PHENOTYPIC CHARACTERIZATION AND THEIR MANAGEMENTAL SYSTEM OF INDIGENOUS CHICKEN ECOTYPES IN AWI ZONE, AMHARA REGIONAL STATE ETHIOPIA

M.Sc. THESIS

BY:

ANDUALEM YIHUN

SEPTEMBER, 2018

JIMMA, ETHIOPIA

Phenotypic Characterization and Their Managemental System of Indigenous Chicken Ecotypes in Awi Zone, Amhara Regional State Ethiopia

M.Sc. Thesis

Submitted To the School of Graduate Studies Jimma University, College of Agriculture and Veterinary Medicine in Partial Fulfillment of the Requirements for the Degree of Master of Sciences in Agriculture (Animal Breeding and Genetics)

By:
Andualem Yihun

Major Advisor: Prof. Manzoor Ahmed Kirmani.

Co-Advisor: Meseret Molla (Assistant professor, M.Sc.)

September, 2018

Jimma, Ethiopia

Jimma University
College of Agriculture and Veterinary Medicine
Thesis Submission for External Defense Request Form (F-07)

Name of Student: Andualem Yihun: ID.No: RM1424/09
Program of Study: M.Sc. In Animal Breeding and Genetics

Title: - Phenotypic Characterization and Their Managemental system of Indigenous chicken Ecotypes in Awi Zone, Amhara Regional state, Ethiopia.

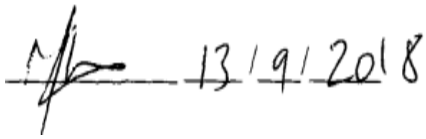
I have incorporated the suggestion and modifications given during the internal thesis defense and got the approval of my advisors. Hence, I hereby kindly request the Department to allow me to submit my thesis to external thesis defense.

Name of the student Andualem Yihun Wolely Signature _____ Date_____/___/____

We, the thesis advisors have verified that the student has incorporated the suggestion and modifications given during the internal thesis defense and the thesis is ready to submitted. Hence, we recommended the thesis has to be submitted to the external thesis defense.

Major Advisor: Manzoor Ahmed Kirmani (Prof.) _____ 12 /09 /2018

Name Signature Date



Co- Advisor: Meseret Molla (M.Sc, Assis.Prof.)

Name Signature Date

Internal Examiner (If depends on the verdict)

Name _____Signature _____ Date _____

Decision/Suggestion of Department Graduate Council (DGC)

_____

_____ _____ ____/____/_____

Chairperson, DGC Signature Date

_____ _____ ____/____/_____

Chairperson, CGS Signature Date

DEDICATION

I dedicated this manuscript to my family especially to my brother Worku yihun and my mother Birikitu Brihanu, Andualem for their moral, encouragement and sacrifice, to finalize my study.

STATEMENT OF AUTHOR

I the undersigned, hereby declare that the thesis entitled "Phenotypic characterization and their managemental system of indigenous chicken ecotypes in Awi Zone, Amhara Regional State Ethiopia" is my own work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for M.Sc. degree at Jimma University and is deposited at the University Library to be available to borrowers under rules of the library. I truly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma or certificate. I concede copyright of the thesis in favor of the Jimma University, Collage of Agriculture and Veterinary Medicine.

Name: Andualem yihun Signature: _____ Date: _____

ACRONYMS AND ABBREVATIONS

AnGR	Animal Genetic Resources
CSA	Central Statistical Agency
DAGRIS	Domestic Animal Genetic Resources Information System
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agricultural Organization Statistics
GLM	General Linear Model
LSM	Least Square Means
MOE	Ministry of Education
NCD	New Castle Disease
PC	Principal Component
PCA	Principal Component Analysis
SD	Standard Deviation
SE	Standard Error
SNNPRS	South Nation Nationality People Regional States

BIOGRAPHICAL SKETCH

The author, Andualem yihun, was born in rural area on December, 1986E.C in Tafoch Dan bull kebele. He attended his elementary and junior education at Dan bull primary and junior schools, and Secondary and preparatory School was in Addis kidame High School. Then he joined to Adigirat University in 2006 E.C and graduated in July two for B.Sc. in Animal production and technology in 2008E.C. After his graduation, he had interred directly to Jimma University by worked M.Sc. ministry of education Exam. In September 2009E.C, he re-joined the School of Graduate Studies at Jimma University to pursue his graduate study in Master of Science in Animal breeding and genetics.

