my direction and recommend that it be accepted as fulfilling the thesis requirement.

| | | |
|---|---|---|
| Dr. Gebeyehu Goshu (Associate Professor) | _____ | _____ |
| Advisor | Signature | Date |
| Prof. Brihan Tamir (Professor) | _____ | _____ |
| Department Head | Signature | Date |

## STATEMENT OF AUTHOR

I declare that this thesis is my bona fide work and that all sources of material used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for an advanced (MSc) degree at Addis Ababa University, College of Veterinary Medicine and Agriculture and is deposited at the University/College library to be made available to borrowers under rules of the library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of an academic degree, diploma or certificate.

Brief quotations from this thesis are allowable without special permission provided that accurate acknowledgment of the source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the College when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

Name: Eyob Tagesse

Signature: _____

College of Veterinary Medicine and Agriculture, Bishoftu

Date of Submission: 20/6/2019

**ACKNOWLEDGMENTS**

Above all, praise is to my almighty GOD for giving me good health, wisdom, ability, and strength to carry out this work and for all other graces.

My special thanks go to Dr. Gebeyehu Goshu (Advisor) for his incalculable advice, supervise, constant encouragements, very constructive inputs, comments, and material support that he was kindly willing in the study period. His patience under all circumstances was models that a few us could hope to achieve.

I would like to recognize and thank Silti, Dalocha, and Wulbareg woreda agricultural office for all their cooperation and generous response to requests for information during survey and data collection. I am deeply grateful to all my M.Sc. classmates and all my Instructors and staff of the Addis Ababa University Department of Animal Sciences.

Finally, my thanks go to all my friends and colleagues who supported me in many different ways during my work.

Most of all, I am profoundly grateful to my parents, my sisters, and brothers, for their willingness and prayer for the success of this paper to me.

## TABLE OF CONTENTS

## LIST OF TABLES

**Table** **Page**

## LIST OF FIGURES

**Figure** **Page**

## LIST OF APPENDICES

**Appendex** **Page**

## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AACMC | Australian Agricultural Consulting and Management Company |
| ANOVA | Analysis of Variance |
| CACC | Central Agricultural Census Commission |
| CSA | Central Statistic Authority |
| DADIS | Domestic Animal Diversity Information System |
| DAGRIS | Domestic Animal Genetic Resources Information System |
| EARO | Ethiopian Agricultural Research Organization |
| IBD | Infectious Bursal Disease |
| ILRI | International Livestock Research Institute |
| IPMS | Improving Productivity and Market Success |
| MD | Marek's Disease |
| NCD | Newcastle disease |
| RIR | Rhode Island Red |
| SAS | Statistical Analysis System |
| SNNPRS | Southern Nation Nationalities and Peoples' Regional State |
| SPSS | Statistical Package for Social Sciences |
| WLH | White Leghorn |
| HDM | Holiday Eve Market |
| ODM | Ordinary day Market |

**ABSTRACT**

A survey together with visual observation and body measurement was conducted in twelve selected farmers' kebeles of Silti, Dalocha, and Wulbareg woredas, located in Silte zone south region of Ethiopia; with the objectives to characterize the morphological characteristics of domestic indigenous chicken and to assess the existing chicken production systems. Data on visual appraisal and linear body measurements were obtained from a total of 600 matured local chickens of both sexes drawn from 120 households. 5 mature chickens (aged more than 6 months) from each household were used for morphological characteristics study. The results indicated that the majority of the male chicken possessed plain head shape (94.7%) and most of them had rose combs (69.7%), grayish ('Gebsma') plumage (49%), yellow shank (58.6%), white and red earlobes (47.1%) and ash skin (46.6%). Majority of the hens possessed rose combs (63.8%), white and red earlobes (47.2%), yellow shank (47.7%), grayish ('Gebsma') plumage (48.5%) followed by black ('Tem') (22.1%) and red ('Kei') /red with black tail (11%). The cocks were generally heavier (1.8 kg) than the hens (1.3 kg). The values for wingspan, comb length, beak length, body weight, breast angle, and keel bone length differed ($P< 0.05$) across the study woredas. The best predictor for assessing the body weight of chicken was shank length and wattle length. The results indicated that the average flock size, age at first egg of hens and eggs produced per clutch were 9.9 heads, 5.8 months and 14.1 eggs, respectively. The number of clutch per hen per year and total eggs produced per hen per year was 3.05 and 43.01 eggs, respectively. The hatchability and survival rate of chicks were 91.9% and 50.5%. Chicken diseases and predators were considered to be the largest threat to village chicken production. The present study suggests that indigenous chickens in the study area possess useful economic traits that could be improved through systematic breeding for enhanced productivity, health care, housing, and feeding are required under scavenging production systems.

**Keywords**: *Indigenous chickens, Linear body measurement, Phenotypic characterization, Qualitative traits, Quantitative traits*

# 1. INTRODUCTION

## 1.1. Background and Justification

Ethiopia is one of the leading nations in Africa and among the global majors in terms of livestock resource. Traditional animal husbandry practices are based on low input low output system of production. Investment opportunities are potentially attractive for commercial livestock production and processing of meat, milk, and eggs (NABC, 2010).

Poultry is the largest livestock group in the world estimated to be about 23.39 billion consisting mainly of chickens, ducks and turkeys (FAO, 2010; CSA., 2013) while chicken alone reached over 1 billion and has remained to be important in the improvement of food security and livelihood (Dessie *et al.*, 2013 and Addis *et al*., 2014) and contributing about 28-30% of all animal protein consumed in the world (FAO, 2010; ELMP, 2014; and Emebet *et al*., 2013). References also disclosed that the total chicken population in Ethiopia has increased and estimated to reach above 65.87 million (CSA, 2011). Moreover; it has also been reported that village chicken production account above 95% of the total chicken production where exotic chicken constitutes below 5% of the chicken production in the country (CSA, 2011; ELMP, 2014).

Diversity for various genetic traits in the indigenous chicken genetic resources of Ethiopia has been observed, this may be attributed largely to diversities in agro-climates, production systems, social, religious and cultural considerations, among others (Halima *et al.*, 2007). Indigenous chickens in Ethiopia are found in large numbers and distributed across different agro-ecologies under traditional scavenging management system indicating that they are important avian resources reared as a source of animal protein and income to most of the rural populations (Fisseha *et al*., 2010). Furthermore, their widespread distribution indicates their adaptive potential to the local environmental conditions, diseases and other stresses.

According to the estimate of (Abdo *et al.*, 2016) the chicken population of Ethiopia is about 65.87 million; of which 95% are indigenous chickens, indicating the significance of local chickens as a potential genetic resource of the country. However, the indigenous chicken populations in South region Ethiopia are not properly characterized either phenotypically or genotypically. Their genetic potential still remains undefined forming a major barrier for the development and implementation of suitable genetic improvement strategies at a national level.

Most of the indigenous chickens have evolved through adaptation to various agro-climatic conditions. As Egahi *et al*. (2010) perceived the indigenous chickens possess genes and special adaptations not found in other improved modern breeds. Understanding the roles and function of local chicken as well as production constraints is of considerable relevance in envisaging future research and development directions and strategies (Reta, 2009; Nigusse, 2010; Aberra and Tegene, 2011). Sustainable rural poultry programs should build on what exists and match technological intervention (Clarke, 2004). Therefore, to identify what exists relating to chicken production and thus paving the ways for any technological intervention would be given due priority.

In Ethiopia, limited attention has been given to the characterization and classification of indigenous non-descriptive chicken types and research is at its rudimentary stage for the identification, description, and evaluation of these genetic resources. Halima *et al.* (2007) studied the indigenous chicken types of Northwestern Ethiopia following the previous studies of Tadelle (2003), where five indigenous chicken types up to 18 weeks of age, which were selected from different parts of the country, were studied.

Aberra and Tegene (2007) reported that identification and characterization of the chicken genetic resources generally require information on their adaptation to a specific environment, possession of unique traits of current or future economic value and socio-cultural importance, which are crucial inputs to decisions on conservation and utilization.

Variations in major morphological traits such as outline and feather contours, shank and ear-lobe colors, and comb types are common among indigenous chicken populations (Aberra and Tegene, 2007). These morphometric characteristics provide a basis for grouping the native chickens according to their phenotypic and morphological appearances.

The study of the existing production system and morphologic variations of domestic indigenous chicken ecotypes and identification of economically important phenotypic traits and constraints of chicken production of the study area was helping to give important and feasible recommendation for further improvement of the system in a sustainable way. Therefore, the description of each of the above parameters, which was possible both by measurement and by appraisal techniques, contributed to the characterization of morphology and production system of the chicken. Thus, the study was conducted with the following objectives.

### 1.2. Objectives

- To generate information on village-based utilization, management practices, opportunities and challenges of indigenous chicken kept in Silte zone.

- To characterize the morphological variation of indigenous chicken populations in Silte zone.

# 2. LITERATURE REVIEW

## 2.1. Ethiopian Poultry Population and Distribution

The word "Poultry" includes all domestic birds kept for the purpose of human food production (meat and eggs) such as chickens, turkeys, ducks, geese, ostrich, guinea fowl, and doves and pigeons. In Ethiopia ostrich, ducks, guinea fowls, doves, and pigeons are found in their natural habitat (wild) whereas, geese and turkey are exceptionally not common (Meseret, 2010).

According to the CSA (2012), the population dynamics of the chicken population in Ethiopia comprises of 40.11% chicks, 33% laying hens, 9.76% cocks, 9.19% pullets, 4.84% cockerels, and 3.1% non- laying hens. The same survey report indicated that the indigenous birds comprise over 95% of the county's chicken population while the remaining (1.03%) and (3.97%) are hybrids and exotic commercial chicken breeds such as the White Leghorn, Rhode Island Red, Fayoumi, and Bovan. Some crossbreeding and grading up work has also been conducted with the indigenous chicken. Further, the report indicated that the majority of the country's chickens (36.41%) are reared in Oromia, followed by Amhara (31.44%), SNNPR (23.18%) and Tigray (11.14%) regional states. The rest of the regions hold only 3.19% of the total poultry.

## 2.2. Poultry Production Systems in Ethiopia

Different authors classified poultry production system in Ethiopia as small, medium and large, based on the chicken types and their scale of production system dynamics. Reports also showed that small scale chicken production system account for more than 95% of poultry production in Ethiopia (Dessie *et al.*, 2013). Besides; small scale production system could be classified into three as traditional free-range poultry production system(having less than 10 chickens), improved free-range poultry production system (having less than 50 birds) and small scale confined poultry production systems (some hybrid inclusive) having range from 50-1000 bird (Reta, 2009; Addis *et al*., 2014).

Some scholars also classified the poultry production system in Ethiopia as village, peri-urban and urban based on the chicken types, purpose of production, level of technologies used and their production environment and the village chicken ecotypes have been vast and important especially for women in developing courtiers like Ethiopia (CSA, 2011; Dessie *et al*., 2013; and Emebet *et al*., 2013). Reports also showed that poultry production in Ethiopia could be classified as extensive, semi-intensive and intensive based on their level of intensity of production, confinement and production objectives set. Moreover, chicken ecotypes could be classified based on their Agro-ecological conditions (Abdo *et al.,* 2016). According to the ELMP (2014) of Ethiopia poultry production system could also be classified as scavenging, semi-scavenging and commercially confined depending on the level of feed and feeding technologies, the chicken types and purpose of production intended in the country.

### *2.2.1. Small scale chicken production system in Ethiopia*

The total number of chickens in Ethiopia was 56 million and now reached to be 65.87 million with expected increase in the future, of which the vast majority (95%) are native indigenous chickens (CSA, 2011; Abdo *et al*., 2016) and some below 5% are commercial chickens (CSA, 2013; Dessie *et al*., 2013) and traditional small scale production can be classified in three and these include the traditional free-range chicken production system (having <10 chickens), improved free-range chicken production system (having 10- 50 chickens) and small scale confined chicken production systems (some hybrid inclusive) and having range from 50-1000 chickens (FAO, 2008; FAO, 2009). Besides the small scale chicken production ranges from traditional free-range to small scale confined in Ethiopia (Reta *et al*., 2009; Addis *et al*., 2014) and differ in their characteristics of production and the level of the management of the chickens in the country.

### *2.2.2. Medium scale chicken production system in Ethiopia*

The medium scale chicken production systems produce from 1,000 to 10,000 chicks and the number of medium scale chicken producing are estimated to reach around fifteen to twenty and these are mainly concentrated in cities in and/or around Addis Ababa/Debre

Zeit/Mojo/Adama area but also growing in number around the other larger regional cities such as Mekelle, Dire Dawa, Gondar, Awassa, Bahir Dar and still emerging in moderate zonal towns in the country (FAO, 2008; Nyaga, 2009).

### *2.2.3. Large scale commercial chicken production system in Ethiopia*

Large scale commercial chicken production systems have a large number of birds of great grandparent stock, parent stock and commercial hybrid (> 10.000 chicks) and these are not yet both horizontally and vertically integrated with the emerging regional medium scale chicken producers (Nyaga, 2009; Embet *et al*.,2010) and are remained to depend only on their production for the chicken input-output system importing exotic chickens and these three large scale commercial chicken farms including parent stock and these are one layer chicken farm (Maranatha), and two broiler farms (Almaz, Dubai investment near Mojo).

### *2.2.4. Integrated large scale commercial chicken production system in Ethiopia*

Large scale commercial chicken production systems have large number of birds of great grandparent stock, parent stock and commercial hybrid (>50,000 chicks) and have been remained to rely on importation of highly producing exotic chickens as the indigenous chickens are fully characterized and improved to the level of commercialization (Nyaga, 2009; Embet *et al*., 2010). Similarly, there are only two integrated large scale commercial chicken farms with great grandparent and parent stock and having their own hatcheries (Alema, Elfora) in the country and explained that integrated large scale chicken production system dynamics and have required high technology with large production and profitability threshold level even though the integration of the farms elaborated in terms of crop production, not with the use of chicken input-output systems (FAO, 2008; Nyaga, 2009).

## 2.3. Morphological Features of Poultry in Ethiopia

The indigenous chickens of Ethiopia have various names and are characterized on different grounds, as in many other parts of Africa. Teketel (1986) characterized them on the basis of

plumage color, for example, ‘Kei’ (red) or ‘Tikur’ (black). Tadelle (2003) referred to them as “local chicken ecotypes” and Halima *et al.* (2007b) as “native chicken populations”, both named on the basis of the geographic region of sampling. Each local ecotype or native population actually comprised chickens with a wide range of morphologic or genetic diversity. Thus, only 5 Ethiopian chicken types have been listed in the Domestic Animal Diversity Information System (DAD-IS) of the FAO (2010) and 10 in the Domestic Animal Genetic Resources Information System (DAGRIS) of the International Livestock Research Institute (ILRI; derived from DAGRIS, 2008), including those listed in DAD-IS. This small number represented in the databases indicates the shortage of data on chicken genetic resources in Ethiopia, suggesting that much of the diversity that exists in the locally adapted populations still remain undocumented.

The unique adaptation features and morphological variations of Ethiopian indigenous chicken population have been reported by several scholars. Halima *et al*. (2007b) reported the phenotypic variation of indigenous chicken populations in northwest Ethiopia. Similarly, studies conducted by Reta (2009) and Nigussie *et al*. (2010) focused on the characterization of indigenous chicken populations found at specific locations that may not necessarily represent the genetic resources of indigenous chickens distributed in the whole country.

Indigenous chickens of the tropics are important reservoirs of useful genes and possess a number of adaptive traits (Horst, 1989). Genetic variations in chickens can be described, among other approaches, using monogenic traits based on pigmentation differences and comb types. Pigmentation differences, which are attributable to melanin, produce a variety of plumage colors in the chickens. The presence and level of melanin pigments such as trichochrome are related to feather color and is considered to be indicative of genetic differences among certain plumage colors (Smyth, 1990). Similarly, the presence or absence of the carotenoid pigments, primarily xanthophyll, in the feed is responsible for the diversity in skin color of chickens. The genetic basis of this variation was described by Eriksson *et al*. (2007). In addition to their significance in describing genetic variations and adaptive attributes, qualitative morphological traits have important economic value in chickens. There

are specific choices for plumage and skin colors that affect preferences of different geographic markets around the world (Jiang, 1999).

In Ethiopia, there is no specific preference for skin color, and plumage color is only second in importance to live weight in affecting market preference for chickens (Nigussie *et al*., 2010). In certain communities of Ethiopia (Leulseged, 1998) and other parts of Africa (Gueye, 2002), it has cultural and religious functions as well. In northern Ethiopia, both producer–sellers and intermediary traders of chickens attach the highest market preference to plumage color and feather distribution followed by comb type (Aklilu, 2007). This clearly suggests that qualitative traits with specific characteristics must be carefully identified and considered in developing breeding strategies.

In fowls, very few studies on proper documentation of the morphometric traits have been conducted in the past. Some measurements reported include length or ornithological measurement, wingspan, beak length, comb length, apparent size, folded wing length, tarsus length and length of the bird. However, according to Francesch *et al*. (2011) body weight, comb length, ear lobes length, the keel of sternum length, breast angle, breast girth, and shank length and circumference are the basic measurable morphological attributes that could be of significance for morphologic characterization of domestic chicken.

### 2.4. The productivity of Indigenous Chickens

As indicated earlier by Teklewold *et al*. (2006) indigenous chickens comprise about 80% of the national flocks in Africa and Asia. When compared to their modern counterparts indigenous chickens are generally poor producers of eggs and meat. Consequently, they are being replaced by commercial strains in many developing countries. In some countries, this strategy was pursued for decades to increase productivity under village systems but failed to bring sustainable improvement. In fact, it posed a serious threat to the existing genetic diversity of indigenous chickens (Besbes, 2009).

Despite their poor growth and egg production, indigenous chickens have a better tolerance towards many economically important diseases and can be better performers under poor nutrition and high environmental temperatures when compared to commercial strains (Nigussie *et al*., 2010). Studies on biodiversity of indigenous chickens in many parts of Africa revealed the presence of high genetic variability between and within ecotypes/ populations (Muchadeyi *et al.,* 2007; Mwacharo *et al*., 2007; Halima *et al*., 2009), indicating the potential for genetic improvement of these chickens through selective breeding. The indigenous chickens of Ethiopia are mostly of non-descriptive types resembling the Jungle fowl. The plumage colors, comb shape, body conformation, shank color, ear lobe color of these chickens are variable. Broodiness (maternal instinct) is pronounced.

Knowledge of genetic parameters is essential for any genetic improvement program. Literature is available on genetic parameters for growth and egg production of commercial poultry populations (Nigussie *et al*., 2010). There are some estimates for growth (Gondwe, 2005; Norris and Nigambi, 2006) and egg production (Sang *et al*., 2006; Kamali *et al*., 2007; Lwelamira *et al.,* 2009) traits in unselected indigenous chickens of Africa and other countries but there are almost no estimates for Ethiopian chickens. All the available evidence indicates that all the imported breeds of chickens performed well under the intensive management system (Solomon, 2007).

FAO (2010) report indicated that the village chicken production system in five different zones in Ethiopia, by integrating a structured questionnaire with participatory rural appraisal and a recall survey to establish specific performance history for each hen, they obtained a detailed and very reliable data set for reproductive performance. The results indicated no differences among the various regions. With respect to meat production, data from Ethiopia are scarce.

The productivity of local chickens reared under scavenging condition is low; chick mortality is high and is coupled with a longer reproductive cycle. Meseret (2010) and Fisseha *et al*. (2010) reported that about 40-60% of the chicks hatched die until the first 8 weeks of age mainly due to disease and predators. Thus, Fisseha *et al*. (2010) found out that about half of the eggs produced have to be hatched to replace mortality; the brooding time of the laying

hens is longer with many brooding cycles required to compensate for its unsuccessful brooding.

Halima *et al*. (2009) in their studies in Northern Ethiopia estimated that, under scavenging conditions, the reproductive cycle of indigenous hens consists of 20-days of laying phase, 21-days of incubation phase and 56-days of brooding phase. This implies the fact that the number of clutches per hen per year is probably 2-3. Assuming 3 clutches per hen per year, the hen would have to stay for about 168 days out of production every year.

The low productivity of the indigenous stock could partially be attributed to the inferior management standard of the traditional household poultry production system. Burley, 1957; Teketel, 1986 and Abebe, 1992 were in the opinion that provisions of proper and timely vaccination, improved feeding, clean water, and nighttime enclosure can improve the performance of the indigenous chickens, but not to an economically acceptable level.

Chickens are among the most adaptable domesticated animals, and there are few places on the globe where climatic conditions make the keeping of chicken flock impossible (Bishop, 1995). The indigenous chickens belong to a group of local unimproved breeds commonly found in developing countries and may include mixed (unspecified) breeds resulting from uncontrolled breeding (Mushi *et al*., 2005). Local chickens are kept in many parts of the world irrespective of the climate, traditions, life standard, or religious taboos relating to the consumption of eggs and chicken meat like those for pig meat.

The importance of village poultry production in the national economy of developing countries and its role in improving the nutritional status and incomes of many small farmers and landless communities has been recognized by various scholars and rural development agencies for the last few decades (Aberra *et al*., 2005; Fisseha *et al*., 2010; Aberra *et al.,* 2011). For instance, there are about 65.87 million chickens in Ethiopia of which 95% are local chickens (Abdo *et al*., 2016), indicating the significance of indigenous chickens as potential Farm Animal Genetic Resources of the country. Village-based chicken production requires less space and investment and can, therefore, play an important role in improving the livelihood of

the poor village family (Samson and Endalew, 2010). However, the production level of scavenging hens is generally low, with only 40-60 small sized eggs produced per bird per year under smallholder management conditions (Nigusse *et al*., 2010; Aberra and Tegene, 2011).

### 2.5. Socio-economic Role of Poultry

Animal production in general and chickens, in particular, play important socioeconomic roles in developing countries (Alders, 2004; Salam, 2005). As indicated in the reports of Jens *et al*. (2004) nearly all rural and peri-urban families in developing countries keep a small flock of free-range chickens. Village chickens are also an integrated component of nearly all rural, many peri-urban and some urban households and accounts for more than 60% of the total chicken population in most African countries.

According to Sonaiya (2005) small farming families, landless laborers and people with incomes below the poverty line were able to raise village birds with low inputs and harvest the benefits of eggs and meat via scavenging feed resources. However, as indicated by Fisseha *et al.* (2010) most rural communities lack the required husbandry skills, training and opportunity to effectively improve their chicken production.