ACKNOWLEDGMENTS

First I thank my Almighty God for giving me health and strength for the completion of the study. I am indebted to many individuals for their help and encouragement rendered while conducting this study. Then, I would like thank to major and Co-advisors, my major advisor Prof. Manzoor Ahmed Kirmani and my Co-advisor, Meseret Molla (Assistant professor, M.Sc.) for their valuable comments, guidance and encouragement from proposal write up to submission of the final thesis write up. I want also to thank Ethiopian ministry of education for offering the opportunity to pursue my M.Sc. study and for the financial grant for my education and research works. Equally, I would like to thank Jimma University College of Agriculture and Veterinary Medicine for the supporting of my research works.

TABLE OF CONTENTS

Page

TABLE OF CONTENTS *(Cond't)*

LIST OF TABLE

Tables pages

LIST OF FIGURES

Figures pages

List of Appendix Tables;

Phenotypic Characterization and Their Managemental System of Indigenous Chicken Ecotypes in Awi Zone, Amhara Regional State Ethiopia

Student: Andualem Yihun
Major Advisor: Manzoor Ahmed Kirmani
Co-Advisor: Meseret Molla

ABSTRACT

*The study was conducted in three districts of Awi zone in Amhara region, with the aim to characterize andidentify the phenotypic variation and their managemental system of indigenous chicken Ecotypes in Faggeta lekoma, Dangila and Zigom district. The study was included questionnaire, linear measurement and a participatory group discussion. The total of 180 households were participated in the interviews, which was conducted using a structured questionnaire and for phenotypic characterization of (720) seven hundred twenty indigenous chicken (504) female and 216 male from the whole districts) to describe qualitative and quantitative traits. The data was analyzed based on the information that was obtained primary data sources by using SAS version 9.3 (2014) and SPSS. The study finding exposed that indigenous chicken rearing seems to be an important activity with an average flock size9.80, 9.10 and 10.20birds per household in high-land, mid-land and low-land agro-ecology respectively. In this result the Scavenging was the major feeding system in all districts. About 85%, 93.33% and 78.33% of the respondents in high-land, mid-land and low-land agro-ecologies were practiced scavenging with supplementary feeds. The standard age of cockerels at first mating and pullets at first egg laying were 5.21 months and 5.77 months, respectively. About 74.4% of the respondents select eggs for incubation, straw and dry hay were commonly used as bedding material for incubation. About 96.7% of the respondent use broody hens for incubation and rearing chicks. The results of the rankings had shown that diseases outbreaks mainly Newcastle (locally called **wotetie**) disease and together with predators were the major and economically important constraint for the existing chicken rearing system. In this result the main breeding objectives of the respondents were meant for household consumption, income generation and for replacement of the flock. The selection criteria used for selection of breeding cock were: disease resistance, growth rate, Comb type, fighting ability, plumage colour, fertility and temperament with an average index value of 0.292, 0.197, 0.123, 0.075, 0.176, 0.100 and 0.037. The highest selection criteria used for selection of breeding hens were also egg number& egg size, growth rate, hatchability, mothering ability, brooding, disease, plumage colour, good scavenging and fighting ability with an index value of 0.367, 0.151, 0.056, 0.045, 0.074, 0.108, 0.087, 0.062 and 0.047, respectively. Local chicken were mostly normally feathered and large phenotypic variability among ecotypes was observed for plumage color. A many plumage colors were identified in all districts in which Red in high-land and mid-land and Gebsima (grayish) colours in low-land were the predominant color of the study area beside a large diversity. The average body weight of local chickens in high-land, mid-land and low-land AEGs were 1.476, 1.75 and 1.71kg respectively, while the respective values for mature cocks and hens were 1.78 and 1.51kg. Variations were also observed in shank length, chest circumference, body length, neck length, wingspan, wing length, comb width, comb length and shank circumference. In conclusion, there is diversity of indigenous chicken population and farmers' preference of different traits that may invite to design community based genetic improvement. These were recommended in poultry breeding policy which focused on managemental system, selection, and trait preference should be designed.*

Keywords: Breeding, Flock Composition, Husbandry Practice, Morphology, Production Environment and Trait Preference.