In Ethiopia, Fisseha *et al.* (2010) observed that chickens are the most widespread domestic birds and almost every rural family owns chickens, which provide a valuable source of family protein and income. The predominant chicken types reared in Ethiopia are local ecotypes, which show a large variation in body condition, plumage color, and comb type and productivity (Halima *et al*., 2007). However, the economic contribution of the sector is not still proportional to the huge chicken numbers, attributed to the presence of many productions, reproduction and infrastructural constraints (Fisseha *et al*., 2010).

Rural poultry is often the only capital that households are left with when declining into poverty (Aklilu, 2007). Further, the author indicated that for the resource-challenged, poultry meat is the only special meal they can afford during religious festivities like New Year, Christmas and Easter. Socio-cultural roles are more important in areas with poorest market access particularly in the Tigray, Amhara and Oromia Regional States of Ethiopia. As

indicated by Bush (2006), the market demand and price of live chickens and eggs experienced during the last 5 years are very much rewarding compared to the previous times indicating that for poor families, poultry is often one of their few sources of petty cash.

## 2.6. Challenges of Poultry Production

### *2.6.1. Diseases and predators*

Production of indigenous chickens under the scavenging production system is widespread and well-established in the country's villages, even where the resource is poor (Hunduma *et al*., 2010). Studies by Reta *et al*. (2006) indicate that they are predominantly raised where a traditional family-based free-range scavenging management system is practiced. Thus, the birds are left to depend primarily on what nature offers.

Attempts have been made from time to time at different times to raise indigenous chickens under confined management in different research stations situated in various geographical areas of the country (Hunduma *et al.,* 2010). However, all attempts have failed due to high morbidities and mortalities of the chickens. These repeated failures have tempted some researchers to conclude that indigenous chickens of Ethiopia are unfit for confined management (Reta *et al*., 2006). Furthermore, Hunduma *et al.* (2010) reported that Newcastle disease (NCD), Infectious Bursal Disease (IBD) or Gumboro, Marek's disease (MD), Fowl typhoid, Cholera, Mycoplasmosis, and Coccidiosis are widely distributed in most African countries. The Ethiopian indigenous flocks are said to be tolerant of various diseases and adapted to their environment. However, survival rates of chicks kept under natural brooding conditions are considered to be very low.

Diseases and predators are known to be the major causes of mortality in the country (Nigussie, 2010). Newcastle disease (NCD) is the most important cause of economic loss since vaccination occurs only in response to an outbreak in the traditional poultry production system. According to Hunduma *et al*. (2010), losses attributed to Newcastle disease are estimated at about 57.3% of the overall annual chicken mortality whereas Fowl pox,

Coccidiosis, and predation account for about 31.6%, 9.4% and 1.7% of the total annual flock mortality, respectively. A survey conducted in Southern Ethiopia by Aberra and Tegene (2007) identified Fowl Cholera, followed by New Castle Disease, Coccidiosis, Fowl influenza (Infectious Bronchitis), Fowl pox, Fowl typhoid, and Salmonella to be the major poultry diseases, respectively.

The general indications suggest that the health status of the backyard poultry production system is very poor and risky since scavenging birds live together with people and other species of livestock. Poultry movement and droppings are very difficult to control and chickens freely roam in the compounds used by households and children. As observed by Solomon (2007), there are no practices (even means) of isolating sick birds from the household flocks and dead birds could sometimes be offered or left for either domestic or wild predators.

### *2.6.2. Nutritional constraints*

Scavenging feed resource base for local birds are inadequate and variable depending on the season (Hoyle, 1992; Alemu and Tadelle, 1997). As observed by Tadelle and Ogle (2000) the amount of feed available for scavenging in relation to the carrying capacity of the land area and flock dynamics across the different seasons and agro-ecologies is still not adequately quantified. However, studies conducted in three villages of the central highlands with different altitudes and in three different seasons revealed that the materials present in the crop, as visually observed, are, seeds, plant materials, worms, insects and unidentified materials.

During the short rainy season (March to May) the percentage of seeds in the crop contents is higher, probably because of the increased availability of cereal grains which had just been harvested and are given to the birds in larger amounts than during the big rainy season and dry season of the year. The relative amounts of available plant materials are lower during the short rainy season. The average percentage of plant materials in the crop contents is highest during the rainy season (June to September) as a result of the increased availability of plant materials, and the relative scarcity of seeds during this season might have increased intake of plant

materials. The largest proportions of worms in the crop contents were found from October to February in higher altitude which might be attributed to the relatively high and extended rainfall.

A larger proportion of insects were also found during the short rainy seasons (Tadelle and Ogle, 2000). Crop analysis studies conducted earlier by Tegene (1992); Tadelle and Ogle (1996b); and Alemu and Tadelle (1997) indicated that the physical proportion of seeds was higher in the short rainy season; however, the concentration of crude protein, calcium, and phosphorus were below the recommended requirements for egg production. Also as suggested by Mbugua (1990), both egg production and egg size vary with season, as the quality and availability of feed vary. According to these findings, there might be deliberate supplementary grain feeding during the ripening and harvesting period (October-March). The quantities of supplementation gradually decrease until June- August, during which scavenging is the only source of their feed (Alemu and Tadelle, 1997).

# 3. MATERIALS AND METHODS

## 3.1. Description of the Study Area

### *3.1.1. The geographical location of the study woredas*

The study was conducted in three adjacent woredas (Silte, Dalocha, and Wulbareg) of Silte Zone, the South Regional State of Ethiopia located between Latitude: 7°49'55.88" and Longitude: 38°16'7.39. Silt'e zone is one of the 14 zones of South Administrative Region found in the southern area of Ethiopia. Silt'e is bordered on the south by Halaba special woreda, on the southwest by Hadiya, on the north by Gurage, and on the east by the Oromia Region. Worabe is the capital town of Silte zone, located 150km South of Addis Ababa.

### *3.1.2. Ecological and demographic characteristics of the study woredas*

Out of the total land size of Silti woreda, 3.42% is lowland, 73.5% mid-altitude and 23.01% highland. The annual mean temperature is $18.8^0$C and the annual rainfall ranges between 1200.5-1818mm with the altitude ranges from 1501 to 2500 m.a.s.l. The land utilization is 65.84% cultivated land, 8.78% grazing land, 4.27% forest bushes and shrubland is 3.97% and 17.14% is covered by others (CSA, 2003).

Silte woreda is bordered on the south by Lanfro and Dalocha, on the southwest by Wulbareg, on the west by Alicho Werero, on the north by the Gurage Zone, and on the east by the Oromia Region. The administrative center of this woreda is Kibet. Based on the 2007 Census conducted by the CSA, this woreda has a total population of 177,249, of whom 87,600 are men and 89,649 women; 16,186 or 9.13% of its population are urban dwellers.

Dalocha woreda is bordered on the south by Sankurra, on the west by Wulbareg, on the north by Silte, and on the east by Lanfro. Towns in Dalocha include Dalocha. Dalocha, the town is the capital of Dalocha woreda, located 180 km of Addis Ababa. Based on the 2007 Census

conducted by the CSA, this woreda has a total population of 89,807, of whom 44,960 are men and 44,847 women; 6,793 or 7.56% of its population are urban dwellers.

Wulbareg woreda is named after the sub-group of the Silt'e people. Part of the Silt'e Zone, Wulbareg is bordered on the southwest by the Hadiya Zone, on the west by Misraq Azernet Berbere, on the north by Alicho Werero, on the northeast by Silte, on the east by Dalocha, and on the south by Sankurra. It was created from parts of Dalocha and Silte woredas. Based on the 2007 Census conducted by the CSA, this woreda has a total population of 79,981, of whom 38,284 are men and 41,697 women; 2,198 or 2.75% of its population are urban dwellers.

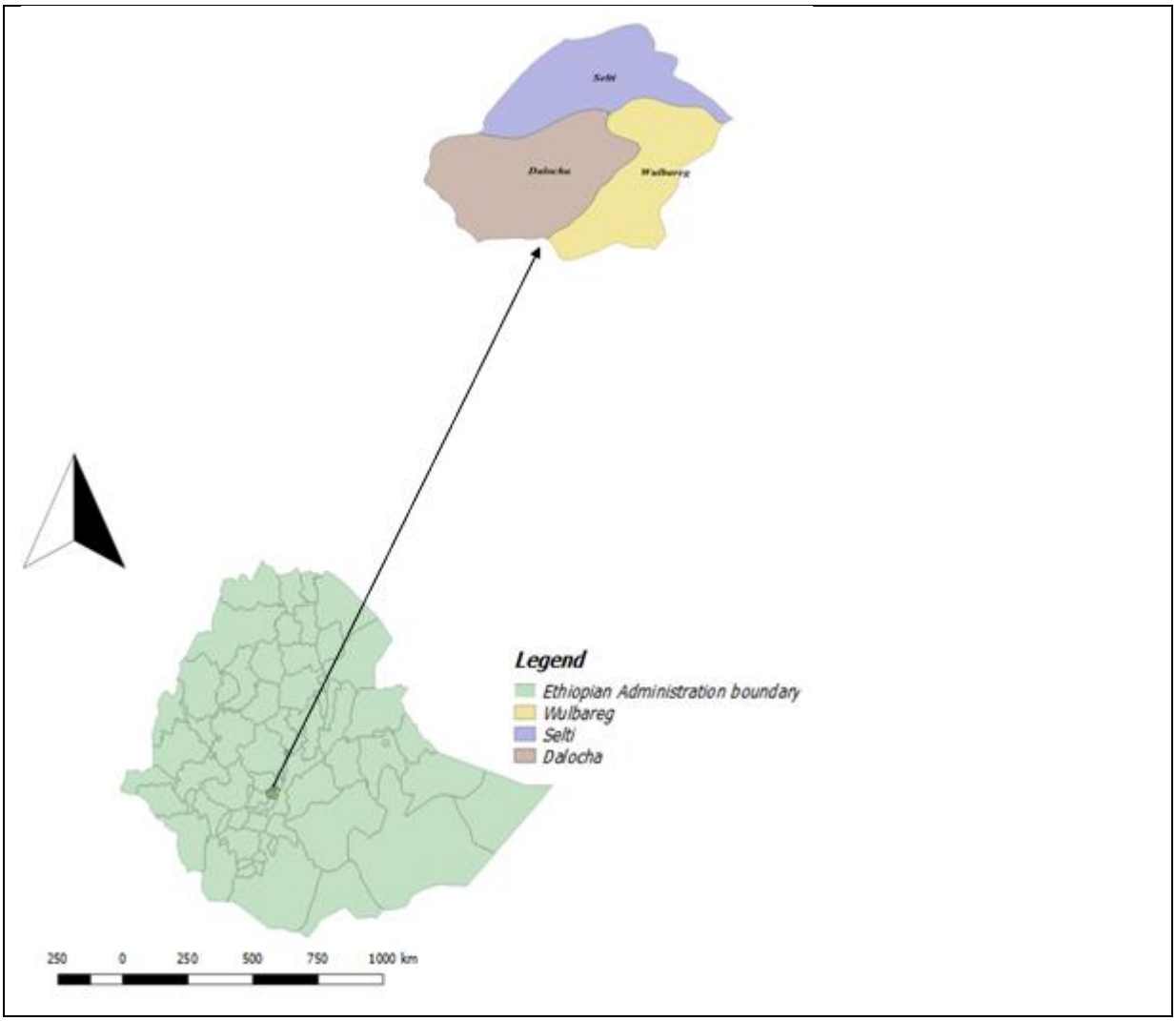



**Figure 1.** Location map of the study woredas

## 3.2. Sampling Method and Data Collection

### *3.2.1. Sampling and data collection for production system survey*

The study woredas were purposively selected based on their potential for chicken production, accessibility, and presence of indigenous chicken productions. From eight woredas of Silte Zone, three woredas namely Silti, Dalocha, and Wulbareg woredas were selected. Four remote rural farmers' kebeles with the least chance of exotic chicken distribution outreach were selected purposively from each woreda and a total of twelve kebeles were used for the survey. From each of the selected kebeles, 10 households (those possessing 5 chickens of indigenous breeds) were purposively selected. Accordingly, a total of 120 (10hhs × 4 kebeles × 3 woredas) households were used in the survey.

Three assistant data collectors (one for each woreda), two with B.Sc. Degree in Animal Science and one Diploma in Animal Science, all with sufficient experience to data collection and familiar to their respective woredas were purposively selected from the Livestock Development, Health Care and Market Agency offices of the study woredas. Prior to conducting the measurements they were oriented on basic methods of conducting the production system survey and efficiently collecting the necessary information from households in order to assist the researcher and to facilitate the data collection process.

A structured questionnaire integrated with Participatory Rural Appraisal (PRA) methods relevant to rural poultry production (ranking of problems, key informants, and group discussions) were used in the data collection process. Information was collected from individual farmers, extension officers (development agents), key informants and village groups using both methods. Before commencing the survey, the questionnaires were pretested using sample households and appropriate adjustments were made on specific contents. The exercises aimed at assessing the perspectives of the poultry production system included:

- Socio-economic characteristics of the chicken owners including:
    - Sex, age, major occupation, educational level, wealth status, and family size
    - Livestock holdings (cattle, sheep/goats, donkey/horse/mule, and chicken)

- The major source of money for chicken raising
- The major purpose of spending money in chicken raising

- Information on indigenous chicken including:
    - Flock structure and ownership: flock size (number of birds per household)
    - Flock characteristics, flock composition (chicks, pullets, layers, cockerels, and cocks)
    - The productivity of chicken and flock performance (number of times the hen incubates in a year, number of eggs per clutch of the hen, number of days per clutch, number of eggs per set of incubation, % hatchability of eggs and % survivability of chicks)
    - Sources of foundation (bought, gift) and replacement stock in the household
- Chicken management practices including:
    - Housing
    - Feeding (feed availability, types, and frequency of feeding)
    - Culling practices
- Diseases and health care practices (major types, occurrences, symptoms, and severity of diseases, and coping mechanism)
- Marketing chicken and eggs
- Provision of extension services and source of information for chicken rising
- Role of the government to improve chicken production and productivity
- Constraints prevailing in chicken production and opportunities for improving poultry production

### *3.2.2. Sampling and data collection for morphological studies*

Four remote farmers' kebeles with the least chance of exotic chicken distribution outreach were purposively selected from each of the three study woredas. From each of the selected four kebeles, 10 households (those possessing 5 indigenous chickens and above) were randomly selected for morphological studies. Households with exotic chicken or their crosses in the vicinity were excluded in the study. Neighboring households were also skipped to avoid the risk of sampling chickens sharing the same cock. All chickens of both sexes having about

6 months or above from each selected household were considered in the morphological study following the FAO descriptors for chicken genetic resources (FAO, 2007). Accordingly, 600 (5 chicken × 10 households' × 4 Kebeles × 3 woredas) adult chickens were used for morphological trait studies.

Quantitative data on body size parameters such as body weight, body girth (the circumference of the breast region), body (trunk) length (the distance from the insertion of the neck to the tail) and shank length (length of the shank from the top of the flexed hock joint to the bottom of the footpad) and shank circumference, beak length, comb length, wattle length, keel length, breast angle and body weight were collected from both sex groups. The age of approximately 6 months and above was chosen by considering the slow maturation of indigenous chickens to reach their adult age. The birds' age was determined by "recalling method" of interviewed farmers. Shank length was measured using mathematical divider and corresponding the equivalent reading by putting it on a graduated ruler. Likewise, beak, comb, wattle, and keel lengths were measured using the same and converted into readings of a graduated ruler. Folded wingspan, body length, and body girth were measured using a tailor's graduated tape. Live body weight was measured in kilogram using a "CAMRY" hanging scale. Breast angle was measured using a simple goniometer.

Qualitative phenotypic data was collected based on feather morphology, feather distribution and patterns, plumage color, shank color, earlobe color, beak color, eye color, skin color, comb and head types, and presence of spur as well as feathers on the shanks.

Descriptions of comb types were based on illustrations presented by Ensminger (1992), Roberts (1997) and Somes (2003). Feather patterns and distribution on shank and feet were described based on illustrations by Batty and Francis (1979) and Roberts (1997).

A copy of color pictures showing the basic comb types and other morphological traits were used during each appraisal process. Furthermore, relevant pictures on indigenous chickens were taken during field visits from villages of the surveyed households. These pictures were used to crosscheck and validate the descriptions given by farmers from each household.

In addition, the typical morphological features of indigenous chicken populations were conducted by the researcher together with the assistants (experienced Animal Science experts from the woreda livestock development offices, one for each study woredas) employed as assistants of the research project, and chicken owner-farmers.

### 3.3. Statistical Analysis

Data collected on qualitative and quantitative traits of indigenous chicken populations were coded and entered into a computer using Microsoft Office Excel (2007). The qualitative and quantitative data sets were analyzed using appropriate statistical analysis procedures. R statistical software and SPSS (2007) was used on some of the quantitative parameters (functional traits) and qualitative parameters. The model was fitted to the main effects of district and sex on body weight and linear body measurements of chickens. Distinct measurements on the qualitative morphological traits were analyzed using frequency procedure of Chi-square ($\chi 2$) test. Body weight and quantitative linear body measurements were analyzed using the Generalized Linear Model procedures (SPSS, 2007). Sampling districts were fitted as fixed independent variables. Means were compared using Duncan's multiple range test and values were considered significant at $P<0.05$. Correlation analysis was conducted to identify the relationship between quantitative morphological traits. Discrete measurements on the qualitative morphological traits of the investigated animals were analyzed using the frequency procedure of Chi-square ($\chi 2$) test. Binomial variables from records on qualitative characters were reported as percentages.

Model for quantitative data sets

$$Y_{ijk} = \mu + A_i + S_j + E_{ijk}$$

Where:

$Y_{ijk}$ = observed linear body measurements of $k^{th}$ individual chicken

$\mu$ = overall mean

$A_i$ = fixed effect of $i^{th}$ district (i = Silte, Dalocha or Wulbareg)

$S_j$ = fixed effect of $j^{th}$ sex (j= male, female)

$E_{ijk}$ = random error

For qualitative data, frequency or proportion was used.

# 4. RESULTS

## 4.1. Production System Parameters of Chicken in the Study Woredas

Tables of summarized results of the components studied to characterize the production system of chicken in the study woredas, and are presented in this section.

### *4.1.1. Socio-economic characteristics of the households*

The overall average family size in the study woredas was 8.03 persons per household and family size of households was significantly less (P<0.05) in Wulbareg but comparable in Silti and Dalocha woredas. Farmers in the study area reared an average number of various types of livestock species including cattle (2.7), sheep/goats (1.3), donkey/horse/mule (0.7) and chicken (9.9) per household (Table 1).

**Table 1.** Mean±SD of socio-economic characteristics of households

| Parameter | Study Woredas | | | | | | |
|---|---|---|---|---|---|---|---|
| | Silti n=40hh | Dalocha n=40hh | Wulbare g n=40hh | Overall n=120hh | Range | | P-value |
| | | | | | Min | Max | |
| Family size of respondents (persons) | 8.2±2.9 | 8.1±0 | 7.8±2.4 | 8.03±2.8 | 3 | 15 | $0.8^{ns}$ |
| Livestock ownership Last year (head) | | | | | | | |
| Cattle | 2.5±1.5 | 2.5±1.9 | 3.1±2.2 | 2.7±1.5 | 0 | 8 | $0.2^{ns}$ |
| Sheep/goats | 0.9±0.7 | 1.2±1.5 | 2±2.2 | 1.3±0.7 | 0 | 9 | $0.1^{ns}$ |
| Donkey/horse/mule | 0.7±0.5 | 0.7±0.5 | 0.8±0.5 | 0.7±.5 | 0 | 2 | $0.2^{ns}$ |
| Chicken | 9.1±2.5 | 9.9±2.6 | 10.7±2.6 | 9.9±2.5 | 5 | 15 | $0.6^{ns}$ |
| Age groups of chicken owned (head) | | | | | | | |
| Chicks | 1.6±2.1 | 2.2±2.4 | 3.1±2.6 | 2.3±2.1 | 0 | 7 | $0.3^{ns}$ |
| Cockerels | 0.4±0.7 | 0.5±0.8 | 0.4±0.6 | 0.4±0.7 | 0 | 3 | $0.6^{ns}$ |
| Pullets | 0.8±1.1 | 0.8±1.0 | 0.7±1.0 | 0.7±1.1 | 0 | 3 | $0.3^{ns}$ |
| Cocks | 1±0.6 | 1.1±0.6 | 1.4±0.7 | 1.2±0.6 | 0 | 3 | $0.3^{ns}$ |
| Hens | 5.3±1.3 | 5.4±1.2 | 5.2±1.3 | 5.3±1.3 | 2 | 8 | $0.4^{ns}$ |

** = significant (P < 0.01); hh = interviewed households; ns, not significant

As presented in Table 2, the age of the respondents in the study woredas was 15-30 years (19.2%), 31-60 years (79.2%) and above 60 years (1.7%). Assessment of educational profile of the household heads indicated that the majority were illiterate (42.5%), followed by those with Read & Write (25.8%), grade 1- 4 (20%) and grade 5–8 education. The farmland holding in the study woredas (Table 8) was 0.5-1 ha (55%), 1-2 ha (25.8%), less than 0.5 ha (18.3%) and 2-3 ha (0.8%).

**Table 2.** Sex, Age, Major occupation, Farmland size, Educational profile, and Wealth status of respondents

| Parameter | Study Woredas | | | | |
|---|---|---|---|---|---|
| | Silti n=40hh | Dalocha n=40hh | Wulbareg n=40hh | Overall n=120hh | $\chi^2$ |
| Sex of respondents (%) | | | | | $0.1^{ns}$ |
| Male | 75.0 | 72.5 | 75.0 | 74.2 | |
| Female | 25.0 | 27.5 | 25.0 | 25.8 | |
| Age of respondents (year) (%) | | | | | $5.4^{ns}$ |
| 15-30 years | 17.5 | 25.0 | 15.0 | 19.2 | |
| 31-60 years | 77.5 | 75.0 | 85.0 | 79.2 | |
| Above 60 years | 5.0 | 0 | 0 | 1.7 | |
| Major occupation of respondents (%) | | | | | $0^{ns}$ |
| Farmer | 100.0 | 100.0 | 100.0 | 100 | |
| Farmland size (%) | | | | | $9.1^{ns}$ |
| 0.5 - 1ha | 45.0 | 55.0 | 65.0 | 55.0 | |
| 1 - 2 ha | 25.0 | 27.5 | 25.0 | 25.8 | |
| 2 - 3 ha | 0 | | 2.5 | 0.8 | |
| Less than 0.5 ha | 30.0 | 17.5 | 7.5 | 18.3 | |
| Educational profile of respondents (%) | | | | | $2.4^{ns}$ |
| Illiterate | 42.5 | 40.0 | 45.0 | 42.5 | |
| Read & Write | 25.0 | 25.0 | 27.5 | 25.8 | |
| Grade 1 to 4 | 17.5 | 27.5 | 17.5 | 20 | |
| Grade 5 to 8 | 15.0 | 10.0 | 10.0 | 11.7 | |
| Wealth status of respondents (%) | | | | | $4.0^{ns}$ |
| Medium | 17.5 | 27.5 | 37.5 | 27.5 | |
| Poor | 82.5 | 72.5 | 62.5 | 72.5 | |

Figures are in percentage; hh = interviewed households; $\chi^2$ = chi-square; ns, not significant

Chicken production requires a foundation and careful replacement source for sustainable rearing of chickens. Purchased, inherited/ gift and hatched chicks were the major sources of foundation and replacement chicken in the study area (Table 3).

**Table 3.** Source of foundation and replacement chicken, expenses and source of money for chicken rising

| Parameter | Study Woredas | | | | $\chi^2$ |
|---|---|---|---|---|---|
| | Silti n=40 hh | Dalocha n=40 hh | Wulbareg n=40 hh | Overall n=120 hh | |
| Source of foundation chicken (%) | | | | | $4.8^{ns}$ |
| A gift from family/friends | 0 | 0 | 5.0 | 1.7 | |
| Hatched at home | 40.0 | 32.5 | 30.0 | 34.2 | |
| Local market | 60.0 | 67.5 | 65.0 | 64.2 | |
| Source of replacement chicken (%) | | | | | $6.5^{ns}$ |
| Hatched at home | 92.5 | 90.0 | 92.5 | 91.7 | |
| Local market | 7.5 | 10.0 | 7.5 | 8.3 | |
| Expenses for chicken raising (%) | | | | | $6.1^{ns}$ |
| Purchase of chicken feeds | 55.0 | 50.0 | 42.5 | 49.2 | |
| Purchase of foundation | 42.5 | 47.5 | 52.5 | 47.5 | |
| Purchase of medicaments | 0 | 0 | 5.0 | 1.7 | |
| Replacement stock | 2.5 | 2.5 | 0 | 1.7 | |
| Source of money for chicken rising (%) | | | | | $9.2^{ns}$ |
| Animal/Products sale | 0 | 0 | 5.0 | 1.7 | |
| Chicken sale | 2.5 | 2.5 | 0 | 1.7 | |
| Crop sale | 85.0 | 87.5 | 85.0 | 85.8 | |
| Egg sale | 5.0 | 0 | 0 | 1.7 | |
| Off-farm income | 7.5 | 10.0 | 10.0 | 9.2 | |
| Intent to boost chicken production (%) | | | | | $0.5^{ns}$ |
| no | 97.5 | 97.5 | 95.0 | 96.7 | |
| yes | 2.5 | 2.5 | 5.0 | 3.3 | |
| Regulation in raising/consumption/sale of chicken and/or eggs (%) | | | | | $0.5^{ns}$ |
| no | 97.5 | 97.5 | 95.0 | 96.7 | |
| yes | 2.5 | 2.5 | 5.0 | 3.3 | |

** = significant ($P < 0.01$); hh = interviewed households; $\chi^2$ = chi-square; ns, not significant

The major source of foundation chicken was the local market (64.2%), and a major source of replacement chicken was hatching at home (91.7%). There is no significant difference (P>0.05) between the study woredas. The major expenses for the chicken rising were chicken feeds purchasing (49.2%) and followed by the purchase of foundation chicken (47.5%). The result also indicates that crop sale (85.8%) was the main source of money for chicken rising (Table 3).

*4.1.2. Feeds and feeding*

The chicken production system in the rural area of the study woredas was predominantly scavenging feed resource. The chickens scavenge under trees, field crops, family leftover feeds and also pilfering of family food when put outside for sun drying. Thus, the combination of these feed sources together with limited supplementation sustains the life of the birds in the study woredas.

All of these are full of risk to the chicken. Chicken scavenging under trees and open field are at risk of predators in general to the hawks and cats in particular. Besides scavenging, there was supplementation to the chickens. In the study woredas, all households provided supplementary feed even though the adequacy is questionable (Table 4).

Based on the results (Table 4), the majority of households (66.7%) fed all types of feeds (grain, concentrates and by-products/ leftover), 16.7% households feed grain and by-products/ leftover, and 16.7% households feed only grain and concentrate. The majority (90.8%) households have used both methods of feed provision (put feed in a container for young chicks and nursing hens and throw feed on the ground for collective feeding of all adults). 90.8% of households given grain feeds (maize and wheat) to chicken.

Feedstuffs such as wheat, maize, barley, either intact or soaked; '*Qinche*' (crushed and cooked wheat), '*Frushka*' and '*Frushkello*' (wheat bran and middlings), '*Enjera*' and '*Dabo firfir'* (soaked scrubs of '*Enjera*' and local bread), and kitchen leftovers were the common types of supplementary feeds for chickens in the study area. The majority (41.7%) households were

given '*Enjera firfir'* only for chickens followed by 40.8% households given '*Enjera firfir'* and '*Dabo firfir*' and 12% households given other by-products to chickens (Table 4).

**Table 4.** Feeds resources, feeding, and watering of chicken

| Parameter (%) | Study Woredas | | | | |
|---|---|---|---|---|---|
| | Silti n=40 hh | Daloch n=40 hh | Wulbareg n=40 hh | Overall n=120h | $\chi^2$ |
| Supplementation (yes) | 100.0 | 100.0 | 100.0 | 100 | $0^{ns}$ |
| Types of supplementary feeds | | | | | $2.0^{ns}$ |
| All types (Grain, concentrates and by-products/ leftover) | 67.5 | 67.5 | 65.0 | 66.7 | |
| Grain and by-products/Leftover | 20.0 | 17.5 | 12.5 | 16.7 | |
| Grain and concentrates only | 12.5 | 15.0 | 22.5 | 16.7 | |
| Method of feed provision | | | | | $13.9^{*}$ |
| Put feed in a container for young chicks and nursing hens | 10.0 | 7.5 | 0 | 5.8 | |
| Throw feed on the ground for collective feeding of all adults | 10.0 | 0 | 0 | 3.3 | |
| Both methods used | 80.0 | 92.5 | 100.0 | 90.8 | |
| Grain feeds given to chicken | | | | | $3.5^{ns}$ |
| Grain and by-products/Leftover | 7.5 | 7.5 | 0 | 5.0 | |
| Maize and wheat | 90.0 | 87.5 | 95.0 | 90.8 | |
| Maize only | 2.5 | 5.0 | 5.0 | 4.2 | |
| Concentrate feeds given to chicken | | | | | $10.3^{ns}$ |
| Both of the above | 50.0 | 65.0 | 67.5 | 60.8 | |
| Crushed and cooked wheat ('*Qinche*') /boiled teff | 22.5 | 12.5 | 12.5 | 15.8 | |
| Grain and by-products/Leftover | 7.5 | 7.5 | 0 | 5.0 | |
| Other concentrate feeds | 0 | 0 | 5.0 | 1.7 | |
| Wheat bran ('*Frushka*') / Wheat short ('*Frushkello*') | 20.0 | 15.0 | 15.0 | 16.7 | |
| By-product feeds given to chicken | | | | | $8.8^{ns}$ |
| "*Enjera firfir*" and "*Dabo firfir*" | 42.5 | 50.0 | 30.0 | 40.8 | |
| '*Enjera firfir'* only | 35.0 | 35.0 | 55.0 | 41.7 | |
| Grain and by-products/Leftover | 7.5 | 7.5 | 0 | 5.0 | |
| Other by-products | 15.0 | 7.5 | 15.0 | 12.5 | |

$^{*}$ = $P < 0.05$; hh = interviewed households; $\chi^2$ = chi-square; ns, not significant

In this study (Table 5), there were two major sources of water to the birds such as a river (35.8%), and pipe (64.2%). About 72.5% of households used plastic equipment (mainly

plastic pan locally called "*Mastatebya*") while 3.3 % used clay made, 6.7% used wooden made and 17.5% used stone made drinkers. The type of grain feeds used was more or less similar among the three woredas as the woredas are adjacent to each other and the grains are readily available at local markets.

**Table 5.** Frequency of feeding, Source of drinking water and type of drinkers used, and limitations to provide supplementary feeds to chicken

| | Study Woredas | | | | |
|---|---|---|---|---|---|
| Parameter (%) | Silti n=40hh | Dalocha n=40hh | Wulbareg n=40hh | Overall n=120hh | $\chi^2$ |
| Frequency of feeding chicken daily | | | | | 11.5* |
| All times (morning, noon, evening) | 42.5 | 47.5 | 15.0 | 35.0 | |
| Morning and noon | 42.5 | 32.5 | 55.0 | 5.0 | |
| Morning only | 15.0 | 20.0 | 30.0 | 60.0 | |
| Frequency of morning feeding | | | | | 0.4ns |
| None | 2.5 | 5.0 | 5.0 | 4.2 | |
| Once | 97.5 | 95.0 | 95.0 | 95.8 | |
| Frequency of noon feeding | | | | | 2.7ns |
| None | 15.0 | 20.0 | 30.0 | 21.7 | |
| Once | 85.0 | 80.0 | 70.0 | 78.3 | |
| Frequency of evening feeding | | | | | 15.8*** |
| None | 50.0 | 45.0 | 85.0 | 60 | |
| Once | 50.0 | 55.0 | 15.0 | 40 | |
| Source of drinking water | | | | | 1.2ns |
| River | 42.5 | 32.5 | 32.5 | 35.8 | |
| Tap/Pipe | 57.5 | 67.5 | 67.5 | 64.2 | |
| Type of drinkers used | | | | | 10.6ns |
| Clay made | 0 | 2.5 | 7.5 | 3.3 | |
| Plastic made | 80.0 | 70.0 | 67.5 | 72.5 | |
| Stone made | 10.0 | 17.5 | 25.0 | 17.5 | |
| Wooden made | 10.0 | 10.0 | 0 | 6.7 | |
| Limitations to provide supplementary feeds to chicken | | | | | 8.8ns |
| Lack of awareness & knowledge about feeds and feeding | 7.5 | 5.0 | 20.0 | 10.8 | |
| Lack of cash credit | 10.0 | 10.0 | 0 | 6.7 | |
| Unavailability of feeds | 82.5 | 85.0 | 80.0 | 82.5 | |

*** = P < 0.001; * =P<0.01; hh = interviewed households; $\chi^2$ = chi-square; figures are in percentage

Only 5.8% of the respondents used the feeder to provide supplementary feed especially for wet feeds such as soaked '*Enjera*', Ethiopian stable food, and 3.3% spread the feeds simply on the ground for all chicken groups which leads to feeding wastage, while the rest (90.8%) used both methods. Even though the majority of the interviewed households (82.5%) reported they had unavailability of feeds for their chicken, some of them blamed lack of knowledge about feeding and feeds of chicken (10.8%) and lack of cash credit (6.7%), among others (Table 5).

*4.1.3. Housing and accommodation of chicken*

Separate house construction for chickens was not a common practice in the study woredas; only 7.5% of the respondents provided a separate house for the chicken. Therefore, the majority (92.5%) of chicken owners shared their main houses with the chicken and other animals which makes the bio-security of the village poultry production system very poor (Table 6).

**Table 6.** Type of night enclosure used for chicken

| Parameter (%) | Study Woredas | | | | |
|---|---|---|---|---|---|
| | Silti n=40hh | Dalocha n=40hh | Wulbareg n=40hh | Overall n=120hh | $\chi^2$ |
| Night enclosure for chicken | | | | | 13.9* |
| A room/ rooster inside the main house/attached to the main house | 5.0 | 2.5 | 7.5 | 5.0 | |
| Handwoven material (basket)/ plastic bag/ etc. | 25.0 | 12.5 | 5.0 | 14.2 | |
| House purposely made for the chicken | 12.5 | 10.0 | 0 | 7.5 | |
| Kitchen / Animals' house | 57.5 | 75.0 | 87.5 | 73.3 | |
| Frequency of house cleaning | | | | | 1.4$^{ns}$ |
| Every day (7days) | 90.0 | 87.5 | 95.0 | 90.8 | |
| Every three days (2 days) | 10.0 | 12.5 | 5.0 | 9.2 | |

* = P< 0.05; hh = interviewed households; $\chi^2$ = chi-square; ns, not significant; figures are in percentage

On the other hand, the present study has also found out that those chicken owners providing the separate house for night enclosure of their chicken clean the houses at different frequencies in a week; (90.8%) every day and (9.2%) every three days (Table 6). The largest

frequency of chicken house cleaning (every day) is an indication of high attention of chicken owners to the important component of chicken husbandry.

*4.1.4. Diseases and health management of chicken*

Like other parts of the country, a disease in the study woredas was challenging to chicken production and there was an occasion where chicken owners lose the whole flock at a time. Majority of the respondents (80%) said that a disease outbreak in the study area occurs in the short rainy season (*Belg*).

To treat sick birds chicken owners used both modern and traditional methods. The modern approach includes taking sick animals to animal health clinic and tablet usage whereas the traditional method includes using mixture of '*Enjera firfir'* (scrubs of Ethiopian staple food made from *Eragrostis teff*), edible oil, spices (like hot pepper and garlic), roots and leaves of some plants (like Vernonia, Sensel (*Adhatoda schimperiana*), '*Endod*' (*Phytolacca dodecandra*), tobacco, neem (*Azadirachta indica*), and chalk, DAP, lemon juice and '*Katikala*' (local methyl alcohol). In general, use of local/traditional medicines (40.0%), modern medicines with prescription (55.8%), modern medicines without prescription (4.2%) and combinations of these were the common methods of treating sick birds (Table 7).

The respondents also reported predators are challenging for their chicken next to diseases in the study area (Table 7). Cats (both domestic and wild), hawks and rats were some of the predators mentioned by the farmers. Predation by wild cats and hawks was said to be the major cause for the chicken loss.

**Table 7.** Diseases and health management of chicken

| Parameter (%) | Study Woredas | | | | |
|---|---|---|---|---|---|
| | Silti n=40hh | Dalocha n=40hh | Wulbareg n=40hh | Overall n=120hh | $\chi^2$ |
| Experience of chicken disease outbreaks (yes) | 100.0 | 100.0 | 100.0 | 100.0 | $0^{ns}$ |
| Actions are taken when a chicken gets sick | | | | | $5.4^{ns}$ |
| Call veterinarian for help | 2.5 | 5.0 | 7.5 | 5.0 | |
| Other actions | 0 | 2.5 | 7.5 | 3.3 | |
| Sell them immediately | 7.5 | 10.0 | 5.0 | 7.5 | |
| Treat with all means | 90.0 | 82.5 | 80.0 | 84.2 | |
| Types of medicines used to treat sick birds | | | | | $6.2^{ns}$ |
| Modern medicines with prescription | 55.0 | 62.5 | 50.0 | 55.8 | |
| Modern medicines without prescription | 0 | 2.5 | 10.0 | 4.2 | |
| Traditional/local medicines | 45.0 | 35.0 | 40.0 | 40.0 | |
| The most common chicken disease encountered | | | | | $3.6^{ns}$ |
| New castle disease (NCD) | 100.0 | 97.5 | 92.5 | 96.7 | |
| No response obtained | 0 | 2.5 | 7.5 | 3.3 | |
| Most noticeable symptoms of NCD | | | | | $1.0^{ns}$ |
| Standing stiff, keeping head down/sleepiness/ heavy breathing/ coughing/stager rotation, etc. | 2.5 | 5.0 | 7.5 | 5.0 | |
| All the above symptoms are noticed | 97.5 | 95.0 | 92.5 | 95.0 | |
| More susceptible age group of chicken to NCD | | | | | $3.6^{ns}$ |
| All age group | 100.0 | 97.5 | 92.5 | 96.7 | |
| No response obtained | 0 | 2.5 | 7.5 | 3.3 | |
| The favorable season for the occurrence of NCD | | | | | $5.6^{ns}$ |
| Ending of the rainy season | 12.5 | 15.0 | 22.5 | 16.7 | |
| No response obtained | 0 | 2.5 | 7.5 | 3.3 | |
| The short rainy season (*Belg*) | 87.5 | 82.5 | 70.0 | 80.0 | |
| The severity of NCD/ tolerance of chicken | | | | | $2.8^{ns}$ |
| No response obtained | 20.0 | 12.5 | 7.5 | 13.3 | |
| Very high/very low for all ages | 67.5 | 75.0 | 80.0 | 74.2 | |
| Very high/very low for young chicken; medium/medium for adults; and very low/very high for old birds | 12.5 | 12.5 | 12.5 | 12.5 | |
| The local treatment used for NCD | | | | | $3.3^{ns}$ |
| A mixture of enjera, edible oil, plant root crush, neem leaf crush, lemon juice, and garlic crush | 50.0 | 57.5 | 70.0 | 59.2 | |
| Possible combinations of all the above | 50.0 | 42.5 | 30.0 | 40.8 | |
| Potential threats or constraints of chicken production and productivity | | | | | $17.8^{**}$ |
| No threat/ no response obtained/ | 0 | 0 | 0 | 0 | |
| Diseases (esp. NCD) | 0 | 0 | 0 | 0 | |
| Predators (both aerial and land) | 32.5 | 15.0 | 0 | 15.8 | |
| Both diseases and predators | 40.0 | 45.0 | 42.5 | 42.5 | |
| Other constraints | 0 | 0 | 0 | 0 | |
| All the above three constraints | 27.5 | 40.0 | 57.5 | 41.7 | |
| Diseases and other constraints | 0 | 0 | 0 | 0 | |

$^{*}$ = P< 0.05; $^{**}$ = P< 0.01; hh = households; $\chi^2$ = chi-square; ns, not significant; figures are in percentage

*4.1.5. The productivity of chicken*

Age at first egg and at sexual maturity of village chickens in the study woreda was 5.8 and 5.2 months, respectively; the average eggs produced per local hen per clutch and the average number of days per clutch was found to be 14.1 and 22.9, respectively; and the average clutch number of hens per year was 3.05, and the total number of eggs produced per hen per year was 43.01 in the study woredas (Table 8).

The average number of eggs incubated per hen in this study was 11.2 (ranging 8-13) which were 79.43% of the eggs laid per clutch. Out of the incubated eggs, only 10.3 chicks were hatched, giving average hatchability percentage of 91.9%. Among the hatched chicks only 5.2 grow to market age which implies 50.5% survival rate suggesting high chick mortality. No significant difference (P > 0.05) was observed among the study woredas in age at first mating, age at first egg, number of eggs per clutch, and a number of days per clutch, and number of chicks surviving. But, a significant difference (P< 0.05) was observed among the study woredas in the number of chicks hatching and hatchability (Table 8).

**Table 8.** Mean ±SD of the productivity of domestic indigenous chicken

| | Study Woredas | | | | | | |
|---|---|---|---|---|---|---|---|
| | Silti | Dalocha | Wulbareg | Overall | Range | | P-value |
| Parameter | n=40hh | n=40hh | n=40hh | n=120hh | Min | Max | |
| Age at first mating (months) | 5.2±0.6 | 5.2±0.5 | 5.2±0.5 | 5.2±0.6 | 4 | 6 | ns |
| Age at first egg (months) | 5.8±0.5 | 5.9±0.5 | 5.9±0.4 | 5.8±0.5 | 5 | 6.5 | ns |
| Number of eggs per clutch | 13.9±2.2 | 14.4±1.9 | 14.1±1.7 | 14.1±2.2 | 10 | 18 | ns |
| Number of days per clutch | 21.8±3.1 | 22.8±3.4 | 24.2±3.2 | 22.9±3.1 | 15 | 30 | ns |
| Number of eggs per set | 11.3±1.5 | 11.4±1.4 | 11.1±1.3 | 11.2±1.5 | 8 | 13 | ns |
| Clutch number per hen/year | 3.05±0.6 | 3.05±0.5 | 3.05±0.5 | 3.05±0.6 | 1 | 4 | ns |
| Number of chicks hatching | 10.3±1.4 | 10.5±1.3 | 9.9±1.5 | 10.3±1.4 | 6 | 12 | * |
| Hatchability (%) | 92.3±11.9 | 93.2±10.5 | 90.1±13.7 | 91.9±12 | 50 | 100 | ** |
| Number of chicks surviving | 5±1.3 | 5.3±1.2 | 5.3±1.4 | 5.2±1.3 | 2 | 8 | ns |
| Survivability (%) | 48.5±9.6 | 50.2±8.3 | 52.7±11.1 | 50.5±9.6 | 20 | 80 | ns |

* = P<0.05; hh = interviewed households; ** = P< 0.01; ns, not significant

a. Grass made with straw bedding

b. Bamboo made with straw bedding

c. Clay material with straw bedding

d. Plastic material with straw bedding

**Figure 2.** Some of the incubation materials used in the study woredas

Figure 2 displays different types of homemade materials used for incubating purposes. As presented in Table 9, the common types of incubating materials used in the study area are wood made material bedded with straw (80%), clay made material bedded with straw (15%), and other materials (like modified plastics, cartoon, bamboo, metal, etc.) 5%. All the chicken owners use bedding materials mainly of crop residues such as '*teff*' straw, barley straw and wheat straw. About 93.3% of chicken owners provided grain and water for their incubating hen every day, whereas only 6.7% did the same every other day.