1. INTRODUCTION

1.1. Background and Justification

Poultry is the largest livestock group in the world estimated to be about 23.39 billion, consisting mainly of chickens, ducks and turkeys (FAOSTATA, 2012). In Africa (Kanginakuduru *et al.*, 2008) reported that local chickens were represented about 98% of the total number of poultry was kept.

Ethiopia is believed to have the largest livestock population. According to (CSA, 2017), there were 56.53 million chickens in Ethiopia, comprising of 94.31, 3.21 and 2.49 % of indigenous, hybrid and exotic types, respectively. In Ethiopia, most chicken populations are non-descriptive type. However, they showed a great variation in their production performance, which might be due to their wide spread distribution and adaptive response to different ecological conditions (Tadelle *et al*., 2003); (Halima, 2007); (Fisseha *et al*. 2010), (Addis, 2013). The local chicken strains are a general term given to the birds kept in the scavenging (the free-range), with no identified description, that is multi-purpose and unimproved (Mengesha, 2012).

Farmers in Africa gave these chicken names like; family chickens, bush chickens or African hen (Gueye, 2009). (Besbes *et al*. 2012) stated that family chickens, are reared by families to get food, income and employment. Local chickens contribute significantly to the livelihood of the rural farmers by providing them with high-quality animal protein in the form of eggs and meat for family consumption (Meseret, 2010). Food security ensures that members of a household have access to an enough diet to lead an active and normal life (Moreki *et al*., 2010).

Phenotypic characterization of AnGR generally refers to the process of identifying distinct breed populations and describing their external and production characteristics within a given production environment. The term production environment is taken to include not only the "natural" environment but also management systems and the uses to which the animals are put, as well as social and economic factors such as market orientation opportunities and gender issues (FAO. 2012).

The term “breed” is used in phenotypic characterization to identify district AnGR populations as units of phenotypic reference and measurement. Diversity in AnGR populations is measured in three forms: interpopulation diversity (between breeds), intrapopulation diversity (within breeds), and inter-relationships between populations. Phenotypic characterization is used to identify and document diversity within and between distinct breeds, based on their observable attributes (FAO. 2011).

Improvement of local chicken productivity through selection and cross breeding is vital for all developing countries especially for Ethiopia since there is dynamic increment of human population, and incompatibility of demand and supply of animal protein. Developing appropriate animal breeding programs for village conditions requires characterizing local chickens, defining the production environments and identifying the breeding practices, production objectives, and trait choices of rural farmers (Solkner *et al*., 2008).Therefore, these existing chicken ecotypes have to be characterized for their overall merits and for subsequent improvement.

Characterization is the initial step for long-term genetic improvement as it provides the basis for any other livestock development interventions and provides information for designing appropriate breeding programs. Breed characterization includes all activities related with the description of the source, development, structure, population, quantitative and qualitative characteristics of the breeds in defined management and climatic conditions (FAO, 2012).(Reta (2006), (Halima *et al.,* 2007), (Nigussie *et al*., 2010), and (Aberra and Azage 2011) indicated the presence of several adaptation and morphological variations among Ethiopian local chicken.

Knowledge and understanding of the indigenous chicken breeding practices and management systemsare important in the design and implementation of chicken based development programs. Furthermore, characterization can identify breeds and/or populations which are at risk of extinction or which are highly desired by farmers, and hence is an important input into nation’s chicken development planning (Halima *et al*., 2007).

Though work on characterization of local chicken in Ethiopia has been carried out by several researchers covering money areas of Ethiopia and Amhara Region, however no such characterization studies have been carried out to characterize and classify the existing local chickens in the participation of the community in Awi zone, generally (Faggeta lekoma, Dangila and Zigom) districts. Given the highest potential for poultry production and presence of diverse ecotypes, it is imperative to conduct comprehensive studies that can covering the entire characteristics of morphological, functional, and adaptive traits of local chickens, identifying farmers breeding practices, and trait preference of local chicken producers with "people centered" perspective.

Therefore this study was planned for phenotypic characterization of indigenous chicken populations to describe their managemental system and breeding practice, and indicate traits of economic interest of indigenous chickens. So this study was, designed with the following general and specific objectives.

1.2: General Objective

- To characterize andidentify the phenotype variation and their managemental system of indigenous chickenEcotypesinAwi Zone of Amhara, through participating the community that serve as a baseline information for further improvement of managemental system and selection criteria of breeding cock and hens based on the environmental conditions.