**Table 9.** Egg incubation and management of hen during incubation period

| Parameter (%) | Study Woredas | | | | |
|---|---|---|---|---|---|
| | Silti n=40hh | Dalocha n=40hh | Wulbareg n=40hh | Overall n=120hh | $\chi^2$ |
| Frequency of incubation per hen per year | | | | | $7.2^{ns}$ |
| Four times | 7.5 | 7.5 | 0 | 5.0 | |
| Thrice | 35.0 | 25.0 | 17.5 | 25.8 | |
| Twice | 57.5 | 67.5 | 82.5 | 69.2 | |
| Materials in which the hens incubate eggs | | | | | $3.1^{ns}$ |
| Clay made material bedded with straw | 15.0 | 15.0 | 15.0 | 15.0 | |
| Other materials (like modified plastics, cartoon, bamboo, metal, etc.) | 7.5 | 7.5 | 0 | 5.0 | |
| Wood made material bedded with straw | 77.5 | 77.5 | 85.0 | 80.0 | |
| Do respondents feed incubating hens? | | | | | $0^{ns}$ |
| yes | 100.0 | 100.0 | 100.0 | 100.0 | |
| Type of feed given and frequency of feeding incubating hens | | | | | $0.2^{ns}$ |
| Grain and water every day | 92.5 | 92.5 | 95.0 | 93.3 | |
| Grain and water every other day (two days) | 7.5 | 7.5 | 5.0 | 6.7 | |
| Kind of care provided for incubating hen | | | | | $6.1^{*}$ |
| No special care except feeding and watering | 0 | 0 | 7.5 | 2.5 | |
| Keep her at a safe and quiet corner of the house | 0 | 0 | 0 | 0 | |
| Keep her secure from the reach of cocks and other chicken | 0 | 0 | 0 | 0 | |
| Keep her from any kind of interference | 0 | 0 | 0 | 0 | |
| All kinds of care listed | 100.0 | 100.0 | 92.5 | 97.5 | |
| Management or decisions made on poor or weak incubator hens | | | | | $9.3^{ns}$ |
| No response obtained | 17.5 | 12.5 | 0 | 10.0 | |
| Avoid using her for incubation purpose anymore | 12.5 | 12.5 | 12.5 | 12.5 | |
| Cull her out (for sale or consumption) | 15.0 | 20.0 | 32.5 | 22.5 | |
| Both methods (b and c) used | 55.0 | 55.0 | 55.0 | 55.0 | |

$^{*}$ = P< 0.05; ns, not significant; hh = interviewed households; $\chi^2$ = chi-square;; figures are in percentage

*4.1.6. Chicken culling practices*

Table 10 presents the summary of chicken culling practiced in the study woredas. The results indicate that majority of chicken owners in the study area (90.8%) purposely cull their chicken at any time, whereas the rest (9.2%) did not purposely cull their chicken at any time.

**Table 10.** Chicken culling practices

| Parameter (%) | Study Woredas | | | | $\chi^2$ |
|---|---|---|---|---|---|
| | Silti n=40hh | Dalocha n=40hh | Wulbareg n=40hh | Overall n=120hh | |
| Do respondents purposely cull their chicken at any time? | | | | | 18.2*** |
| no | 0 | 2.5 | 25.0 | 9.2 | |
| yes | 100.0 | 97.5 | 75.0 | 90.8 | |
| Major purpose of culling chicken | | | | | 1.5ns |
| For consumption | 7.5 | 5.0 | 12.5 | 8.3 | |
| For sale | 92.5 | 95.0 | 87.5 | 91.7 | |
| Major determinant factor for culling a chicken | | | | | 2.4ns |
| Age (oldness) | 27.5 | 40.0 | 35.0 | 34.2 | |
| Other reasons | 30.0 | 27.5 | 25.0 | 27.5 | |
| Poor productivity | 32.5 | 25.0 | 35.0 | 30.8 | |
| Sickness (diseases) | 10.0 | 7.5 | 5.0 | 7.5 | |
| Age at which chicken is culled (for both sexes) | | | | | 5.0ns |
| 2 years | 97.5 | 95.0 | 85.0 | 92.5 | |
| 2.5 years | 2.5 | 5.0 | 15.0 | 7.5 | |

*** = P< 0.001); ns, not significant; hh = interviewed households; $\chi^2$ = chi-square; figures are in percentage

The highest proportion of chicken owners (34.2%) reasoned age (oldness) as the major determinant for culling, followed by poor productivity (30%), other reasons like the need of money and lack of space (27.5%) and diseases (7.5%). 91.7% of the interviewed chicken owners responded selling was the major purpose of culling their chicken, while only 8.3% cull for home consumption (scarification). The maximum age for culling old birds in the study area was 2 years as witnessed by 92.5% of the chicken owners, followed by 2.5 years (7.5%).

Further, the respondents relate the general decline of productivity with the age of the chicken as well as feeding and management aspects (Table 10).

*4.1.7. Marketing of chicken and eggs*

As presented in table 11, the result of the current study revealed that village chicken owners traveled an average distance of 4.7 km (ranging 3-5.5) to reach to nearby local and/or urban markets.

The market price of chicken showed variation between sex and size as well as between holiday eve markets (HDM) and ordinary markets (ODM). A small sized cockerel and a large sized cock had average market prices of 65.2 Birr and 168.8 Birr at holiday markets and 55.1 Birr and 138.5 Birr at ordinary markets, respectively. Price of eggs also varied between holiday eves and ordinary markets (Table 11).

There is no formal poultry and poultry product marketing channel in the study area and informal marketing of live birds and eggs involving open markets are common throughout the woredas. The farmers directly sell their chicken and/or to consumers and/or to small retail traders who take them to large urban centers. Live chickens and eggs are sold either at the small village market (primary market) or at larger woreda market (secondary markets in towns). There is an exchange of commodities throughout the week with one regular market day at Wulbareg (Wulbareg woreda town), Kibat (Silti woreda town) and two regular market days at Dalocha (Dalocha woreda town).

On the other hand, 100% of the women in the study area are involved in collecting and selling of eggs and participate in selling chicken, respectively (Table 11). Body weight, health status, and other factors were the principal determinants (98.3%), whereas plumage color accounted for only 1.7% for the marketing of chicken in the study area. All of the chicken owner farmers (100%) reasoned demand seasonality as major market problems.

**Table 11.** Mean± SD of chicken and egg marketing

| Parameter | Study Woredas | | | | | |
|---|---|---|---|---|---|---|
| | Silti n=40hh | Dalocha n=40hh | Wulbareg n=40hh | Overall n=120hh | Range Min | Max |
| Market distance (km) | 4±1.0 | 5±0 | 5±0.1 | 4.7±0.7 | 3.0 | 5.5 |
| Price of a small-sized cockerel at HDM (Birr) | 68±9.7 | 65.4±9.2 | 62.1±7 | 65.2±9.0 | 45 | 80 |
| Price of small-sized cockerel during ODM (Birr) | 58±9.7 | 55.5±9 | 51.9±7 | 55.1±9.1 | 35 | 70 |
| Price of a medium-sized cockerel at HDM (Birr) | 92.3±16.7 | 88.3±14 | 86.5±14 | 89.0±15.2 | 60 | 120 |
| Price of medium-sized cockerel during ODM (Birr) | 81.5±15.6 | 77±11.4 | 73.8±10 | 77.4±12.9 | 50 | 120 |
| Price of large-sized cock at HDM (Birr) | 174.8±20 | 170±17 | 161±14 | 168.8±18 | 130 | 200 |
| Price of large-sized cock at ODM (Birr) | 145±21.4 | 139.5±18 | 131±9.8 | 138.5±18 | 120 | 180 |
| Price of small-sized pullet at HDM (Birr) | 58.1±9.1 | 55.8±8.4 | 53±6.6 | 55.6±8.3 | 40 | 70 |
| Price of small-sized pullet during ODM (Birr) | 47.9±8.4 | 46.4±7.8 | 44±6.3 | 46.1±7.6 | 30 | 60 |
| Price of medium-sized pullet at HDM (Birr) | 73.6±9.3 | 71.4±8.9 | 68±7.7 | 70.9±8.9 | 60 | 90 |
| Price of medium-sized pullet during ODM (Birr) | 63.3±9.8 | 61.3±9 | 57.9±7 | 60.8±9.0 | 50 | 80 |
| Price of large-sized hen at HDM (Birr) | 130±13 | 127±14.8 | 121.6±5 | 126.2±14 | 80 | 150 |
| Price of the large-sized hen during ODM (Birr) | 105.4±9.7 | 103±9.9 | 98.5±9 | 102.4±9.8 | 75 | 120 |
| Price of an egg at HDM (Birr) | 3.5±0.4 | 3.5±0.3 | 3.6±0.3 | 3.5±0.3 | 3.0 | 4.0 |
| Price of an egg during ODM (Birr) | 3±0.4 | 3.1±0.3 | 3.1±0.3 | 3.0±0.3 | 2.5 | 3.5 |
| Parameter (%) | | | | | $\chi^2$ | |
| Who collects & sells eggs? (%) | | | | | $0^{ns}$ | |
| Owners themselves (mainly women) | 100.0 | 100.0 | 100.0 | 100.0 | | |
| Do women participate in selling chicken and eggs? yes | 100.0 | 100.0 | 100.0 | 100.0 | $0^{ns}$ | |
| The principal basis for selling chicken (%) | | | | | $4.0^{ns}$ | |
| Plumage color | 5.0 | 0 | 0 | 1.7 | | |
| Other bases (body wt.) | 95.0 | 100.0 | 100.0 | 98.3 | | |
| Marketing problems (%) | | | | | $0^{ns}$ | |
| Demand seasonality | 100.0 | 100.0 | 100.0 | 100.0 | | |

hh = interviewed households; $\chi^2$ = chi-square; ns, not significant; HDM, Holiday Market; ODM, Ordinary Day Market

*4.1.8. Extension services and source of information for chicken production*

Most of the interviewed chicken owner farmers (41.7%) blamed that in recent times, they are not receiving any kind of technical support with regard to chicken husbandry, and the majority of the same farmers (58.3%) said that they are using their own knowledge to raise chicken (Table 12).

**Table 12.** Extension service and information source for chicken production

| Parameter (%) | Study Woredas | | | | |
|---|---|---|---|---|---|
| | Silti n=40hh | Dalocha n=40hh | Wulbareg n=40hh | Overall n=120hh | $\chi^2$ |
| Source of information to raise chicken | | | | | 1.9$^{ns}$ |
| No information source | 50.0 | 40.0 | 35.0 | 41.7 | |
| Electronic media | 0 | 0 | 0 | 0 | |
| Mass media | 0 | 0 | 0 | 0 | |
| NGOs | 0 | 0 | 0 | 0 | |
| Other sources | 50.0 | 60.0 | 65.0 | 58.3 | |
| Do respondents discuss with DAs about chicken rearing? | | | | | 5.0$^{ns}$ |
| no | 22.5 | 15.0 | 5.0 | 14.2 | |
| yes | 77.5 | 85.0 | 95.0 | 85.8 | |
| Where do the respondents meet DAs for discussion? | | | | | 7.8$^{ns}$ |
| At public meetings | 7.5 | 12.5 | 12.5 | 10.8 | |
| At the respondent's house | 65.0 | 72.5 | 82.5 | 73.3 | |
| No response obtained | 27.5 | 15.0 | 5.0 | 15.8 | |
| Frequency of contact with Das | | | | | 19.1$^{*}$ |
| No response obtained | 27.5 | 15.0 | 5.0 | 15.8 | |
| Once in a month | 5.0 | 0 | 0 | 1.7 | |
| Once in four months | 20.0 | 22.5 | 27.5 | 23.3 | |
| Once in six months | 2.5 | 7.5 | 15.0 | 8.3 | |
| Once in three months | 30.0 | 37.5 | 47.5 | 38.3 | |
| Once in two months | 15.0 | 17.5 | 5.0 | 12.5 | |
| The reason for not contacting DAs for discussion | | | | | 7.8$^{ns}$ |
| DAs are not readily reached and they are busy with other activities | 60.0 | 67.5 | 62.5 | 63.3 | |
| Lack of attention/ignorance | 12.5 | 2.5 | 0 | 5.0 | |
| No response obtained | 27.5 | 30.0 | 37.5 | 31.7 | |
| Have the respondents heard about improved chicken rearing practices? | | | | | 3.0$^{ns}$ |
| no | 17.5 | 12.5 | 5.0 | 11.7 | |
| yes | 82.5 | 87.5 | 95.0 | 88.3 | |
| Major information source for improved chicken raising | | | | | 2.5$^{ns}$ |
| DAs/Livestock experts at FTC and meetings | 77.5 | 82.5 | 87.5 | 82.5 | |
| No response obtained | 17.5 | 15.0 | 12.5 | 15.0 | |
| Other sources | 5.0 | 2.5 | 0 | 2.5 | |

$^{*}$ = P< 0.05; hh = interviewed households; $\chi^2$ = chi-square; ns, not significant

The study also revealed that only 88.3% of chicken owner farmers of the study area have been getting proper agricultural extension service related to village chicken production like; advisory service & training. 82.5% of the respondents who get chicken extension services said that they meet the development agents at public meetings and the majority (38.3%) of them at the frequency of once in three months (Table 12).

Lack of development agents specialized in animal science for their kebeles (assigned agents leave the kebeles looking for better job opportunities in towns or for pursuit of non-agricultural studies) and hence irrelevance of the other DA's was the main reason (39.2%) identified for absence of proper extension service with regard to village chicken production. On the other hand, most of the interviewed chicken owner farmers (82.5%) responded that their major source of information for improved chicken production are Development Agents or livestock experts at Farmers Training Centers (FTC's) and at the meetings (Table 12).

All of the chicken owner farmers also said that they do intend to expand chicken production in the future with a stock size comprising of about 20 layer hens (36.7%); and they demand vital support from the government to provide efficient veterinary service at farmer level, to improve and strengthen extension services for chicken production and management, and to provide credit services (esp. for infrastructures required for chicken production), among others (Table 13).

**Table 13.** Future expansion, barriers, and role of government on chicken production

| Parameter (%) | Study Woredas | | | | |
|---|---|---|---|---|---|
| | Silti n=40h | Dalocha n=40hh | Wulbareg n=40hh | Overall n=120hh | $\chi^2$ |
| Do respondents intend to expand chicken production in the future? Yes | 100.0 | 100.0 | 100.0 | 100.0 | $0^{ns}$ |
| To what flock size do respondents intend to expand? | | | | | |
| Up to 10 layer hens | 5.0 | 7.5 | 27.5 | 13.3 | $14.7^{ns}$ |
| Up to 15 layer hens | 37.5 | 35.0 | 30.0 | 34.2 | |
| Up to 20 layer hens | 37.5 | 40.0 | 32.5 | 36.7 | |
| Up to 25 layer hens | 7.5 | 10.0 | 10.0 | 9.2 | |
| Up to 30 layer hens | 12.5 | 7.5 | 0 | 6.7 | |
| Barriers against future expansion | | | | | $0.9^{ns}$ |
| Lack of proper chicken house (esp. that can protect predators) | 82.5 | 85.0 | 90.0 | 85.8 | |
| Other reasons | 17.5 | 15.0 | 10.0 | 14.2 | |
| Role of government to expand chicken production and improve their productivity in rural areas | | | | | $15.3^{*}$ |
| a). No response obtained | 20.0 | 12.5 | 0 | 10.8 | |
| b). Provide efficient veterinary service at farmer level | 0 | 0 | 5.0 | 0 | |
| c). Improve and strengthen extension services for chicken production and management | 0 | 0 | 0 | 0 | |
| d). Provide credit service (esp. for infrastructures needed for chicken production) | 0 | 0 | 0 | 0 | |
| e). Provide efficient vet service and strengthen extension services for chicken (b&c) | 77.5 | 80.0 | 80.0 | 79.2 | |
| f). All the three above (b,c & d) | 2.5 | 7.5 | 15.0 | 8.3 | |

$^{*}$ = P< 0.05; $^{**}$ = P< 0.01; hh = interviewed households; $\chi^2$ = chi-square; ns, not significant

## 4.2. Morphological Features of Chicken

### *4.2.1. Qualitative morphological traits of chickens*

The results of the present study indicated that the majority of the observed chickens (65.3%) were female chickens, whereas the rest (34.7%) were male birds. The morphologic traits of

local indigenous chicken identified in the study woredas have been presented in the following Table (Table 14).

**Table 14.** Shape and type of phenotypic traits of chicken

| Parameter | | Study woredas | | | | $\chi^2$ |
|---|---|---|---|---|---|---|
| | | Silti N=200 | Dalocha N=200 | Wulbareg N=200 | Overall N=600 | |
| Sex of chicken | M | 74(37)[a] | 73(36.5) | 61(30.5) | 208(34.7) | $2.3^{ns}$ |
| | F | 126(63) | 127(63.5) | 139(69.5) | 392(65.3) | |
| Spur | P | 120(60) | 116(58) | 98(49) | 334(55.7) | $5.5^{ns}$ |
| | A | 80(40) | 84(42) | 102(51) | 266(44.3) | |
| Comb type | Pea | 6(3) | 6(3) | 4(2) | 16(2.7) | $8.9^{ns}$ |
| | Rose | 137(68.5) | 140(70) | 118(59) | 395(65.8) | |
| | Single | 45(22.5) | 44(22) | 66(33) | 155(25.8) | |
| | V-shape/Double | 12(6) | 10(5) | 12(6) | 34(5.7) | |
| Head shape | Crested ("*Gutya*") | 16(8) | 14(7) | 17(8.5) | 47(7.8) | $0.3^{ns}$ |
| | Plain | 184(92) | 186(93) | 183(91.5) | 553(92.2) | |
| Shank feather | P | 8(4) | 6(3) | 6(3) | 20(3.3) | $0.4^{ns}$ |
| | A | 192(96) | 194(97) | 194(97) | 580(96.7) | |

[a]Figures in parenthesis are percentage; ns, not significant; N, number of chickens; $\chi^2$, chi-square test

The results of the present study (Table 14) indicate that 55.7% and 3.3% of the chicken in the study woredas have been found to possess, whereas 44.3% and 96.7% of them are devoid of spurs and shank feathers, respectively. The highest proportion (65.8%) of the chickens in the study area possess rose comb, followed by single comb (25.8%), V-shape/Double (5.7%) and pea comb (2.7%). The rose comb type was the dominant comb accounting for 68.5%, 70 % and 59 % for Silti, Dalocha, and Wulbareg woredas, respectively. The proportion of chickens with a single comb was 22.5%, 22% and 33 % for Silti, Dalocha, and Wulbareg woredas, respectively. Similarly, 92.2% of the chicken in the study area possessed plain followed by crested (7.8%) head shapes. The plain head shape was the most prominent type among both the sexes irrespective of the study woredas.

The present investigations (Table 15) revealed that significant differences were observed in head shape between male and female ($P< 0.05$) chickens but no significant differences ($P>$

0.05) were observed in head shape between chickens among the studied woredas. More than three fourth (94.7%) of male and (90.8%) female chicken in the study woredas had plain head shape and insignificance differences were observed among the woredas. About 63.5%, 73.9% and 72.1% of the male chicken in the Silti, Dalocha and Wulbareg woredas, respectively, possessed rose combs.

**Table 15.** Shape and type of phenotypic traits with the sex of chicken

| Qualitative traits | | Silti N=200 | | Dalocha N=200 | | Wulbareg N=200 | | Overall N =600 | | $\chi^2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | M | F | M | F | M | F | M | F | Woreda | sex |
| | | 37 | 63 | 36.5 | 63.5 | 30.5 | 69.5 | 34.7 | 65.3 | | |
| Spur | P | 100 | 36.5 | 100 | 33.9 | 100 | 26.6 | 100 | 32.1 | $5.6^{ns}$ | $253.6^{***}$ |
| | A | 0 | 63.5 | 0 | 66.1 | 0 | 73.4 | 0 | 67.9 | | |
| Comb type | Pea | 4.1 | 2.4 | 2.7 | 3.2 | 1.6 | 2.2 | 2.9 | 2.6 | $8.9^{ns}$ | $14.4^{**}$ |
| | Rose | 63.5 | 71.4 | 73.9 | 67.7 | 72.1 | 53.2 | 69.7 | 63.8 | | |
| | Single | 20.3 | 23.8 | 19.1 | 23.6 | 14.8 | 41 | 18.3 | 29.9 | | |
| | V-shape/Double | 12.2 | 2.4 | 4.1 | 5.5 | 11.5 | 3.6 | 9.1 | 3.8 | | |
| Head shape | Crested ("*Gutya*") | 6.8 | 8.7 | 5.5 | 7.9 | 3.3 | 10.8 | 5.3 | 9.2 | $0.3^{ns}$ | $2.9^{ns}$ |
| | Plain | 93.2 | 91.3 | 94.5 | 92.1 | 96.7 | 89.2 | 94.7 | 90.8 | | |
| Shank feather | P | 2.7 | 4.8 | 1.4 | 3.9 | 1.6 | 3.6 | 1.9 | 4.1 | $0.4^{ns}$ | $1.9^{ns}$ |
| | A | 97.3 | 95.2 | 98.6 | 96.1 | 98.4 | 96.4 | 98.1 | 95.9 | | |

Figures are in percentage; ns, not significant; '$^{***}$'=P<0.001, '$^{**}$'=P<0.01; N, number of chickens; $\chi^2$, chi-square test

*Color Traits of Chickens*

As presented in Table 16, seven types of plumage colors have been identified in the study area locally named as '*Gumera*' (White), '*Tem*' (Black), '*Kei*' (Red) / red with black tail, '*Gebsma*' (Grayish), '*Ambesma*' (Multicolor), '*Teterma*' (Black / red with white spots), and '*Kokma*' (Red-brownish). The dominant body plumage color was Grayish ('*Gebsma*') 48.7%, followed by Black ('Tem') 19.3% and Red ('Kei') / Red with a black tail (14.2%). Red-brownish ('*Kokma*') 8.2%, White ('*Gumera*') 8.2%, Black with white tips ('*Teterm*a') 1.1% and Multicolor ('*Ambesma*') 0.3% were the least of the body plumage colors of chicken in the study area.