1.3: Specific Objective

i. To assess the socioeconomic characteristics and the production environment of indigenous chicken ecotypes in the study areas;
ii. To asses farmers breeding objectives, breeding practice, and traits of preference for local chickens in the study area.
iii. To characterize and describe the phenotypic variation of indigenous chicken ecotype in the study area;

2. LITERATURE REVIEW

2.1. Importance of Indigenous Chickens

In Ethiopia, indigenous chicken production system is a traditional type which is characterized by small flock size and usually affected by disease outbreaks (Mammo, 2012). A study conducted by International Food Policy Research Institute indicated that chicken is one of the potential areas to develop in the livestock subsector, primarily to create employment and generate income through reduction of risk factors (Alemu *et al*., 2008).

In developing countries, nearly all families at the village level, even the poor and landless, are owners of chicken (Addisu, 2012). Chickens are mainly owned and managed by women and often essential elements of female-headed households. Chicken production is increased because of the following qualities: short-time generation interval, low quality feed consumption, high breeding ability, capacity to have a great number of chickens per unit area and low breeding costs (Addisu, 2012).

(Melesse, 2014) described that local chickens are valuable in rural areas because they fulfill majorroles and benefits the livelihood of rural families. (Okeno *et al*., 2012) described localchickens as an investment to the welfare of women and children in the tropics. For that reason, even farmers without income may afford keeping local chickens. (Kingori *et al*., 2010) described local chickens as efficient converters of leftover grains as well as insects into valuable protein, for example meat and eggs. Since the local chickens scavenge in crop fields, (Gueye 2009) suggested that farmers might use local chickens to control weeds and insects. (Moreki, 2012) suggested that farmers was also use local chicken faeces as fertiliser for vegetable gardens and crop fields.

A number of studies have reported that consumers prefer local chicken meat because of their texture and strong flavor (Gueye 2009); (Magothe *et al*., 2012) and (Chowdhury, 2013). Studies further showed that local chicken meat contains low fats than commercial chickens,

because their diet consist of kitchen leftovers, worms, insects, green leaves and other plant materials (Gueye 2009), (Magothe *et al*., 2012); (Aila *et al.*,2012)and (Chowdhury, 2013).

2.2. Classification of Indigenous Chicken Population

In Ethiopia ostriches, ducks, guinea fowls, doves and pigeons are found in their natural habitat (wild) whereas, geese and turkey are exceptionally not common in the country. Thus, the word poultry production is synonymous with chicken production under present Ethiopian conditions (Meseret, 2010). Indigenous chicken of Ethiopia do not have phenotypic standards and their classification was based on colours and name of place where they are identified. Extensive production system was the dominant management practice of chicken with small feed supplementation (Addis, 2014).

2.3. Poultry Rearing and Distributions in Amhara Region

According to the (CSA in 2017), the total poultry population in Ethiopia was estimated to be about 59.49millions. The total poultry population in Ethiopia, Amhara regional state (Both total and Zone-wise) is shown **in table 1**below. Local chickens are the most numerous types used in the rural areas of Ethiopia and their reported numbers vary from one region to another. According to, (Sonaiya, 2009) most rural farmers kept chickens, But the farmers often regard local chickens as secondary to other livestock and crop farming activities.

Kingori *et al.* (2014) reported average flock size of 16 per household in south west coast of Kenya. They further stressed that majority of farmers keep chickens when there is plenty of feed and few predators. The flock sizes per household varied between seasons mainly because of diseases and predators.

Table 1: Flock Composition of Poultry in Amhara (Zone-wise) and Country wide Distribution

Geographical Area	Total poultry	Cocks	Cockerel	Pullets	Non-laying hens	Chicks	Laying hens
Ethiopia	59495026	5842973	32962650	6246339	1628833	22568332	19912284
Amhara	19961861	1602860	10541107	2125245	394725	8680336	6104588
North Gonder	6204610	386895	464271	751281	117268	3127401	1357494
South Gonder	1983589	123976	81548	187316	26056	938432	626261
North Wollo	1147256	194571	45742	108754	25907	399017	373266
South Wollo	2100202	289271	95632	232734	46702	635962	799901
North Shewa	2057757	179602	73047	178072	53256	684328	889452
East Gojam	1245284	97003	33609	104470	48570	458669	502962
Weast Gojam	3436085	191567	164274	365655	39208	1669284	1006098
Waghimra	322973	32322	15184	41236	15990	117800	100442
Awi	**1151708**	**71236**	**63150**	**128656**	**12749**	**508463**	**363456**
Oromia	279456	31913	12512	24129	-	125968	76691