**Table 16.** Color traits of chicken

| Parameter | | Study woredas | | | | |
|---|---|---|---|---|---|---|
| | | Silti N=200 | Dalocha N=200 | Wulbareg N=200 | Overall N=600 | $\chi^2$ |
| Sex of chicken | M | 74(37)[a] | 73(36.5) | 61(30.5) | 208(34.7) | $2.3^{ns}$ |
| | F | 126(63) | 127(63.5) | 139(69.5) | 392(65.3) | |
| Body plumage colors | Grayish(‘*Gebsma*’) | 96(48) | 102(51) | 94(47) | 292(48.7) | $7.3^{ns}$ |
| | Black (‘*Tem*’) | 38(19) | 38(19) | 40(20) | 116(19.3) | |
| | Red (‘*Kei*’) /Red with black tail | 30(15) | 26(13) | 29(14.5) | 85(14.2) | |
| | Red- brownish (‘*Kokma*’) | 16(8) | 18(9) | 15(7.5) | 49(8.2) | |
| | White (‘*Gumera*’) | 17(8.5) | 13(6.5) | 19(9.5) | 49(8.2) | |
| | Multicolor (‘*Ambesma*’) | 2(1) | 0(0) | 0(0) | 2(0.3) | |
| | Black with white tips(‘*Teterma*’) | 1(0.5) | 3(1.5) | 3(1.5) | 7(1.1) | |
| Shank color | Black | 33(16.5) | 23(11.5) | 24(12) | 80(13.3) | $9.6^{ns}$ |
| | Blue | 4(2) | 4(2) | 3(1.5) | 11(1.8) | |
| | Green | 3(1.5) | 0(0) | 2(1) | 5(0.8) | |
| | White | 71(35.5) | 66(33) | 58(29) | 195(32.5) | |
| | Yellow | 89(44.5) | 107(53.5) | 113(56.5) | 309(51.5) | |
| Earlobe color | Other color | 4(2) | 3(1.5) | 6(3) | 13(2.2) | $3.4^{ns}$ |
| | Red | 34(17) | 38(19) | 42(21) | 114(19) | |
| | White | 56(28) | 62(31) | 56(28) | 174(29) | |
| | White and red | 100(50) | 91(45.5) | 92(46) | 283(47.2) | |
| | Yellow | 6(3) | 6(3) | 4(2) | 16(2.7) | |
| Eye color | Black | 2(1) | 0(0) | 11(5.5) | 13(2.2) | $22.8^{***}$ |
| | Blue black | 6(3) | 3(1.5) | 11(5.5) | 20(3.3) | |
| | Dark ash | 23(11.5) | 18(9) | 17(8.5) | 58(9.7) | |
| | Dark brown | 169(84.5) | 179(89.5) | 161(80.5) | 509(84.8) | |
| Beak color | Black | 59(29.5) | 64(32) | 60(30) | 183(30.5) | $5.4^{ns}$ |
| | Other color combinations | 34(17) | 27(13.5) | 27(13.5) | 88(14.7) | |
| | White | 26(13) | 16(8) | 18(9) | 60(10) | |
| | Yellow | 81(40.5) | 93(46.5) | 95(47.5) | 269(44.8) | |
| Skin color | Ash | 96(48) | 109(54.5) | 101(50.5) | 306(51) | $16.8^{*}$ |
| | Black | 2(1) | 0(0) | 0(0) | 2(0.3) | |
| | Light red | 28(14) | 39(19.5) | 37(18.5) | 104(17.3) | |
| | Light yellow | 26(13) | 20(10) | 34(17) | 80(13.3) | |
| | White | 48(24) | 32(16) | 28(14) | 108(18) | |

[a]Figures in parenthesis are percentage; ‘$^{***}$’=P<0.001, ‘$^{**}$’=P<0.01; ns, not significant;

As presented in Table 16, yellow shank color was the most prominent (51.5%), followed by another color like white (32.5%), and black (13.3%), whereas blue (1.8%) and green (0.8%) were the least. The white and red earlobe color was the most common (47.2%), followed by white (29%), red (19%) and yellow (2.7%), and other colors were the least (2.2%). The present study (Table 3) also indicate that there were not significance (P> 0.05) differences in color traits of chickens except eye color and skin color in the study woredas.

**Table 17.** Color traits of chicken with sex

| Qualitative traits | | Silti N=200 | | Dalocha N=200 | | Wulbareg N=200 | | Overall N =600 | | $\chi^2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | M | F | M | F | M | F | M | F | Woreda | sex |
| | | 37 | 63 | 36.5 | 63.5 | 30.5 | 69.5 | 34.7 | 65.3 | | |
| Body plumage colors | Black (‘*Tem*’) | 17.6 | 19.8 | 16.4 | 20.5 | 6.6 | 25.9 | 13.9 | 22.12 | $7.3^{ns}$ | $15.1^{*}$ |
| | Black with white tips(‘*Teterma*’) | 1.4 | 0 | 2.7 | 0.8 | 0 | 2.2 | 1.4 | 1 | | |
| | Grayish(‘*Gebsima*’) | 54.1 | 44.4 | 43.8 | 55.1 | 49.2 | 46 | 49 | 48.5 | | |
| | Multicolor (‘*Ambesma*’) | 0 | 1.6 | 0 | 0 | 0 | 0 | 0 | 0.5 | | |
| | Red- brownish (‘*Kokma*’) | 6.8 | 8.7 | 8.2 | 9.5 | 4.9 | 8.6 | 6.7 | 8.9 | | |
| | Red (‘Kei’) /Red with black tail | 17.6 | 13.5 | 20.5 | 8.7 | 23 | 10.8 | 20.2 | 11 | | |
| | White (‘*Gumera*’) | 2.7 | 11.9 | 8.2 | 5.5 | 16.4 | 6.5 | 8.7 | 7.9 | | |
| Shank color | Black | 17.6 | 15.8 | 13.7 | 10.2 | 8.2 | 13.7 | 13.5 | 13.3 | $9.6^{ns}$ | $9.7^{*}$ |
| | Blue | 0 | 3.2 | 2.7 | 1.6 | 1.6 | 1.4 | 1.4 | 2 | | |
| | Green | 0 | 2.4 | 0 | 0 | 0 | 1.4 | 0 | 1.3 | | |
| | White | 31.1 | 38.1 | 28.8 | 35.4 | 18 | 33.8 | 26.4 | 35.7 | | |
| | Yellow | 51.4 | 40.5 | 54.8 | 52.8 | 72.1 | 49.6 | 58.6 | 47.7 | | |

Figures are in percentage; ns, not significant; ‘*’=P<0.05; N, number of chickens; $\chi^2$, chi-square test

The present study (Table 17) indicate that male chickens (58.6%) and female chickens (47.7%) possessed yellow shank color, male (49%) and female (48.5%) chickens possessed grayish (‘*Gebsima*’) body plumage color. The highest proportion (84.8%) of the chicken had dark brown eye color, followed by dark ash (9.7%) and blue-black (3.3%), whereas black was the least (0.7%) eye color. Yellow beak color (44.8%) was the dominant beak color followed by black beak color (30.5%), other color combinations (14.7%) and white (10%) beak colors.

Ash skin color (51%) accounted for the highest for the chicken in the study area, followed by white (18%), Light red (17.3%), light yellow (13.3%) and black (0.3%), respectively.

**Table 18.** Ear lobe, eye, beak, and skin colors of chicken

| Qualitative traits | | Silti N=200 | | Dalocha N=200 | | Wulbareg N=200 | | Overall N =600 | | $\chi^2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | M | F | M | F | M | F | M | F | Wored a | sex |
| | | 37 | 63 | 36.5 | 63.5 | 30.5 | 69.5 | 34.7 | 65.3 | | |
| Ear lobe color | Other color | 1.4 | 2.4 | 0 | 2.3 | 0 | 4.3 | 0.5 | 3.1 | $3.4^{ns}$ | $14.4^{*}$ |
| | Red | 23 | 13.5 | 23.3 | 16.5 | 29.5 | 17.3 | 25 | 15.8 | | |
| | White | 25.7 | 29.4 | 31.5 | 30.7 | 21.3 | 30.9 | 26.4 | 30.4 | | |
| | White and red | 47.3 | 51.6 | 45.2 | 45.7 | 49.2 | 44.6 | 47.1 | 47.2 | | |
| | Yellow | 2.7 | 3.2 | 0 | 4.7 | 0 | 2.9 | 1 | 3.6 | | |
| Eye color | Black | 1.4 | 0.8 | 0 | 0 | 3.3 | 6.5 | 1.4 | 2.6 | $22.8^{**}$ | $2.2^{ns}$ |
| | Blue black | 4.1 | 2.4 | 2.7 | 0.8 | 0 | 7.9 | 2.4 | 3.8 | | |
| | Dark ash | 13.5 | 10.3 | 6.8 | 10.2 | 4.9 | 10.1 | 8.7 | 10.2 | | |
| | Dark brown | 81.1 | 86.5 | 90.4 | 89 | 91.8 | 75.5 | 87.5 | 83.4 | | |
| Beak color | Black | 33.8 | 26.9 | 32.9 | 31.5 | 16.4 | 36 | 28.4 | 31.6 | $5.4^{ns}$ | $3.2^{ns}$ |
| | Other color combinations | 12.2 | 19.8 | 15.1 | 12.6 | 14.8 | 13 | 13.9 | 15.1 | | |
| | White | 5.4 | 17.5 | 9.6 | 7.1 | 9.8 | 8.6 | 8.2 | 11 | | |
| | Yellow | 48.7 | 35.7 | 42.5 | 48.8 | 59 | 42.5 | 49.5 | 42.3 | | |
| Skin color | Ash | 51.4 | 46 | 54.8 | 54.3 | 31.2 | 59 | 46.6 | 53.3 | $16.8^{*}$ | $4^{ns}$ |
| | Black | 0 | 1.6 | 0 | 0 | 0 | 0 | 0 | 0.5 | | |
| | Light red | 17.6 | 11.9 | 15.1 | 22.1 | 26.2 | 15.1 | 19.2 | 16.3 | | |
| | Light yellow | 17.6 | 10.3 | 8.2 | 11 | 21.3 | 15.1 | 15.4 | 12.2 | | |
| | White | 13.5 | 30.2 | 21.9 | 12.6 | 21.3 | 10.8 | 18.8 | 17.6 | | |

Figures are in percentage; ns, not significant; '$^{**}$'=P<0.01; '$^{*}$'=P<0.05; N, number of chickens; $\chi^2$, chi-square test

The present study (Table 18) indicate that male (47.1%) and female (47.2%) chickens possessed white and red ear lobe color, male (87.5%) and female (83.4%) chickens possessed dark brown eye color, and male (49.5%) and female (42.3%) chickens possessed yellow beak color, male (46.6%) and female (53.3%) chickens possessed ash skin color of the dominant color traits across all the study woredas.

White grey | Brown | Grey | White grey

Crested white | Crested & necked neck dark brown | Yellow | Crested black

**Figure 3.** Sample pictures of different plumage colors of indigenous female chickens

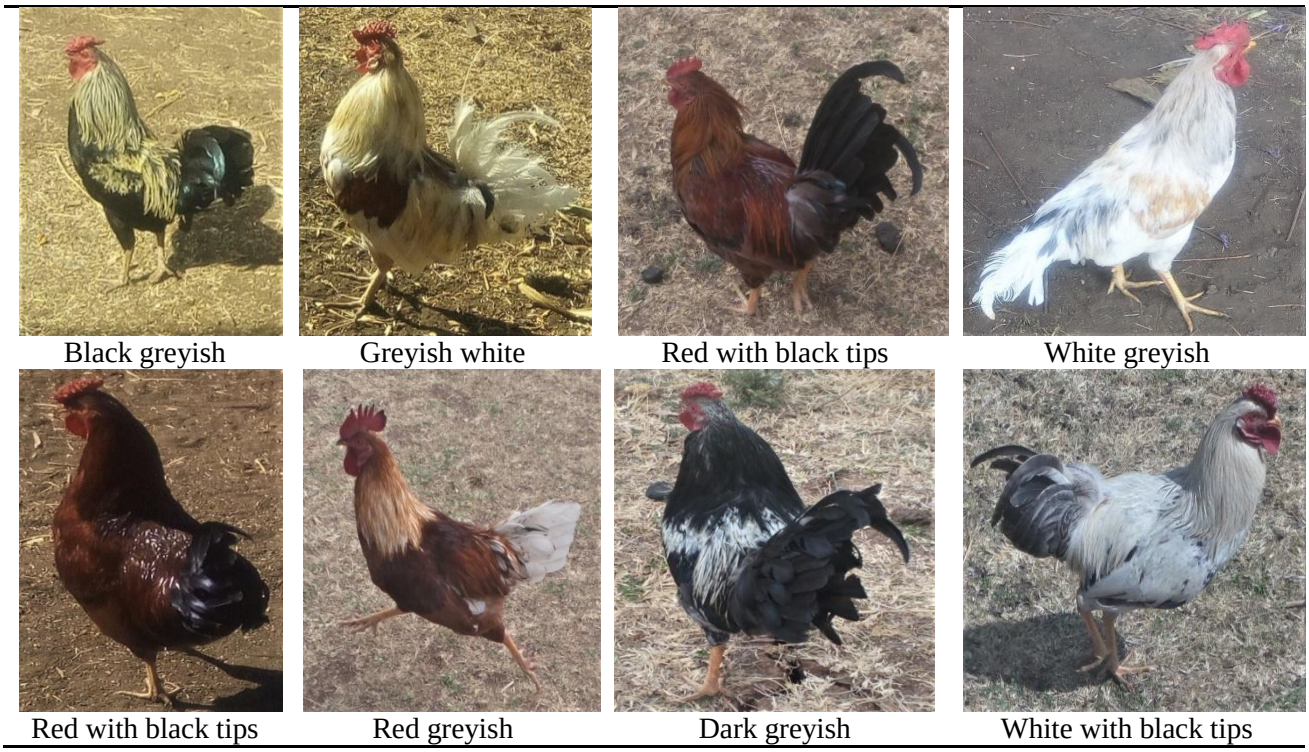



**Figure 4.** Sample pictures of different plumage colors of indigenous male chickens

*4.2.2. Quantitative Morphological Traits of Chicken*

The following tables (Table 19) and (Table 20) presents a summary of linear body measurements taken to estimate the quantitative morphologic traits of chicken in the study woredas.

According to the results (Table 19) average folded (arrested) wingspan was 36.8 cm (ranging 30- 46); spur length was 0.4 cm (ranging 0-1.5); shank length was 8.4 cm (ranging 6-11); shank circumference was 3.2 cm (ranging 2.4-4); comb length was 3.7 cm (ranging 1.6-8.5); wattle length was 1.5 cm (ranging 0.2-4); beak length was 2.6 cm (ranging 1.8-3.5); body length was 35.8 cm (ranging 29-41); body width (breast girth) was 23.7 cm (ranging 20-27); and keel length was 9.2 cm (ranging 7.5-11). The average live body weight was 1.5 kg (ranging 0.8-2.4) and breast angle was 42.2 degrees (ranging 38-52). Significant differences ($P<0.05$) existed among the three woredas with regard to all the above parameters. Wingspan and body length of chickens reared in the study woredas were significantly ($P<0.01$) different. Wingspan and body length in Silti chickens had a higher value than Dalocha and Wulbareg

districts. Wingspan and body length of chickens reared in Dalocha were also higher than Wulbareg districts.

**Table 19.** Mean±SD of linear body measurements of chicken

| Parameter | Study Woredas | | | | Range | | P-value |
|---|---|---|---|---|---|---|---|
| | Silti N=200 | Dalocha N=200 | Wulbareg N=200 | Overall N=600 | Min | Max | |
| Folded Wing Span(cm) | 37.2±2.3 | 37±2.8 | 36.1±2.7 | 36.8±2.7 | 30 | 46 | *** |
| Spur Length (cm) | 0.4±0.4 | 0.4±0.5 | 0.4±0.5 | 0.4±0.5 | 0 | 1.5 | *** |
| Shank Length (cm) | 8.5±1.4 | 8.5±1.4 | 8.2±1.2 | 8.4±1.4 | 6 | 11 | *** |
| Shank Circumference (cm) | 3.3±0.4 | 3.2±0.4 | 3.1±0.4 | 3.2±0.4 | 2.4 | 4 | *** |
| Comb Length (cm) | 3.9±1.6 | 3.8±1.5 | 3.4±1.2 | 3.7±1.5 | 1.6 | 8.5 | *** |
| Wattle Length (cm) | 1.7±1 | 1.5±1 | 1.3±0.9 | 1.5±1 | 0.2 | 4 | *** |
| Beak Length (cm) | 2.6±0.4 | 2.6±0.3 | 2.5±0.3 | 2.6±0.3 | 1.8 | 3.5 | *** |
| Body Weight (kg) | 1.5±0.4 | 1.4±0.4 | 1.4±0.4 | 1.5±0.4 | 0.8 | 2.4 | *** |
| Breast Angle (degrees) | 42.1±2.6 | 42.4±2.7 | 41.8±1.9 | 42.2±2.4 | 38 | 52 | * |
| Body Length (cm) | 36.5±2.1 | 35.9±2.8 | 34.8±3 | 35.8±2.8 | 29 | 41 | *** |
| Body Width/ Breast Girth (cm) | 23.8±1.5 | 23.8±1.5 | 23.3±1.3 | 23.7±1.5 | 20 | 27 | *** |
| Keel Length (cm) | 9.4±0.9 | 9.1±0.9 | 9.1±0.9 | 9.2±0.9 | 7.5 | 11 | * |

N, number of chickens; '*'=P <0.05, '***' =P<0.001 or = (P< $2.2e^{-16}$); ns, not significant

The value of chest width in chickens reared in Wulbareg district was lower (P<0.01) than those chickens reared in Silti and Dalocha woredas while Silti and Dalocha woredas had comparable value. Shank length values of chickens measured in Silti and Dalocha woreda did not differ but were (P<0.01) higher than those observed in Wulbareg woreda. The shank circumference of chickens reared in all study districts differed significantly (P<0.01) being higher in Silti district than those reared Dalocha and Wulbareg woredas. Chickens reared in Dalocha woreda had higher shank circumference value than those of Wulbareg district (Table 19).

As shown in Table 20, district and sex had a significant effect on all quantitative traits. The overall average body weight of males and females was 1.8 kg and 1.3 kg, respectively. The results for keel bone and wingspan, body length and width, shank length and circumference were highly different across all the studied districts. The value of keel bone for chickens

reared in Silti district was significantly higher (P< 0.01) than, Dalocha and Wulbareg districts. However, there was no significant difference (P >0.05) in the keel bone of chickens reared in Dalocha and Wulbareg districts.

**Table 20.** Mean±SD of linear body measurements of chicken in the study woredas between sexes of chickens

| Variables | Sex of chicken | Silti M=74 F=126 | Dalocha M=73 F=127 | Wulbareg M=61 F=139 | Overall M=208 F=392 | Range | | p-value | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD | Min | Max | Sex | Woreda |
| wing span(cm) | M | 39.4±1.8 | 39.7±2.0 | 38.8±1.1 | 39.4±1.7 | 36.0 | 46.0 | | |
| | F | 35.9±1.4 | 35.5±2.0 | 35.0±2.3 | 35.4±2.0 | 30.0 | 40.0 | *** | *** |
| spur length(cm) | M | 0.9±0.3 | 0.9±0.4 | 0.9±0.4 | 0.9±0.4 | 0.2 | 1.5 | | |
| | F | 0.2±0.3 | 0.1±0.3 | 0.1±0.3 | 0.2±0.3 | 0.0 | 0.9 | *** | *** |
| shank length(cm) | M | 10.1±0.8 | 10.1±0.8 | 9.7±0.9 | 10.0±0.8 | 7.0 | 11.0 | | |
| | F | 7.5±0.8 | 7.6±0.9 | 7.6±0.7 | 7.6±0.8 | 6.0 | 9.0 | *** | *** |
| shank circumference(cm) | M | 3.7±0.3 | 3.6±0.3 | 3.5±0.3 | 3.6±0.3 | 3.0 | 4.0 | | |
| | F | 3.1±0.3 | 3.0±0.3 | 2.9±0.3 | 3.0±0.3 | 2.4 | 4.0 | *** | *** |
| comb length(cm) | M | 5.5±1.5 | 5.4±1.3 | 4.9±1.2 | 5.3±1.4 | 3.0 | 8.5 | | |
| | F | 3.0±0.6 | 2.9±0.7 | 2.8±0.5 | 2.9±0.6 | 1.6 | 4.7 | *** | *** |
| wattle length(cm) | M | 3.0±0.4 | 2.8±0.5 | 2.6±0.5 | 2.8±0.5 | 1.2 | 4.0 | | |
| | F | 1.0±0.2 | 0.9±0.2 | 0.8±0.2 | 0.9±0.2 | 0.2 | 1.5 | *** | *** |
| beak length(cm) | M | 2.9±0.4 | 2.8±0.4 | 2.7±0.31 | 2.8±0.4 | 2.2 | 3.5 | | |
| | F | 2.5±0.3 | 2.5±0.3 | 2.4±0.25 | 2.5±0.3 | 1.8 | 3.2 | *** | *** |
| body wt.(kg) | M | 1.9±0.2 | 1.8±0.2 | 1.8±0.3 | 1.8±0.2 | 1.1 | 2.4 | | |
| | F | 1.3±0.3 | 1.3±0.3 | 1.3±0.3 | 1.3±0.3 | 0.8 | 1.8 | *** | *** |
| breast angle(degrees) | M | 43.9±3.0 | 44.0±3.4 | 42.8±2.2 | 43.6±3.0 | 40.0 | 52.0 | | |
| | F | 41.2±1.8 | 41.6±1.7 | 41.4±1.5 | 41.4±1.7 | 38.0 | 45.0 | *** | * |
| body length(cm) | M | 38.3±1.1 | 38.1±0.9 | 37.7±1.3 | 38.0±1.1 | 34.0 | 41.0 | | |
| | F | 35.5±1.9 | 34.7±2.8 | 33.6±2.6 | 34.6±2.6 | 29.0 | 39.0 | *** | *** |
| breast girth(cm) | M | 25.3±1.0 | 25.0±1.3 | 24.8±1.1 | 25.1±1.2 | 23.0 | 27.0 | | |
| | F | 23.0±0.9 | 23.0±1.2 | 22.7±0.8 | 22.9±1.0 | 20.0 | 25.0 | *** | *** |
| keel length(cm) | M | 10.3±0.6 | 10.0±0.7 | 10.0±0.8 | 10.1±0.7 | 8.5 | 11.0 | | |
| | F | 8.9±0.7 | 8.7±0.6 | 8.7±0.6 | 8.7±0.6 | 7.5 | 11.0 | *** | * |

N, number of chickens; '*'=P <0.05, '***' =P < 0.001 or = ($P < 2.2e^{-16}$); ns, not significant

*4.2.3. Correlation between Body Weight and other Linear Body Measurements*

As presented in Table 21, all linear body measurements of chickens in the studied districts were highly correlated with body weight.

The highest correlation (0.77) between body weight & shank circumference followed by correlation (0.71) between body weight & wattle length were estimated. Similarly, correlation (0.70) between body weight & body length and correlation (0.68) between body weight and wingspan were also estimated but there were significant correlations between body weight and all other linear body measurements (Table 21).

**Table 21.** Estimation of correlations among various body measurement traits

| Traits | BW | WS | SPL | SHL | SHC | CL | WL | BKL | BRA | BL | BRG | KL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BW | 1 | 0.68** | 0.65** | 0.77** | 0.46** | 0.64** | 0.71** | 0.43** | 0.30** | 0.7** | 0.52** | 0.59** |
| WS | 0.68** | 1 | 0.52** | 0.7** | 0.54** | 0.64** | 0.69** | 0.44** | 0.54** | 0.76** | 0.6** | 0.5** |
| SPL | 0.65** | 0.52** | 1 | 0.67** | 0.51** | 0.65** | 0.75** | 0.45** | 0.22** | 0.48** | 0.62** | 0.61** |
| SHL | 0.77** | 0.7** | 0.67** | 1 | 0.62** | 0.75** | 0.83** | 0.41** | 0.46** | 0.58** | 0.58** | 0.6** |
| SHC | 0.46** | 0.54** | 0.51** | 0.62** | 1 | 0.6** | 0.79** | 0.53** | 0.39** | 0.45** | 0.51** | 0.63** |
| CL | 0.64** | 0.64** | 0.65** | 0.75** | 0.6** | 1 | 0.79** | 0.30** | 0.43** | 0.62** | 0.55** | 0.53** |
| WL | 0.71** | 0.69** | 0.75** | 0.83** | 0.79** | 0.79** | 1 | 0.57** | 0.47** | 0.62** | 0.73** | 0.75** |
| BKL | 0.43** | 0.44** | 0.45** | 0.41** | 0.53** | 0.30** | 0.57** | 1 | 0.23** | 0.36** | 0.55** | 0.44** |
| BRA | 0.30** | 0.54** | 0.22** | 0.46** | 0.39** | 0.43** | 0.47** | 0.23** | 1 | 0.26** | 0.29** | 0.13** |
| BL | 0.7** | 0.76** | 0.48** | 0.58** | 0.45** | 0.62** | 0.62** | 0.36** | 0.26** | 1 | 0.53** | 0.46** |
| BRG | 0.52** | 0.6** | 0.62** | 0.58** | 0.51** | 0.55** | 0.73** | 0.55** | 0.29** | 0.53** | 1 | 0.7** |
| KL | 0.59** | 0.5** | 0.61** | 0.6** | 0.63** | 0.53** | 0.75** | 0.44** | 0.13** | 0.46** | 0.7** | 1 |

** Correlation is significant at the 0.01 level; BW: Body weight, BL: Body length; WS: Wingspan; SHL: Shank length; SHC: Shank Circumference; SPL: Spur length; KL: Keel length; WL: Wattle length; CL: Comb length; BKL: Beak length; BRA: Breast angle; and BRG: Breast girth.

# 5. DISCUSSION

## 5.1. Production System Parameters of Chicken in the Study Woredas

### *5.1.1. Socioeconomic characteristics of the households*

The overall average family size in the study woredas was 8.03 persons per household and family size of households was significantly less ($P<0.05$) in Wulbareg but comparable in Silti and Dalocha woredas (Table 1). Every family member including children above seven years old had responsibility for the household activity. The male household taking the overall management was specifically responsible for plowing, mowing, threshing, etc. The wife/mother of the household is particularly responsible at home management while also assisting her husband in the farm field in relation to weeding, land preparation, and others especially if children were absent. The sons (7-14 years old) were responsible for herding the livestock whereas daughters were involved in all activities such as helping their mothers at home, assisting their father in the field, and herding the livestock when the son was not around and if a male child is lacking. The results of this study are not similar to the findings of Zemene (2011) and Fisseha *et al*. (2010), who reported the average family size per household at 6.0 persons in Goncha Siso Enese woreda of Western Amhara region and 6.2 persons in Bure woreda of North West Amhara, respectively.

Family size, a proxy to labor availability, may influence the adoption of poultry technology positively as its availability reduces the labor constraints faced in poultry production. Older farmers are more risk-averse and less likely to be flexible than younger farmers and thus have a lesser likelihood of adopting new technologies. Similarly, producers with more education are more likely to be adopters than farmers with less education (Teklewold *et al*., 2006).

The farmland holding in the study woredas (Table 2) was 0.5-1 ha (55%), 1-2 ha (25.8%), less than 0.5 ha (18.3%) and 2-3 ha (0.8%). The current finding is less than the average farmland size of 1.34 ha per household reported for West Amhara (Zemene, 2011), and 1.28 ha for

Northwest Ethiopia (Halima *et al*., 2007a). Moreover, smaller farmland size of 0.86 ha/household was reported for SNNPRS (Mekonnen, 2007).

Farmers in the study area reared an average number of various types of livestock species including cattle (2.7), sheep/goats (1.3), donkey/horse/mule (0.7) and chicken (9.9) per household (Table 1). The result of the present study is significantly higher than the results of Zemene (2011) with regard to equine and chicken holdings per household, which was 0.5 and 7.9 respectively, for Goncha Siso Enese woreda of Amhara region. Similarly, the present findings are higher than the reports of Fisseha (2008) for sheep/goats and equine holdings per household for Bure woreda of Amhara region at 1.23 and 0.2, respectively, but the present finding is less than the above finding of 4.16 for cattle number per household and for chicken number of 13.1.

The present finding is also significantly higher than the findings of Halima *et al*. (2007a) and Aberra and Tegene (2009) who reported average flock size of about 7 for northwest and southern parts of Ethiopia, respectively. Similarly, the earlier findings of Mekonnen (2007) which showed an average chicken flock size of 9.2 per household for SNNPRS, is still less than the present result.

Average flock size of 12 chickens per household, which was reported for the Rift Valley of Oromia by Hunduma *et al*. (2010) was higher than the results of the present study. Yakubu (2010) reported an average flock size of 13.9 birds per household in Nigeria, which ranged between 4 and 48 chickens per household, was also higher the current result.

*5.1.2. Feeds and feeding*

The chicken production system in the rural area of the study woreda was predominantly scavenging feed resource. Besides scavenging, there was supplementation to the chickens. In the study woreda, all (100%) households provided supplementary feed even though the adequacy is questionable. The current finding is in line with the finding of Halima *et al*. (2007a) who reported that about 99.3% of chicken owners of North-West Amhara provided

supplementary feed to village birds once per day, mainly during feed shortage seasons. Similarly, the supplementary feed was provided by the majority (97.5%) of chicken owners in Burie woreda of Amhara region (Fisseha *et al*., 2010). In a study conducted by Bogale (2008) in Farta woreda of Amhara Region, the majority (88.9%) of farmers reported that they gave supplementary feed on top of scavenging. Aberra and Tegene (2009) reported that 60% of chicken owners in SNNPRS provide supplementation which is comparatively lower than reported in the present study. On the contrary, lack of supplementary feed was one of the characteristics of a free-ranging backyard poultry production system as reported by Gueye (2003).

Even though the majority of the interviewed households (82.5%) reported they had unavailability of feeds for their chicken, some of them blamed lack of knowledge about feeding and feeds of chicken (10.8%) and lack of cash credit (6.7%), among others. Samson and Endalew (2010) reported that 95% of respondents of chicken producers in the Rift Valley of Oromia blamed feed shortage as a major limitation for supplementing their chicken indicating the major feed shortage time for chicken was June to August and suggesting that supplementation is important during these times which was agreed with the current findings.

Only 5.8% of the respondents used feeder to provide supplementary feed especially for wet feeds such as soaked '*Enjera*', Ethiopian stable food, and 3.3% spread the feeds simply on the ground for all chicken groups which leads to feeding wastage, while the rest (90.8%) used both methods (Table 4). Halima *et al*. (2007a) reported that only 3.4% of chicken owners in North-west Ethiopia provided supplementary feed in a container while the remaining threw the feed on the ground which agrees with the present study. Kugonza *et al*. (2008) reported that most of the farmers (73%) in Uganda provide feeds by spreading the feed on the ground while the rest use containers.

Feedstuffs such as wheat, maize, barley, either intact or soaked; '*Qinche*' (crushed and cooked wheat), '*Frushka*' and '*Frushkello*' (wheat bran and middlings), '*Enjera*' and '*Dabo firfir*' (soaked scrubs of '*Enjera'* and local bread), and kitchen leftovers were the common types of supplementary feeds for chickens in the study area, mostly (60%) once a day (Table 4).

Halima *et al*. (2007a) reported that the majority of the farmers who practiced supplementary feeding used maize, barley, wheat, finger millet, and household waste products to feed their chickens, mostly once per day, which is in line with the current study.

Similarly, Badubi *et al*. (2006) reported that most farmers (91.9%) in Gabon who feed their chickens use unbalanced feed supplements such as kitchen waste, maize, sorghum, millet, sorghum bran, maize bran and sunflower fed individually or in combination. No village chicken producer in Rift Valley of Oromia formulates chicken feed (Samson and Endale, 2010).

Even though all of the chicken owners provide supplementary feed to their chicken, is not possible to say that it is adequate both in quantity and quality because they provide the feedstuffs without measuring (Fisseha, 2008); supplementation was seasonal and the amount of scavangable feed resource is not yet determined by research. Spreading the feed on the ground for collective feeding, which was found to be part of the major method of feeding in the present study (81.7%) and the recent findings of Zemene (2011) and earlier results of Fisseha (2008), which were 83.7% and 91.4%, respectively leads to both wastage and contamination of feed as some of the stuff may be lost in cracks or mixed with dust and may come in contact with microbes.

Water is given ad-libitum to the birds all year round with particular emphasis during the dry season. During the rainy season, the birds are expected to drink from the surrounding. There were two major sources of water to the birds such as a river (35.8%), and pipe (64.2%) which was in line with Mekonnen (2007) who reported that water for chickens in SNNPRS was drawn from the river (37%), pond (35%) and borehole (28%).

About 72.5% of households used plastic equipment (mainly plastic pan locally called "*Mastatebya*") while 3.3 % used clay made, 6.7% used wooden made and 17.5% used stone made drinkers. None of this equipment maintains the quality of the water because they are always left open as well as placed anywhere in an open place. As a result, the water was commonly used by dogs, cats, wild birds, chicken, and even large animals which results in the

easy transmission of disease particularly from wild birds to the chicken. In addition to this, chicken particularly chicks can also be stepped on by large animals. The current result was in line with Abdleqader *et al*. (2007) reported that water quality for local chickens was poor owing to dirty drinkers or unhealthy water sources.

The results of the present study disagree with results obtained by Halima *et al*. (2007a) and Zemene (2011) who reported that 27.9%, 37.3% and 34.8% of chicken owners in North West Ethiopia used plastic made, wooden made and clay made drinkers, respectively. In Mozambique Alders *et al*. (1997) reported that 66% of chicken owners used clay dish, followed by metal dish (17%), plastic dish (8%), other (6%) and a tin can (3%) which was also in contrary with the current results.

*5.1.3. Housing and accommodation of chicken*

Separate house construction for chickens was not a common practice in the study woredas; only 7.5% of the respondents provided a separate house for the chicken. Therefore, the majority (92.5%) of chicken owners shared their main houses with the chicken and other animals which makes the bio-security of the village poultry production system very poor (Table 6). It was not uncommon to see chicken droppings anywhere in the family house including materials in which the owners themselves use.

Zemene (2011) reported that only 11.7% of the respondents provided a separate house for the chicken. Therefore, the majority (88.3%) of chicken owners shared their main houses with the chicken. Similarly, Mokenen (2007) reported that 97.6% of the respondents in three woredas of SNNPRS do not have a separate house for their chickens other than sharing the family house, which is all in agreement with the results of the present study. However, the present finding is contrary to the work of Mandal *et al*. (2006) who reported that 97.5% separate house in India is provided for chickens as night enclosure. Muchadeyi *et al*. (2004) also reported that 82% of the households in Zimbabwe provided separate housing for their chicken, while the remaining 18% had no separate chicken housing.

*5.1.4. Diseases and health management of chicken*

Majority of the respondents (80%) said that disease outbreak in the study area occurs in the short rainy season (*Belg*) which is in agreement with the findings of Aberra and Tegene (2009) in Southern Region of Ethiopia. This could be explained by the fact that the moisture creates a suitable environment for disease-causing micro-organisms. The current result is in good agreement with the report of Elijah and Adidapo (2006) who disclosed that poultry diseases in Nigeria are common between months of May and October because these months are conducive for the breeding of diseases parasites. On the other hand, Kugonza *et al.* (2008) reported that chicken diseases in Uganda mainly occur during the dry season.

The current result was indicated that chicken owners treat sick birds by the use of local/traditional medicines (40.0%), modern medicines with prescription (55.8%), modern medicines without prescription (4.2%) and combinations of these were the common methods of treating sick birds (Table 7). Fisseha *et al*. (2010) reported that chicken producers in Burie woreda of Amhara region of Ethiopia use different herbs '*Smize*' (*Justitia schemperina*) and '*Endod*' to treat sick birds, and Zemene (2011) found out that chicken owners in Goncha Siso Enese woreda of the same region also use combinations of similar types of herbs to treat their chicken when they get sick which was in good agreement with the current findings. Similarly, 33.3% of chicken producers in Nigeria (Yakubu, 2010) used local herbs to treat sick birds and the type of herbs (mahogany, neem tree, onion) used is fairly in agreement with the results of the current study.

Only 15% of the farmers in Jordan reported that they consulted veterinary extension services, while 12% practiced annual vaccination against Newcastle disease (NCD) and Infectious Bronchitis (IB) whereas the use of ethnoveterinary medicine was reported by 28% of households (Abdleqader *et al*., 2007). The farmers apply these herbs regardless of the type of disease and the dosage was also unknown. Therefore, the potency and dosage of these locally applied herbs to a particular disease have to be a subject for future investigation that calls scientific community involvement.

The respondents also reported predators are challenging for their chicken next to diseases in the study area (Table 7). Cats (both domestic and wild), hawks and rats were some of the predators mentioned by the farmers. Predation by wild cats and hawks was said to be the major cause for the chicken loss. The present result is in agreement with the findings of Tadelle (2001) and Aberra and Tegene (2009) which reported that in some parts of Ethiopia, the disease was cited as the most important problem reducing both the number and productivity of the birds.

However, the present finding disagrees with the findings of Zemene (2011) who reported that predation was the first challenging problem in Goncha Siso Enese woreda of Amhara region; Mekonnen (2007) who reported that predation is the major cause accounting to 65.7% of chicken loss in SNNPRS of Ethiopia and Conroy *et al*. (2005) who reported that predation causes more mortality than diseases in India. Scavenging chickens are vulnerable to predation as they need to leave the family dwelling to scavenge for feed (Solomon, 2008). On the other hand, domestic cats usually kill chicks than adults.

According to group discussion held with stakeholders, chicken owner farmers said that wild birds (hawks) specifically target at younger flocks. The attack of the hawk is strategic because it sits over a tree or fence near the homestead and carefully observes the movement of the chicken which then swiftly dives into the chicks and takes them away. Preventive mechanisms were chicken owners mount some kind of objects that swing by the wind and scare away the hawk. Fisseha *et al.* (2010) and Zemene (2011) reported that the attack of wild birds was very serious on young chicks.

Similarly, participants said that predator challenge was seasonal (rainy and dry season) and varies according to daily cycle (diurnal and nocturnal). Thus, preventive measures have to consider these facts. Majority of the participants also reported that cat attack was prevalent during the rainy season which implies that rainy season is conducive for the cat to attack the birds. The reason for this may be the dense plant growth and shrubby condition that provide a suitable place for the cat to hide and strike unnoticed. Hawk attack was more challenging

during the dry season where there is little vegetation cover and hence the chickens are easily seen and exposed to the aerial predators.

The participants also reported that chickens with light plumage color are most exposed to predators; particularly to the hawks because of their conspicuousness. The finding of this group discussion is in agreement with Zemene (2011) who reported that birds with white plumage colors are very conspicuous to hawks in Goncha Siso Enese woreda of Amhara region and Aberra and Tegene (2009) who noted that wild birds (eagle, hawks) were the most common predators during the dry season while wild cat was the most dangerous predator during the rainy season in SNNPRS of Ethiopia. Similarly, Conroy *et al.* (2005) reported that predation by mammals is more serious during rainy season whereas predation by birds is more of a threat when there is little or no cover.

Attack of predators was essentially serious when the family was away from the homestead for various activities such as weeding of crops, shopping, fetching water and others. Thus, the chickens are left exposed to the predator defenselessly particularly to house cats attack.

*5.1.5. The productivity of chicken*

Age at first egg and at sexual maturity of village chickens in the study woreda was 5.8 and 5.2 months, respectively (Table 8). This is in close agreement with the findings of Mammo *et al.* (2008) who reported an average age of maturity 2 was 5.4 months. On the other hand, Kugonza *et al*. (2008) and Iqbal and Pampori (2008) who reported an average age of maturity for male and female 5-6 and 6-7months, respectively. Tadelle *et al.* (2003a) and Mandal *et al*. (2006) reported a relatively delayed maturity of 6.8 and 7.6 months for female and male chickens, respectively.

The average eggs produced per local hen per clutch and the average number of days per clutch in the study woreda was found to be 14.1 and 22.9, respectively (Table 8). The average clutch number of hens in the study woreda per year was 3.05, and the total number of eggs produced per hen per year was 43.01. According to Tadelle (2001) the feed resource base for local birds

in the villages is from scavenging and is inadequate for the production of more than around 40 eggs per bird per year). Mandal *et al*. (2006) also reported a similar result for Indian backyard chicken to be 45-55 eggs/hen/year. However, relatively lower egg production of 34 eggs /hen/year was identified by Aganga *et al*. (2000) for indigenous chicken in Botswana. As compared to the high producing chicken breeds, the egg production of village chickens is very low.

The current result indicated that out of the incubated 11.2 eggs only 10.3 chicks were hatched, giving average hatchability percentage of 91.9%. The number of hatched chicks out of the incubated eggs identified in this study was higher than the finding of Yakubu (2010) who reported average hatched chicks of 8.78. Scavenging system is characterized by huge chick mortality in the first two weeks of life, caused by different factors such as disease, predators, and the hostile environment for newly hatched chicks (Tadelle, 2001). Pedersen (2002) found that the number of eggs incubated per clutch was 10.6 with average hatchability rate of 73%. Ssewannyana *et al*. (2008) also reported a higher percentage (87%) of hatchability for Uganda local chickens.

A significant difference ($P< 0.05$) was observed among the study woredas in age at first mating (male chicken), age at first egg, and a number of days per clutch. The present finding is different from the results of Zemene (2011), which indicated significant differences in clutch size, egg production per clutch per hen, number of eggs incubated and number of chicks hatched in west Amhara region of Ethiopia with all the possible attributes.

About 93.3% of chicken owners provided grain and water for their incubating hen every day, whereas only 6.7% did the same every other day. The present finding is in disagreement with the results of Zemene (2011) who reported that 79.6% of chicken owners in Goncha Siso Enese woreda of Amhara region allowed the incubating hen to feed and drink every other day while only 20.4 % of the respondents let the hen feed, drink and dust bath every day. Those chicken owner farmers using every other day frequency of feed and water provision were restricting their hens for twenty four hours, which means that the hens do not feed for ten solid days out of the twenty-one incubating days which could result in a serious weight loss, which

in turn will shorten the clutch length thereby reducing the number of eggs produced per clutch.

The common types of incubating materials used in the study area were wood made material bedded with straw (80%), clay made material bedded with straw (15%), and other materials (like modified plastics, cartoon, bamboo, metal, etc.) 5%. The present finding does not agree with the reports of Zemene (2011) who found out that mud made (63.1%), grass made (9.2%), bamboo made (13.9 %), clay made (9.5%) and other materials such as cartoon, wooden made, on earth, etc. (4.3%) were used as incubating materials in Goncha Siso Enese woreda of Amhara region of Ethiopia. In other parts of Ethiopia, clay pots, bamboo baskets, cartons or even simply a shallow depression on the ground were common materials and locations used for egg setting (Tadelle *et al*., 2003a; Fisseha, 2008).

Group discussion result indicated that egg selection for better hatchability is slightly practiced in the study area. The majority of chicken owners select eggs meant for incubation; they set for incubation eggs that are less soiled, not cracked, and with comparable size as well as little in age. However, the respondents still complain lack of technical support and awareness as well as their ignorance for not attaining high hatchability rates.

*5.1.6. Chicken culling practices*

Farmers have their own criteria and strategies of culling and depopulating birds that are unproductive at any time of the year. The results indicate that majority of chicken owners in the study area (90.8%) purposely cull their chicken at any time, whereas the rest (9.2%) did not purposely cull their chicken at any time, and about 91.7% of the interviewed chicken owners responded selling was the major purpose of culling their chicken, while only 8.3% cull for home consumption (scarification) which was in line with the study of Emebet *et al*. (2013) in southwest Shoa and Guraghe areas described that majority of respondents cull their bird for selling purpose (income) with an overall average of 72.3% in the study area followed by culling for home consumption and income (16.9%), and for only home consumption (9.1%). The major determinant factors for culling chickens in the study area were oldness (34.2%) and

poor productivity (30%) which was in line with a study conducted by Halima *et al.* (2007) indicated that 74.7% of the respondents in cull their chicken because of poor productivity and old age.

*5.1.7. Marketing of chicken and eggs*

As presented in table 6, the result of the current study revealed that village chicken owners traveled an average distance of 4.7 km (ranging 3-5.5) to reach to nearby local and/or urban markets. Significant differences ($P<0.05$) were found in the market distance as well as in chicken and eggs prices among the three woredas. Access to market, which greatly influences chicken and egg marketing system of the study woredas, was mainly determined by the distance to the market and infrastructure (roads), which agrees with the reports of Holloway and Ehui (2002).

The current study revealed that all of the chicken owner farmers (100%) reasoned demand seasonality as major market problems which was in line with the findings of Meseret (2010) and Fisseha (2008) that reported unstable price and demand seasonality were the major problems of egg and live chickens marketing in Gomma woreda of Oromia region and Bure woreda of Amhara region of Ethiopia, respectively.