Source: CSA (2016-17)

2.4. Characteristics of Local Chickens

The most important characteristic of local chickens are their potential to produce meat and eggs (dual-purpose). Most local chickens in rural areas have good maternal qualities, high survival rate and are hardier than exotic breeds (Kingori *et al.*, 2010). Although they grow slowly, they have the potential to grow fast if farmers select chickens with such characteristic for breeding (Mengesha, 2012). (Lyimo *et al*., 2014) pointed out that variation in their growth and productivity is from gene possession. However (Apuno*et al.*, 2011) reported that some differences in appearance of local chickens because of major gene marker, which increases adaptability of these breeds to tropical environments. They further explained that frizzled and naked-necke allow better heat dissipation. According to (Okeno *et al.*,2012) local chickens need little care and adapt well to rural condition.

The farmers with little or no income can also keep local chickens because they feed by scavenging from the surrounding. The method of producing local chickens is still primitive and suffers setback due to poor housing, poor feeds and feeding systems, disease outbreaks and predators (Blackie, 2014). (Dorji *et al.*, 2011) stressed that production performances of local chickens is low because of inadequate feeding and the harsh environmental conditions in which they exist.

2.5. Productivity of Local Chickens and Flock Size

(Fisseha *et al.,* 2010) reported that small body size, lateness in maturing, egg sizes, and clutch sizes are important production characteristics of local chicken breeds. (Addisu *et al.,* 2013) reported that local chickens grow slowly and reach sexual maturity late and this influences production performance.The annual egg production of local chicken types in Ethiopia has been summarized **in Table 2.**

Regarding the production potential of indigenous birds, studies carried out in western zone of Tigray (Markos *et al.,* 2015) indicated that the average annual egg production of the indigenous chicken was 52.68. A study carried out by (Halima, 2007), (Meseret, 2010), (Ayalew and Adane, 2013) and (Addisu *et al.*,2013) at North West Ethiopia, Gomma wereda of Jimma zone, Chagni town in Awi administrative Zone Amhara and North Wollo zone of Amhara, respectively, revealed that the average egg production of local birds were 18-57 eggs, 43.8 eggs, 27-45 eggs and 49.51 eggs.

(Aberra and Tegene 2011); (Nigussie *et al.* 2010) reported that 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. Higher egg productions per year per hen were reported by (Fisseha *et al.,* 2010) in Bure district (60 eggs), (Mekonnen, 2007) in Wonsho district (62.95eggs).

The overall number of eggs/hen per clutch of local hen reported by (Meseret 2010), (Addisu *et al.*,2013), and (Wondu *et al.*,2013) in Gomma wereda, North Wollo Zone, North Gondar Amhara region and Ethiopia national average were 12.92, 12.64, 11.53 (8-15) and 12. But higher overall number of eggs/hen per clutch of local hen were reported by (Tadelle, 2003) 17.7 eggs in five agro-ecological zones of Ethiopia and (Bogale, 2008) 16.6 eggs in Fogera district.The average flock size of 9.2and9.18 chickens per household in central zone of Tigray and in south Wollo were reported by (Merge, 2016)and (Melaku, 2016) respectively.

The average flock size of chickens per household in central zone of Tigray was 5.6(Alem, 2013). There was higher number of chickens reported in Burre district was13 chickens/household (Fisseha *et al.,* 2010). (Melesse and Negesse, 2011) reported that average flock size of 7.0 chickens for northwest and southern parts of Ethiopia. In southern Ethiopia,

(Mekonnen, 2007) reported an average flock size of 9.2 chickens per household for scavenging local chickens. On the other hand, a relatively higher flock size of 12 chickens per household was reported by (Hunduma *et al.,* 2010) in the Oromia regional states of Ethiopia.

(Kingori *et al.*, 2014) reported average flock size of 16 per household in south west coast of Kenya. They further stressed that majority of farmers keep chickens when there is plenty of feed and few predators. The flock sizes per household varied between seasons mainly because of diseases and predators.