With response to the seasonality of chicken prices, planning of village chicken production with careful consideration of high demand seasons could be very important. If village chicken production could be carefully planned and managed to match the fluctuating market demand, economic benefits of the sector might be higher. Formation of a marketing plan could be implemented by chicken owners by identifying where and when chicken products would be sold to receive reasonable prices.

Development of market information system at farmer's level and strengthening of agricultural extension services, through training and advisory services, to village chicken owners could also be important to alleviate the above-mentioned chicken marketing constraints, which in turn result in improvement of village chicken production sector of the study area. Chicken

management in the study area was supposed to be the duty of females just like cooking food because chicken is animals staying around homestead all the time. The implication of this finding is that any improvement activities relating to chicken production should be dealt with women. Training on chicken feeding and husbandry, financial credit service and other opportunities should be prioritized for women. The trend that women do not go out of home and take training must be tackled.

*5.1.8. Extension services and source of information for chicken production*

The proportion of farmers who obtain extension service (88.3%) in the present study (Table 12) is higher than those reported for Bure District (37.5%) and North-West Ethiopia (52.5%) by Fisseha (2008) and Halima (2007), respectively.

## 5.2. Morphological Traits of Chickens

*5.2.1. Qualitative morphological traits of chickens*

Local chicken ecotypes may vary in their possession of some of the phenotypic traits like a spur and shank feathers. They may also differ in endowments of head shape and comb types. With regard to the type of comb, the present study (Table 14) indicated that the highest proportion (65.8%) of the chickens in the study area possess rose comb, followed by single comb (25.8%), V-shape/Double (5.7%) and pea comb (2.7%) which is in agreement with the reports of Akililu *et al.* (2013) who indicated that 48.4 % of chickens in Horro district possessed rose combs.

In close agreement with the results of the present study, Halima (2007) and Nigussie (2010) observed 50.72% and 53% of chicken in North West Ethiopia and other parts of Ethiopia to be of pea and rose comb type, respectively. However, Moreda *et al.* (2014) conducted in South-West and South parts of Ethiopia indicated that 59.2 and 31.8% of chickens were single and rose combed which was different from the current findings. In Ethiopia, farmers prefer to have double-combed (more precisely rose combed) cocks for home slaughter (sacrifice) purposes,

in addition to their color preferences (Tadelle, 1996). Not only producers but also buyers prefer double combed birds. Exotic birds such as White Leghorn, apart from being white, are not selected for consumption because they are single-combed (Aklilu *et al*., 2007).

In the current study, male chickens (94.7%) and female chickens (90.8%) had plain head shape across all the study districts, which is in good agreement with the reports of (Bekele *et al.,* 2015; Getu *et al*., 2014; and Moreda *et al*., 2014). A substantial amount of phenotypic diversity for various traits in the indigenous chicken genetic resources of Ethiopia is expected because of diverse agro-climates, ethnic groups, socioeconomic, religious and cultural considerations (Halima *et al*., 2007b). McAinsh *et al*. (2004) reported that the great variations in phenotypes seem to be exactly what characterizes the local chickens.

The dominant body plumage color was Grayish ('*Gebsma*') 48.7%, followed by Black ('*Tem*') 19.3% and Red ('*Kei*') / Red with a black tail (14.2%). The findings of Zemene (2011), where the dominant color was red (38%) followed by white (26.1%) in West Amhara region of Ethiopia and Fisseha (2008), who noted that red plumage color was dominant in Burie woreda of West Gojjam are all in disagreement with the present finding. Reports by Halima *et al*. (2007b), where white was the dominant plumage color in other parts of North West Amhara Region, Apuno *et al*. (2011) where black and mottled with the frequency of 17.07% was the most common, while the white and mottled and black plumage colors were least with frequencies of 6.86% and 6.21%, respectively in local chicken of Nigeria, and Bogale (2008), who indicated that even though there was slight variation in the naming and abundance of the local ecotypes, the most frequent village chicken eco-types in Fogera woreda were white/ '*Netch*' and red/ '*Key*' are all in disagreement with the present finding.

The present finding (Table 16) revealed that yellow shank color was the most prominent (51.5%), followed by other colors like white (32.5%), and black (13.3%), whereas blue (1.8%) and green (0.8%) were the least. The results of shank color in the present study indicated that male (58.6%) and female (47.7%) chickens possessed yellow shank, which was in line with the findings of (Negassa *et al*., 2014 and Melesse *et al*., 2011) who reported that majority of chicken populations (52.5%) in southern and eastern parts of Ethiopia were characterized by

yellow shank. However, Apuno *et al*. (2011) reported that chickens with pink shanks accounted for the largest (38.8%), while those having red shank only accounted for less than 1% in local chicken in Nigeria which disagreed with the current findings.

The present study (Table 16) also found out that white and red earlobe color was the most common (47.2%), followed by white (29%), red (19%) and yellow (2.7%), and other colors were the least (2.2%), which is disagree with the reports of Negassa *et al.* (2014).

In the present study (Table 16), above 84.8 % of the studied chickens were characterized by dark brown eye color and is in line with the findings of Apuno *et al.* (2011) who reported eye colors of dark brown (37.9 %), light brown (28.8 %t) and dark red (28.6 %) for indigenous chickens of Nigeria. On the other hand, Mancha (2004) and Guni and Katule (2013) reported orange eye color as most common among the indigenous chickens of Nigeria and Tanzania, respectively.

### *5.2.2. Quantitative morphological traits of chicken*

The results of linear body measurement traits in the current study were comparable with most of the observations in different parts of the country. According to the reports of Emebet *et al*. (2013) chickens reared in southwest and south part of Ethiopian weigh 1.41 kg which was lower than the current result (1.5 kg). Similarly, the mean body weight of local chickens across the Silte zone (1.5 kg) was higher than native chickens of western Ethiopia (Halima *et al*., 2007). Body weight of male chickens (1.63 kg) was reported for chickens reared in North Gonder Zone of Ethiopia (Getu *et al*., 2014) which was lower than the current result of 1.84 kg male chicken. The average body weight of local adult female chicken in Silte zone was 1.28 kg (Table 20) which was higher than the reported values for the central highlands of Ethiopia (1.04 kg) by Alemu and Tadelle (1997) and that reported (847.77 g) by Halima *et al.* (2007) in northwest Ethiopia. The corresponding values for the mature male chicken were 1.84 kg which was also higher than the values reported Alemu and Tadelle (1997) central highlands of Ethiopian chicken (1.5 kg) and lower than the average weight (2.05 kg) of indigenous chicken in north-west Ethiopia (Halima *et al.*, 2007).

Shank length of male chickens from Silte zone was 9.98 cm which was comparable with the reported value (9.8 cm) by Bogale (2008) and with that of (10.31 cm) reported by Halima *et al.* (2007) in other parts of Ethiopia. Female chickens had shank length (7.58 cm) which was higher than that of (7.25 cm) reported by Bogale (2008). The mean values of comb length (5.25 cm and 2.87 cm) for male and female chickens in Silte zone, respectively, were lower than 5.3 cm of male and higher than 2.3 cm reported by Bogale (2008). In this study long legs, large combs and wattle were observed, which could be important morphological traits that allow better heat dissipation in the tropical hot environment. The comb and wattles play important role in sensible heat losses. This specialized structure accounts for about 40% of the major heat losses, by radiation, convection, and conduction of heat produced from body surfaces at an environmental temperature above $26.7^0$C (Nesheim, 1979).

The measured shank circumference of male indigenous chickens of Bangladesh as reported by Bett *et al.* (2014) is in agreement with the current value (3.2 cm). However, the study conducted by Addisu *et al.* (2013) in North Gonder recorded a comparatively higher value (3.81 cm). The recorded mean wingspan of Silte zone chicken populations was 36.8 cm, which was in contrary with the findings of Guni *et al.* (2013) for chickens 47.6 cm reared in the Southern Highlands of Tanzania. However, the wingspan value in the current study was in line with those reported by Addisu *et al.* (2013) 37.04 cm in North Gonder zone.

### *5.2.3. Correlation between body weight and other linear body measurements*

In the current study, positive and significant ($P < 0.01$) correlations was observed between body weight and linear body measurement traits and are in good agreement with the reports of Negassa *et al*. (2014) and Getu *et al*. (2014). These positive correlations of body weight with linear body measurements observed in the present study suggest that measuring one of these quantitative traits enables to predict the body weight of local chickens in rural farming society. The results of the present study and findings of other scholars, therefore, suggest that selection for any of these linear body measurable traits will cause direct improvement in body weight of indigenous chicken populations (Negassa *et al*., 2014; Tabassum *et al*., 2014; and Ukwu *et al*., 2014).

# 6. CONCLUSIONS AND RECOMMENDATIONS

## 6.1. Conclusions

- The average family size of chicken owners in the study area was 8.03 persons per household (ranged 3-15), and the chicken population was 9.9 chicken per household (ranged 5-15).

- Majority of interviewed chicken owners were males (75%), with a dominant (100%) farming occupation. Highest proportions of them were illiterate (42.5%). The local market was the principal source of foundation chicken stock (64.2%) and the majority (49.2%) of the chicken owners in the study area spends money to buy chicken feeds during the time of feed shortage and most of these (85.8%) get the money from crop sale.

- Although scavenging was the major source of chicken feed reported in all the woredas of the study area, the entire village chicken owners (100%) provided supplementary feed to their chicken, especially during feed shortage seasons

- All of the interviewed village chicken owners of the study area experienced chicken disease problems in their localities. Newcastle Disease (NCD) was identified as a major and economically important health constraint that hinders the expansion of chicken production in the study area.

- The average ages of local cockerels at first mating and pullets at first egg were 5.2 and 5.8 months, respectively. The average number of eggs laid per clutch of local hens was 14.1 (ranged 10-18) and the number of total clutch periods/hen/year was 3.05. The mean annual egg production of local hens under the existing management condition was 43.01 eggs.

- Broody hens were the sole means of egg incubation and chick brooding in the study woredas. The average number of eggs incubated once per a hen was 11.2 eggs (ranged 8-13) and reasonably high numbers of chicks 10.3 were hatched (ranged 6-12). Accordingly, the

mean hatchability performance of local hens was 91.9% (ranged 50-100%). However, because of the high prevalence of diseases, predators and poor management of young chicks the average survivability percent of young chicken to grower stage was only 50.5% (ranged 20-80%).

- Chicken owners of the study area traveled an average distance of 4.7km (ranging 3-5.5) to reach the nearby local/urban markets. Demand seasonality was the most prevailing chicken marketing constraint of the study area.

- The sex profile of the indigenous chicken in the study woreda was comprised of 65.3% females and 34.7% males. Regardless of their sexes majority of observed chicken possessed spurs and earlobes with different lengths (sizes) and plain head types; whereas shank feather was observed for only 3.3% of them.

- Rose comb, yellow shank and red & white earlobes, dark brown eyes, yellow beak color, and ash skin colors were the predominant phenotypic traits of indigenous chickens across the three woredas. The most prevalent plumage color of chicken in all the study woredas was grayish ('Gebsma') occurring at comparable proportions.

- Both the largest (40 cm) and the smallest (30 cm) wingspan measurements were recorded for female chicken, and the largest (46 cm) and smallest (36 cm) for male chicken; and the smallest ($38^0$) and the largest ($52^0$) breast angle values were obtained from female and male chicken in the study area, respectively.

- The lowest body length, body width (breast girth) and keel length values of 29 cm, 20 cm, and 7.5 cm were all recorded for female chicken, whereas the highest values of 41 cm, 27 cm and 11 cm for the same variables were recorded for both sexes. Significant correlations ($P<0.01$) were found pairwise between body weight and all of the other linear measurement traits.

## 6.2. Recommendations

The following recommendations are suggested based on the results of the current study:

- For the existing scavenging system of chicken management in the study woredas, indigenous birds are preferred and their productivity could be enhanced by relatively simple changes in management interventions such as housing, feeding, health care which will promote their productivity and reduce mortality.

- There is a strong need for appropriate intervention in diseases and predator control activities so as to reduce chicken mortality and improve the productivity of village flock of the study woredas. Control of diseases, mainly NCD, could be achieved through improvement in veterinary and advisory services. Introduction and utilization of the newly coming thermo-stable vaccines against NCD could also be important to reduce heavy mortalities.

- The problem of predators could be reduced by convincing farmers to construct predator proof separate chicken houses and housing birds, especially during the night. Young chicks needed to stay in protected areas for the first 4–5 weeks of life, as this is the time when they are most vulnerable to predators and other accidents. Introduction and utilization of locally made hay−box brooders should be encouraged to provide extra care for young chicks and reduce mortality.

- Provision of proper training to chicken producers on how to formulate supplementary rations to village birds, using locally available feed ingredients, could be important.

- The population of indigenous chickens studied showed heterogeneity in most morphological traits considered. Thus, an in-depth molecular evaluation using genetic markers should be undertaken to substantiate the level of genetic differentiation and relationships among indigenous chicken populations.

## 7. REFERENCES


Abdelqader, A., Wollny, C. B. A., & Gauly, M. (2007). Characterization of local chicken production systems and their potential under different levels of management practice in Jordan. *Tropical Animal Health and Production,* **39(3):**155-64.

Abdo, M., Samson, H., Gebremedhin, G., & Kefyalew, G. (2016). Challenges and Opportunities of Small Scale Poultry Production System in Jigjiga zone. Ethiopia: Somalia Regional State.

Abebe, H. (1992). Terminal report on the comparative evaluation of native chicken in the Hararge administrative region and their crosses with the single comb white Leghorn. Mimeographed Report (pp. 22–27). Alemaya University of Agriculture.

Aberra Melesse, S. Maak and G. von Lengerken. (2005). The performance of the naked neck and their F1 crosses with Lohmann White and New Hampshire chicken breeds under long-term heat stress conditions. *Ethiopian Journal of Animal Production,* **5(1):** 91–106.

Aberra, M., & Tegene, N. (2009). Study on the characterization of local chickens found in Southern Ethiopia. In: Proceedings of Annual Research Review Workshop, Hawassa University, Awassa, Ethiopia, May 16-17.

Addis, B., Tadesse, D., and Mekuriaw, S. (2014). Study on major causes of chicken mortality and associated risk factors in Bahir Dar Zuria District, Ethiopia. *African Journal of Agricultural Research,* **9(48):**3465-72.

Aganga, A. A., Omphile, U. J., Malope, P., Chabanga, C. H., Motsamai, G. M., & Motsumi, L. (2000). Traditional poultry production and commercial broiler alternatives for small-holder farmers in Botswana. *Livestock Research for Rural Development* 12(4). Retrieved from http://www.cipav.org.co/lrrd/lrrd12/4/Aga124a.htm Accessed April 4, 2011.

Aklilu, E., Kebede, K., Dessie, T., & Banerjee, A. K. (2013). Phenotypic characterization of the indigenous chicken population in Ethiopia. *International Journal of Interdisciplinary and Multidisciplinary Studies,* **1(1):**24-32.

Aklilu, H. A. (2007). Village poultry in Ethiopia- Socio-technical analysis and learning with farmers.Ph.D. Thesis, Wageningen University, Wageningen, Netherland. 178p.

Aklilu, H. A., Almekinders, C. J. M., Udo, H. M., & Van der Zijpp, A. J. (2007). Village poultry consumption and marketing in relation to gender, religious festivals, and market access. *Tropical Animal Health and Production*, **39(3):**165-177.

Alders, R. (2004). Poultry for profit and pleasure. FAO. Diversification Booklet 3. *FAO, Rome*.

Alders, R. G., Fringe, R., & Mata, B. (1997). Village Chicken Production in Bilene District, Mozambique: Current Practices and Problems. *Proceedings IFPD workshop M'Bour Senegal Dec*.9-13-1997. pp: 189-195.

Apuno, A. A., Mbap, S. T., & Ibrahim, T. (2011). Characterization of local chickens (*Gallus gallus domesticus*) in Shelleng and Song Local Government Areas of Adamawa State, Nigeria. *Agriculture and Biology Journal of North America*, **2(1):** 6–14.

AZADO. (2011). Arsi Zone Agricultural Development Office. Plan and Program Desk of Arsi Zone Agricultural Development Office. Arsi Zone, Oromia.

Badubi, S. S., Rakereng, M., & Marumo, M. (2006). "Morphological characteristics and feed resources available for indigenous chickens in Botswana." *Livestock Research for rural development*, **18(1):**205-211. http://www.lrrd.org/lrrd18/1/badu18003.htm.

Batty, J., & Francis, C. (1979). *Poultry color guides* (2nd ed.). Saiga Publishing Co. Ltd.

Bekele, G., Kebede, K., & Ameha, N. (2015). On-farm Phenotypic Characterization of Indigenous Chicken and their Production System in Bench Maji Zone, South Western Ethiopia. *Science, Technology, and Arts Research Journal*, **4:** 68–73.

Besbes, B. (2009). Genotype evaluation and breeding of poultry for performance under suboptimal village conditions. *World's Poultry Science Journal*, **65:** 260–271.

Bishop, J.P., (1995). Chickens: Improving small-scale production. Echo technical note. 10p

Burley, R.H. (1957). IECA and JATS staff report. Agriculture of Ethiopia, Vol. **VI**.

Central Agricultural Census Commission (CACC), (2003). Statistical report on farm management practices, livestock and farm managements Central Statistical Authority report of 2004-2005, Vol. **II**, Addis Ababa, Ethiopia.

Clarke, B. (2004). Poultry for profit and pleasure.FAO Diversification booklet 3. Rome, Italy.

Conroy, C., Sparks, N., Chandrasekaran, D., Sharma, A., Shindey, D., Singh, Anitha, K. (2005). The significance of predation as a constraint in scavenging poultry systems: Some findings from India. *Livestock Research for Rural Development*, *17*(6). Retrieved from http://www.lrrd.org/lrrd17/6/conr17070.htm Accessed July 10, 2010

Crawford, R. D. (1990). Origin and history of poultry species. Poultry breeding and genetics (pp. 1–42). Amsterdam, Netherlands: Elsevier.

CSA (Central Statistical Authority). (2011). Agricultural sample survey, Volume **2**: Report on livestock and livestock characteristics (prevent peasant holdings). Statistical Bulletin 505, Addis Ababa, February 2011, pp: 12

CSA (Central Statistical Authority). (2013). Agricultural sample survey. Report on livestock and livestock characteristics. The Federal Democratic Republic of Ethiopia, Private Peasant Holdings, Statistical Bulletin 570, Central Statistical Authority (CSA), Addis Ababa, Ethiopia, April 2013.

CSA, (2012). Central Statistics Agency of Ethiopia. Report on Livestock and Livestock Characteristics, Agricultural Sample Survey 2010-11(2003E.C). Statistical Bulletin No.532, Vol. **II**. March 2012. Addis Ababa Ethiopia.

DAGRIS, (2008). Domestic Animal Genetic Resources Information System. International Livestock Research Institute, Nairobi (available at http://dagris.ilri.cgiar.org/)

Dana, N. (2010). Breeding programs for indigenous chicken in Ethiopia: Analysis of diversity in production systems and chicken populations. Ph.D. thesis, Wageningen University, The Netherlands (2011), 148 pp.

Dana, N., Dessie, T., van der Waaij, L. H., & van Arendonk, J. A. M. (2010). Morphological features of indigenous chicken populations of Ethiopia. *Animal Genetic Resources*, **46:** 11–23.

Demeke, S. (2008). Poultry sector country review. FAO, Animal Production and Health Division. Emergency Centre for Transboundary Animal disease, Socioeconomics, Production, and Biodiversity Unit. Jimma, Ethiopia.

Dessie, T. (1996). Studies on Village poultry production systems in the central highlands of Ethiopia.M.Sc Thesis.Swedish University of Agricultural Sciences, Uppsala 72p.

Dessie, T. (2001). The Role of scavenging poultry in integrated farming systems in Ethiopia. Debre Zeit Agricultural Research Center, Debre Zeit, Ethiopia. Livestock Feed Resources within Integrated Farming Systems. 377

Dessie, T. (2003). Phenotypic and genetic characterization of local chicken ecotypes in Ethiopia. Humboldt University of Berlin, Berlin, 209 pp. (Ph.D. thesis).

Dessie, T., Esatu, W., Waaij, L. V., Zegeye, F., Gizaw, S., Mwai, O., & van Arendonk, J. (2013). Village Chicken Production in the Central and Western Highlands of Ethiopia: Characteristics and Strategies for Improvement. Nairobi, Kenya: International Livestock Research Institute.

Dessie, T., Yami, A., and Peters, K.J., (1999). Indigenous chicken in Ethiopia: their genetic potential, attempts made in the past for improvement and future areas of research. Biodiversity and Development of Animal Genetic Resources.

Dinka, H., Chala, R., Dawo, F., Bekana, E., & Leta, S. (2010). Major Constraints and Health Management of Village Poultry Production in Rift Valley of Oromia, Ethiopia. *American-Eurasian Journal of Agricultural & Environmental Sciences*, **9(5):** 529–533.

Dinka, H., Chala, R., Dawo, F., Leta, S., & Bekana, E. (2010). Socio-economic importance and management of village chicken production in the rift valley of Oromia, Ethiopia. *Livestock Research for Rural Development*, **22(11)**.

Domestic Animal Genetic Resources Information System, (2008). International Livestock Research Institute, Nairobi (available at http://dagris ilri.cgiar.org/)

Duguma, R. (2006). Phenotypic characterization of some indigenous chicken ecotypes of Ethiopia. *Livestock Research for Rural Development*, **18(9)**. Retrieved from HTTP://ww.cipav.org.co/lrrd/lrrd18/9/dugu18131.htm

Duguma, R., Dana, N., & Yami, A. (2006). Marek's Disease Vaccination Opened the Door to Rear Indigenous Chickens of Ethiopia under Confined Management. *International Journal of Applied Research in Veterinary Medicine*, **4(2):** 2006.

Egahi, J. O., Dim, N. I., Momoh, O. M., & Gwaza, D. S. (2010). Variations in qualitative traits in the Nigerian local chicken. *International Journal of Poultry Science*, **9(10):** 978–979.

Elijah, O.A., and A. Adedapo, A. (2006). Effect of Climate on Poultry Productivity in Ilorin Kwara State, Nigeria. *International Journal of Poultry Science,* **5(11):** 1061–1068.

ELMP. (2014). National Livestock Master Plan for Poultry of Ethiopia. Paper presented by ILRI scientist at the Fourth Poultry Sub-Sector Stakeholders Meeting on October 25, 2014.

Emebet, M. Harpal, S. Tesfaye and S.Anna, M. (2010). Phenotypic characterization of the indigenous chicken population in the southwest and south part of Ethiopia.

Emebet, M., Hareppal, S., Johansson, A., Sisaye, T., & Sahile, Z. (2013). Characteristics of Indigenous Chicken Production System in South West and South Part of Ethiopia. *British Journal of Political Science,* **2:** 25–32.

Ensminger, M. E. (1992). *Poultry Science* (3rd ed.). USA: Interstate Publisher Inc.

Eriksson, J., Larsen, G., Gunnarsson, U., Bed'hom, B., Tixier-Boichard, M., Stromstedt, L., Wright, D., Jungerius, A., Vereijken, A., Randi, E., Jensen, P. & Andersson, L. (2007). Identification of the yellow skin gene reveals the hybrid origin of domestic fowl. *PLoS Genet.,* **4(2):** *e1000010 (*doi: 10.1371*/journal. pgen.1000010).*

FAO, (2007). The state of the world's animal genetic resources for food and agriculture (B. Rischkowsky & D. Pilling, Eds.). Rome.

FAO, (2008). Domestic animal diversity information system. Rome (available at http://www.fao.o rg/dad-is/)

FAO, (2009). The state of food and agriculture: Livestock in the balance. Food and Agriculture Organization of the United Nations. Rome, Italy: FAO.

FAO, (2010). Poultry genetics and breeding in developing countries. Genetic diversity and conservation of genetic resources. Poultry development review by Robert Pym, Paper N° 5 Rome.

FAO, Food and Agriculture Organization of the United Nations; Rome: (2008). Poultry Sector Country Review.

FAO:-Food and Agricultural Organization. (2010). Poultry Meat and Eggs: Agribusiness Handbook. Director of Investment Centre Division, FAO. Rome, Italy, Pages: 77.

Faruque, S., Siddiquee, N. U., Afroz, M. A., & Islam, M. S. (2010). Phenotypic characterization of Native Chicken reared under an intensive management system. *J. Bangladesh Agril. Univ,* **8(1):** 7982.

Francesch, A., Villalba, I., & Cartañà, M. (2011). Methodology for morphological characterization of chicken and its application to compare Penedesenca and Empordanesa breeds. FAO (Food and Agriculture Organization of the United Nations). *Animal Genetic Resources*, **48:** 79–84.

Getu, A., Alemayehu, K., & Wuletaw, Z. (2014). Phenotypic Characterization of Indigenous Chicken Ecotypes in North Gondar Zone, Ethiopia. *Global Veterinaria,* **12:** 361–368.

Gondwe, T.N.P., 2005. Characterization of local chicken in low input low output production systems: is their scope for appropriate production and breeding strategies in Malawi, (unpublished Ph.D. thesis, Georg-August-Universitat Gottingen)

Griffin, A. M., Renema, R. A., Robinson, F. E., & Zuidhof, M. J. (2005). The influence of rearing light period and the use of broiler or broiler breeder diets on 42-day body weight, fleshing and flock uniformity in broiler stocks. *Journal of Applied Poultry Research,* **14(2):** 204–216.

Gueye, E. F. (2002). Newcastle disease in family poultry: Prospects for its control through ethnoveterinary medicine. *Livestock Research for Rural Development,* **14(5).**

Guni, F. S., & Katule, A. M. (2013). Characterization of local chickens in selected districts of the southern highlands of Tanzania: I. Qualitative characters. *Livestock Research for Rural Development,* **25(153)**.

Halima, H., & Mogesse, F. (2007). Phenotypic and genetic characterization of indigenous chicken populations in North-West Ethiopia.Ph.D. Thesis. Submitted to the faculty of natural and agricultural sciences department of animal, wildlife and grassland Sciences. The University of the Free State, Bloemfontein, South Africa.

Halima, H., Neser, F. W. C., de Kock, A., & van Marle-Koster, E. (2009). Study on the genetic diversity of native chickens in northwest Ethiopia using microsatellite markers. *African Journal of Biotechnology*, **8(7):** 1347–1353.

Halima, H., Neser, F. W. C., van Marle-Koster, E., & de Kock, A. (2007b). Phenotypic variation of native chicken populations in northwest Ethiopia. *Tropical Animal Health and Production*, **39(7):** 507–513.

Halima, H., Neser, F. W. C., van Marle-Koster, E., & de Kock, A. (2007). Phenotypic variation of native chicken populations in northwest Ethiopia. *Tropical Animal Health and Production,* **39(7):** 507–513.

Halima, H., Neser, F. W., Van Marle-Koster, E., & De Kock, A. (2007a). Village-based indigenous chicken production system in north-west Ethiopia. *Tropical Animal Health and Production*, **39(3):** 189–197.

Holloway, G. and Ehui, S., (2002). Expanding market participation among smallholder livestock producers. Socio-economic and Policy Research Working Paper **48**; International Livestock Research Institute, Nairobi, Kenya.

Horst, P. (1989). Native fowls as a reservoir for genomes and major genes with a direct and indirect effect on the adaptability and their potential for tropically oriented breeding plans. *Archiv für Geflügelkunde*, **53(3):** 93–101.

Hoyle, E. (1992). Small-scale poultry keeping in Welaita, North Omo region. Technical pamphlet No. 3 Farmers Research Project (FRP). Farm Africa Addis Ababa.

Iqbal, S.and Pampori, Z. A. (2008). Production potential and qualitative traits of indigenous chicken of Kashmir. Livestock Research for Development, 20(11). http://www.lrrd.org/lrrd20/11/iqba20182.htm (Accessed on January 2, 2011).

Jennifer, B. (2006). The Threat of Avian Flu Predicted Impacts on Rural Livelihoods in Southern Nation, Nationalities and Peoples Region (SNNPR), Ethiopia. The Food Economy Group, May 2006.

Jens Christian R, Anders P, Charlotte V, Anish MC, Lone F. (2004). Keeping Village Poultry.A technical manual for small-scale poultry production. Copenhagen, Denmark.

Jiang, X. (1999). Broiler breeding: breeding goals, selection schemes and the usefulness of local breeds of China. Wageningen, The Netherlands, Wageningen University. 185 pp. (Ph.D. thesis)

Kamali, M. A., Ghorbani, S. H., Sharbabak, M. M., & Zamiri, M. J. (2007). Heritability and genetic correlations of economic traits in Iranian native fowl and estimated genetic trend and inbreeding coefficients. *British Poultry Science*, **48(4):** 443–448.

Kibret, B. (2008). In situ characterization of local chicken eco-types for functional traits and production system in Fogera woreda, Amhara Regional state. Msc Thesis. Haramaya University, Ethiopia. 107p.

Kugonza, D. R., Kyarisiima, C. C., & Iisa, A. (2008). Indigenous chicken flocks of Eastern Uganda: I. Productivity, management, and strategies for better performance. *Livestock Research for Rural Development*, **20(9)**.

Leulseged, Y. (1998). Study on production systems of indigenous and improved poultry in rural areas of North Wollo. Alemaya, Ethiopia, Alemaya University of Agriculture. 102 pp. (M.Sc. thesis)

Lwelamira, J., Kifaro, G. C., & Gwakisa, P. S. (2009). Genetic parameters for body weights, egg traits and antibody response against Newcastle Disease Virus (NDV) vaccine among two Tanzania chicken ecotypes. *Tropical Animal Health and Production*, **41(1):** 51–59.

Mancha, Y.P. (2004). Characterization of local chickens in Northern part of the Jos Plateau. Animal Production Programme, School of Agriculture, ATBU, Bauchi, Nigeria. (A Ph.D. Thesis)

Mandal, M. K., Khandekar, N., & Khandekar, P. (2006). Backyard poultry farming in Bareilly district of Uttar Pradesh, India: An analysis. *Livestock Research for Rural Development*, **18(7)**.Retrieved from http://www.lrrd.org/lrrd18/7/mand18101.htm Accessed April 21, 2011.

Mbugua, N.P., (1990). Rural smallholder poultry production in Kenya. In Proceedings, CTA Seminar on Smallholder Rural Poultry Production, Thessaloniki, Greece, 9–13 October 1990. Vol. **2:** 119–131.

Mcainsh, C. V., Kusina, J., Madsen, J., & Nyoni, O. (2004). Traditional chicken Production in Zimbabwe. *World's Poultry Science Journal,* **60:** 233–246.

Mekonnen, M. (2007).Characterization of the smallholder poultry production and marketing system of Dale, Wonsho and Loka Abaya woredas of SNNPRS, Ethiopia.M.Sc Thesis. Hawassa University, Ethiopia. 95p

Melesse, A. (2007). Poultry Production and Management in the Tropics. Teaching Material. Hawassa, Ethiopia: Hawassa University, College of Agriculture.

Melesse, A. (2008). Physiology of Animal Adaptations in Stressful Environments. Teaching Material. Hawassa, Ethiopia: Hawassa University, College of Agriculture.

Melesse, A., & Negesse, T. (2011). Phenotypic and morphological characterization of indigenous chicken populations in the southern region of Ethiopia. Animal Genetic Resources, 2011, 00, 1-13. ©. *Food and Agriculture Organization of the United Nations, 2011*. https://doi.org/10.1017/S2078633611000099

Melesse, A., Tiruneh, W., & Negesse, T. (2011). Effects of feeding Moringa stenopetala leaf meal on nutrient intake and growth performance of Rhode Island Red chicks under tropical climate. *Tropical and Subtropical Agroecosystems,* **14(2):**485-492.

Melesse, N. T. (2011). Phenotypic and morphological characterization of indigenous chicken populations in the Southern region of Ethiopia. *Anim Genetic Resources Info J,* **49:** 19–31.

Mengesha, M., Tamir, B., & Dessie, T. (2008). Socio-economic contribution and labor allocation of village chicken production of Jamma district of South Wollo Ethiopia. *Livestock Research for Rural Development, 20*(10).

Mengesha, M., Tamir, B., & Dessie, T. (2008). Village chicken characteristics and their seasonal production situation in Jamma District, South Wollo. *Livestock Research for Rural Development,* **20(7)**.

Moges, F. (2008). Studies on production and marketing systems of local chicken ecotypes in Burie district of North West Amhara. Msc thesis. Hawassa University, Hawassa, Ethiopia.187p.

Moges, F., Melesse, A., & Dessie, T. (2010). Assessment of village chicken production system and evaluation of the productive and reproductive performance of local chicken ecotype in Bure district, North West Ethiopia. *African Journal of Agricultural Research,* **5(13):** 1739–1748. Retrieved from http://www.academicjournals.org/AJAR

Moges, F., Mellesse, A., & Dessie, T. (2010a). Assessment of village chicken production system and evaluation of the productive and reproductive performance local chicken ecotype in Bure district, North West Ethiopia. African Journal of Agricultural Research, **5(13):** 1739-1748.

Molla, M. (2010). Characterization of village chicken production and marketing system in Gomma woreda, Jimma zone, Ethiopia. MSc Thesis submitted to Jimma University, College of Agriculture and Veterinary Medicine, August (2010). Pdf 110 pp.

Moreda, E., Singh, H., Sisaye, T., & Johansson, A. M. (2014). Phenotypic Characterization of Indigenous Chicken Population in South West and South Part of Ethiopia. *British Journal of Political Science,* **3:** 15–19.

Muchadeyi, F. C., Eding, H., Wollny, C. B. A., Groeneveld, E., Makuza, S. M., Shamseldin, R. Weigend, S. (2007). Absence of population substructuring in Zimbabwe chicken ecotypes inferred using microsatellite analysis. *Animal Genetics,* **38(4):** 332–339.

Muchadeyi, F. C., Sibanda, S., Kusina, N.T., Kusina, J., and Makuza, S. (2004). The village chicken production system in Rushinga District of Zimbabwe. Livestock Research for Rural Development **16 (6)**. http://www.lrrd.org/lrrd16/6/much16040.htm. (Accessed on April 12, 2011)

Mushi, E. Z., Binta, M. G., Chabo, R. G., & Seipone, B. (2005). Chick Mortality in Indigenous Chickens (Gallus domesticus) under free-range management in Sebele, Gaborone, Botswana. *Journal of Animal and Veterinary Advances,* **4(9):** 768–770.

Mwacharo, J. M., Nomura, K., Hanada, H., Jianlin, H., Hanotte, O., & Amano, T. (2007). Genetic relationships among Kenyan and other East African indigenous chickens. *Animal Genetics,* **38(5):** 485–490.

NABC, (2010).Livestock in Ethiopia and opportunity analyses for Dutch investment.Fact Sheet Livestock Ethiopia, Netherlands-African Business Council, September 2010, pdf 27pp.

Negassa, D., Aberra Melesse, A., & Banerjee, S. (2014). Phenotypic characterization of indigenous chicken populations in Southeastern Oromia Regional State of Ethiopia. *Anim Genetic Resources Info J,* **55:** 101–113.

Negesse, T. (1992). Dietary status of smallholder local chicken in Leku, Southern Ethiopia. *Sinet. An Ethiopian Journal of Science,* **15(1):** 59–67.

Nesheim C.M., E.R. Austic, and E.L. Card. Poultry production. Philadelphia. 12th edition. Lea and Febiger, 1979.

Norris, D., & Ngambi, J. W. (2006). Genetic parameter estimates for body weight in local Venda chickens. *Tropical Animal Health and Production,* **38(7-8):** 605–609.

Pedersen, C.V., (2002). Production of semi-scavenging chickens in Zimbabwe.Ph.D Thesis.Royal Veterinary and Agricultural University, Copenhagen, Denmark. 143p.

Reta, D. (2009). "Understanding the role of indigenous chickens during the long walk to food security in Ethiopia." *Livestock Research for rural development,* **21(8):**116.

Riise, J. C., Permin, A., & Kryger, K. N. (2005). Strategies for developing family poultry production at the village level. Experiences from West Africa & Asia. *World's Poultry Science Journal,* **61:** 15–22.

Roberts, V. (1997). *British poultry standards* (5th ed., pp. 4–18). Blackwell Sci. Ltd.

Rushton, J. and Ngongi, S. (2002). Poultry, Women, and Development: Old Ideas, New Applications and the Need for More Research. Department of Agriculture, University of Reading, UK. FAO World animal review 91-1998/2

Salam, K.R., (2005). Improvement of village chicken production in a mixed (chicken-ram) farming system in Burkina Faso. Ph.D. Thesis.Wageningen Institute of Animal Sciences, Animal Nutrition Group, Wageningen University, the Netherlands.

Sang, B., Kong, H. S., Kyukim, H., Choi, C. H., Kim, S. D., Cho, Y. M., Lee, H. K. (2006). Estimation of genetic parameters for economic traits in Korean native chickens. *Asian-Australasian Journal of Animal Sciences,* **19(3):** 319–323.

Smyth, J. R. (1990). Genetics of plumage, skin and eye pigmentation in chickens. In R. D. Crawford (Ed.), Poultry breeding and genetics (pp. 109–168). Amsterdam: Elsevier Science Publishers.

Solomon Demeke. (2007). Suitability of hay-box brooding technology to rural household poultry production system. Jimma, Ethiopia: Jimma University College of Agriculture and Veterinary Medicine.

Somes, R. G. (2003). Mutations and major variants of plumage and skin in chickens. In R. D. Crawford (Ed.), Poultry breeding and genetics (3rd ed., pp. 169–208). The Netherlands: Elsevier Science Publishers.

Sonaiya, E. B., & Swan, S. E. J. (2005). Small-scale poultry production, technical guide manual.FAO Animal Production and Health 1.Food and Agriculture Organization of the United Nations. FAO.

SPSS, (2007). Statistical Package for Social Sciences. SPSS for Windows, User's guide: Statistics version 16. Inc. Cary, NC.

Ssewannyana, E., Ssali, A., Kasadha, T., Dhikusooka, M., Kasoma, P., Kalema, J., Aziku, L. (2008). On-farm characterization of indigenous chickens in Uganda. *Journal of Animal & Plant Sciences,* **1(2):** 33–37.

Tabassum, F. M. A., Hoque, F., Ritchil, C. H., Faruque, M. O., & Bhuiyan, A. K. F. H. (2014). Phenotypic and Morphometric characterization of indigenous chickens at jhenaigatiupazila of sherpur district in Bangladesh. *SAARC Journal of Agriculture,* **12:** 154–169.

Tadelle Dessie and Ogle, B., (1996b). Nutritional status of village poultry in the central highlands of Ethiopia as assessed by analyses of crop contents and carcass measurements M.Sc. Thesis. SLU, Dept of Animal Nutrition and Management, 15pp.

Tadelle Dessie, Million T., Alemu Y. and Peters K.J. (2003a). Village chicken production systems in Ethiopia: 1. Flock characteristics and performance. *Livestock Research for Rural Development,* **15(1),** 2003.

Tadelle Dessie., and Ogle, B. (2000). Nutritional status of village poultry in the central high lands of Ethiopia as assessed by analyses of crop contents. *Eth J. Agri. Sci.,* **17:** 47–57.

Teketel, F. (1986). Studies on the meat production potential of some local strains of chicken in Ethiopia.Ph.D Thesis.J.L.University of Giessen, Germany.210 p.

Teklewold, H., Dadi, L., Yami, A., & Dana, N. (2006). Determinants of adoption of poultry technology: A double-hurdle approach. *Livestock Research for Rural Development,* **18(3)**. Retrieved from http://www.cipav.org.co/lrrd/lrrd18/3/tekl18040.htm

Ukwu, H. O., Okoro, V. M. O., & Nosike, R. J. (2014). Statistical Modeling of Body Weight and Linear Body Measurements in Nigerian Indigenous Chicken. *IOSR Journal of Agriculture and Veterinary Science,* **7:** 27–30.

Yakubu, A. (2010). Indigenous Chickens of Nasarawa state, Nigeria: Their characteristics, Husbandry, and Productivity. *Tropical and Subtropical Agroecosystems,* **12:** 69–76.

Yami, A. (1995). Poultry production in Ethiopia. *World's Poultry Science Journal,* **51:** 197–201.

Yami,A., & Dessie,T. (1997). The status of poultry research and development in Ethiopia, research bulletin No.4, poultry commodity research program Debrezeit Agricultural research center. Alemaya University of agriculture, Ethiopia.pp. 62.

Zemene, W. (2011). Assessment of Village Chicken Production System and the Performance of Local Chicken Populations in West Amhara Region of Ethiopia. MSc thesis submitted to Hawassa University college of Agriculture November (2011). Pdf 118 pp.

## 8. APPENDICES

**Appendix 1.** Some of the commonest body plumage colors of chickens and the morphologic measurement instruments traits in the study area

Red (‘*Kei*’) with black-tailed  Greyish white  Red greyish with white-tailed

White with black tail  Black tailed greyish (‘*Gebsima*’)  Multicolored

Red-brownish (‘*Kokma*’)

Full black (‘*Tikur*’)

Some of the commonest body plumage colors of chicken in the study area

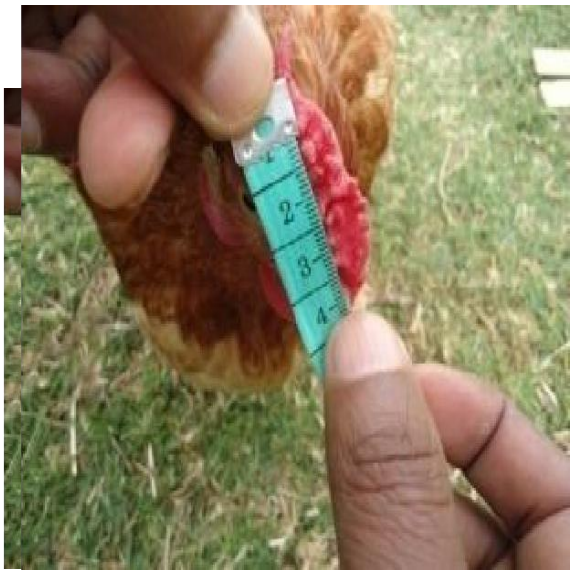
Wattle length measurement

Spur length measurement

Beak length measurement

Shank length measurement

Shank circumference measurement



Comb length measurement

Breast girth measurement

Keel length measurement

Breast angle measurement

Live body weight measurement

Some of the morphologic traits measurement instruments for chicken in the study area

**Appendex 2.** Definition of the local language Names

1. Tem/ Tikur= Black
2. Yetem dama= Black brown
3. Bush/ Key= Red
4. Gumera/Nech= White
5. Yetem/Yetikur gebsima= Black grey
6. *Kuncho/ Gutya*=Crest type of head
7. Yegumera/ Yenech gebsima= White grey
8. Yebush/ Yekey gebsima= Red grey
9. *Zigra/ Kokma* = Red- brownish
10. *Anbesima*= Grayish yellow with varying mixture/ Multicolor
11. *Gebsima*= Grayish with a varying mixture
12. *Mastatebya=Plastic pan*
13. *Qinche* = Crushed and cooked wheat
14. *Frushka*= Wheat Bran
15. *Frushkello*= Wheat middlings
16. *Enjera firfir*= Scrubs of Ethiopian staple food made from *Eragrostis teff*
17. *Katikala*= Local methyl alcohol
18. *Endod= Phytolacca dodecandra*
19. *Dabo firfir*= Scrubs of local bread
20. *Belg*= the short rainy season

**Appendex 3.** Sample Questionnaire on Qualitative and Quantitative Morphological Traits

Sample Questionnaire on Qualitative Morphological Traits

Woreda _____ Kebelle_____ Household name_____ Date _____

| ID of chicken | sex of chicken | Spur | Comb type | Head shape | Shank feather | Body plumage color | Shank color | Earlobe color | Eye color | Beak color | Skin color |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |

Sample Questionnaire on Quantitative Morphological Traits

| ID of chicken | Sex of chicken | WS (cm) | SPL (cm) | SHL (cm) | SHC (cm) | CL (cm) | WL (cm) | BKL (cm) | BW (kg) | BRA (degrees) | BL (cm) | BRG (cm) | KL (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | |

BW: Body weight, BL: Body length; WS: Wingspan; SHL: Shank length; SHC: Shank Circumference; SPL: Spur length; KL: Keel length; WL: Wattle length; CL: Comb length; BKL: Beak length; BRA: Breast angle; and BRG: Breast Girth