Table 2: Annual Egg Production of Local Chicken Types in Ethiopia

S.No.	Location	Chicken Type	Agro-ecology				Reference
			Low-land	Mid-land	High-land	Overall	
i	Western zone of Tigray	Local	48.98	54.20	54.87	52.68	(Markos et al, 2015)
ii	Eastern zone of Tigray	Local	54.8	51.6	54.8	53.4	(Letebrhan et al,2015)
iii	Northern Wollo	Local	47.99	48.32	52.30	49.536	(Addisu et al., 2013)
iv	Central Tigray	Local	44.3	42.7	-	43.5	(Alem, 2014)
v	Southern Tigray	Local	48.71	44.73	49.83	47.753	(Gebre Mariam et al,2016)

2.6. Management Practices of Chickens

2.6.1 Feeding Practice

The major feed sources of local chickens are earthworms, insects, seeds, green leaves and other plant materials in the household yard. Feed supplementation has been reported in various countries as a common practice to promote chicken performance. In Ethiopia, more than 97%, feed supplementation by chicken owners were reported (Halima, 2007); (Fisseha *et al.*, 2010); (Mengesha, *et al.,* 2011).

In Ethiopia, village chicken production systems is usually kept under free range system and the major rearing system was obtained by scavenging. The major components of Scavenging Feed Resource Base (SFRB) are reported to be insects, worms, seeds and plant materials, with very small amounts of grain and table leftover supplements from the household. Many studies showed that there is no purposeful feeding of rural household chickens in Ethiopia and the scavenging feed resource is almost the only source of feed.

(Mekonnen, 2007) and (Meseret, 2010) reported that almost all of the respondents (95-98, 97.8%, respectively) practice scavenging system with supplementary feeding in Gomma districts, and around Awassa and Dale areas. Feeding chicken according to their age and production status is still uncommon practice in Ethiopia. A study conducted in Halaba district southern Ethiopia by (Nebiyu, 2013) revealed that 81.8% of farmers fed their chicken in whole flocks. Only chicks have been managed in separate group for few weeks unless other chicken categories scavenge freely around the back yard without any restriction.

According to (Solomon et al., 2013) 83.6% of the respondents were feeding their chicken flock in group and the rest 16.4% of the respondents fed separately to the different age classes of chickens. On the other hand (Halima, 2007) reported that almost all 99.28% of the farmers in Northwest Ethiopia provided supplementary feeding to their chickens and chickens of different age groups were fed together. However, the type and amount of feed depended on the crops grown in the area as well as the seasons.

The majority of the farmers who practiced supplementary feeding systems (mostly once per day) used maize, barley, wheat, finger millet and household waste products to feed their chickens. After hatching, the chicks were allowed to forage and roam freely with their mothers in open areas near the home and surroundings.

2.6.2. Watering Practices

(Halima, 2007) reported that about 99.45% of the farmers in Amhara region provided water for their chickens in plastic, wooden or clay bowls, and 31.52% of the respondents cleaned the bowl daily. In many cases the bowl was filled once per day. As usually, Chicken as other livestock require water especial in dry season to facilitate its metabolism system based on voluntary basis when allowed ad-labium access to water.

According to (Emebet, 2015),as pointed out the type of waterer and frequency of cleaning waterer in Southwest Showa and Gurage zone was revealed that almost all respondents (99.7%) in the four districts of those two zones had the experience of watering their poultry. While about (76.4%) of chicken owners provide water in plastic container followed by clay pots (20.3%) and a very small number of respondents use wooden (2.7%) & metallic (0.7%) containers while on an average (22.6%) of the respondents in the study area did not clean the

chicken waterer at all. Further, in other study also reported that about (92.6%) farmers were supplied water for their birds from river (66.1%) and tape water (21.7%). Moreover, about (48.7%) respondents supplied water by wooden made materials, (16%) required in plates and (6.4%) supplied by clay materials in west Oromia (Feyera, 2016).

2.6.3. Housing

Good housing is a precondition for any sustainable poultry production. In rural areas, housing occupies a low priority in managing poultry including chickens under free-range (Ndahambelela, 2016). Housing systems in backyard is rudimentary and mostly built with locally available materials. In traditional free range, there is no separate poultry house and the chickens live in family dwelling together with humans (Solomon, 2007).

Lack of housing is one of the constraints of the smallholder poultry production systems. In some African countries, a large proportion of village poultry mortality accounted due to nocturnal predators because of lack of proper housing. (Bogale, 2008) indicated that the mortality of scavenging birds reduced by improved housing. In most cases they roosted inside the family dwelling at night (88.8%), the roost being made of two or three raised parallel plants of wood. A few households (11.5%) had constructed the house and this night shelter was occasionally cleaned by the house wife. (Meseret, 2010) has also reported that in Gomma district about 94.4% of the rural households have no separate poultry houses.

(Mekonnen, 2007) also reported that there is no specific separate poultry house in Dale District. (Halima, 2007) reported that significant number of the rural households (51%) of Northern Ethiopia had separate sheds for their chickens, almost all farmers provided night shelter for their chickens either in part of the kitchen (1.36%) or in the main house (39.07%), in hand-woven baskets (7.29%), in bamboo cages (1.51%) or in separate sheds purpose-made for chickens (51%). These shelters were made of locally available materials such as Eucalyptus poles and branches.

(Fisseha *et al.,* 2010) reported that in Bure district, North West Ethiopia, 77.9% of the village chicken owners provide only night shelter and only 22.1% provided separate poultry house. Another study by (Mengesha *et al.,* 2011) in Jamma district, South Wollo reported that 41.3%

and 21.2% of chicken owners share the same room and provided separate poultry house, respectively.

2.6.4. Diseases and Predators

Disease is a condition that hinders normal body functions. Diseases result from a combination of indirect and direct causes. Indirect causes are those conditions that influence resistance and direct causes are those that produce diseases (Mesert *et al.*, 2011).Scavenging system is characterized by high chick mortality in the first two weeks of life, caused mainly by predators and Newcastle disease (Aberra, 2011).

High incidence of chicken diseases, mainly Newcastle Disease (NCD), is the major and economically important constraint for village chicken production system (Fisseha *et al.*, 2010*). (*Moreki, 2013) reported that absence of disease control in many rural areas contribute to high mortality among local chickens. Vaccination with standard vaccines is not common in rural areas because many chicken farmers do not have income to buy such vaccines.

The predation is strongly associated with the rainy season. The predators include primarily birds of prey such as vultures, which prey only on chicken and wild mammals such as cats and foxes, which prey on mature birds as well as chicks (Tadelle and Ogle, 2001). Predators such as birds of prey (locally known as "Culullee") (34%), cats and dogs (16.3%) and wild animals (15%) were identified as the major causes of village poultry in rift valley of Oromia, Ethiopia (Hunduma *et al.*, 2010).

2.6.5. Marketing

(Merga, 2016) reported that in the central zone of Tigray most of the village chicken owners (81%) participated in chicken and egg marketing. (Markos *et al.*, 2014) reported that 99.7% of the respondents had participated in selling of chicken products. Higher proportions of households sold chicken products to their neighbors in the same village (98.8%) in lowland than in midland (67.9%). Greatest proportions of respondents in western zone of Tigray sold their chicken products in either district market (9.6%) or both the same village and district market (90.4%) in highland as compared to both midland (3.1% and 28.2%) and lowland (3.3% and 1.2%) (Markos et.*al.* 2014).

(Bogale, 2008) also reported that 41.7% and 33.3% of the respondents in Fogera districts sold their chicken products in the nearest market and district market during market days, respectively while 19.4% sold their products within their respective kebeles during non-market days. (Meseret, 2010) also reported that chicken products were sold either at the farm gate, primary market (small village market) or at secondary market (at large district town) in Gomma district of Jimma zone.

2.6.6. Factors Affecting Poultry Marketing

(Reta, 2009) reported that chicken morphology is linked to the socio-cultural and religious sacrifices. Red and white cock is sacrificed for good rain and harvest, red and black spotted color (giracha) cock for New Year celebration, white and black spotted (gebsima) cock to prevent evil and calamities and red pullet for dead ancestors (animism) (Tadelle and Ogle , 2001).

According to (Fisseha *et al.,* 2010) chicken type (sex, age, color and comb type) played an important role on market price of live birds. In addition, most village chicken owners considered plumage color and comb type as main determinant factors in selection of birds for production, consumption and marketing purposes. Red and white plumage colors were most preferred and demanded highly in the chicken marketing system of Burea district (Fisseha, 2010).

The selection of plumage colors was attributed to attractiveness by the public and high sale price in marketing. Regarding comb type, double (rose) comb was more privileged than single comb types in terms of preference, market price and demand. (Markos *et al.,* 2014) reported that plumage color, body weight, comb type, shank color, smoothness of shank, sex, spur presence, length of legs, head shape and market site were the major factors that cause variation in the price of live chickens in western zone of Tigray. Similarly, (Bogale, 2008) reported that plumage color, comb type, plumage color and comb type, body weight, age, sex and seasons were relevant factors that brought variations on the price of live chickens at market level in Fogera district.

(Addisu *et al.,* 2013) also reported that the prices of live chickens were determined by body weight (41.83%), combination of comb type and plumage color (32.4%) and plumage color

(25.8%) in North Wollo zone of Ethiopia. Likewise, most of the respondents were the opinion that the eggs (90%) and meat (92%) obtained from exotic breeds have poorer taste. This have confirmed by the lower market preference for eggs from exotic chickens. Plumage color, live weight, and comb type were important traits affecting market price of chickens (Nigussie *et al*., 2010).

2.7. Major Constraints of Poultry Production

The study of (Tadelle and Ogle, 2001) showed that, high mortality of chicks under village chicken production in the central highlands of Ethiopia was due to diseases, parasites, predation, lack of feed, poor housing and insufficient water was main constraint in poultry production. High incidence of chicken diseases, mainly (NCD) is the first and economically important constraint for village chicken production system following by feeds (Nigussie and Ogle, 2000); (Halima, 2007).

The other comprehensive study showed that (NCD) was highly infectious and causes more losses than any other diseases in the tropics and it spreads rapidly through the flock and mortality could reach up to 100% (Nigussie D.*et al*., 2003) ; (Serkalem., 2005).

Predators are the net causes for their loss (Eshetu, 2001). Further, village poultry production is constrained by poor access to markets, goods and services, weak institutions, and lack of skills and knowledge (Gueye, 2003); (Besbes, 2009) reported that poor nutrition and health problems are the main constraints.

2.8. Sexual Maturity, Clutch Size and Incubation Practice

(Sonaiya and Swan, 2004) reported that indigenous village chicken in Ethiopia attains sexual maturity at an average of 7 months. (Halima, 2007) also reported that pullets and cocks reached sexual maturity at an age ranging from 20 to 24 weeks; however, 31.92% of the pullets and 20.07% of the cocks reached maturity at 28 to 32 weeks, indicating late maturity in North West Ethiopia. Similarly (Worku *et al*., 2012) and (Markos *et al*., 2015) reported that age at first mating for cockerel in West Amhara region and western zone of Tigray was 6.49 month and 5.71 month, respectively.

However, late (5.9-7.1 month) average age at first egg laying of indigenous chicken reported by (Fisseha *et al.*, 2010) in Bure districts and (Habte *et al.*, 2013) (7.02 months) in the Nole Kabba wereda of Western Wollega which is an expression of low productivity of local chickens . (Mekonnen, 2007) also reported that the mean age at first egg laying of young indigenous pullets in three districts of SNNPR was 7.7 months and (Addisu *et al.*,2013) also reported that the age at first egg laying of local chickens in North Wollo zone of Amhara region was 6.6 months.

According to (Horst, 1989) indigenous chickens are ideal mothers, good sitters, hatching their own eggs, excellent foragers and vigor. They are aggressive, hardy and possess some degree of natural immunity against some diseases. These factors are important ideal requirements for replication and sustaining their generation in scavenging nature. The most important characteristic of indigenous chicken is their broodiness (maternal instinct), which is pronounced for indigenous chickens in Ethiopia.

Broody hens were the only means of egg incubation and brooding young chicks. It is identified that, the average hatchability percentage of local hens in western zone of Tigray was 74.3% (Markos *et al.*, 2015). Other authors (Tadelle and Ogle, 2001), (Halima, 2007) and (Habte *et al.*, 2013) reported that the average hatchability of eggs of indigenous chickens under scavenging management condition was 60.7% - 82.1%, 82.74% and 81% in North Western of Ethiopia, Nole Kabba wereda of Western Wollega and Central highlands of Ethiopia, respectively.

Similarly, higher hatchability percentage were reported by (Worku *et al.*, 2012), (Solomon *et al.*, 2013), (Wondu *et al.* 2013), and (Nebiyu *et al.*, 2014) who reported that the average egg hatchability of local chickens in West Amhara region of Ethiopia, Metekel Zone of North West Ethiopia, North Gondar Amhara regional state and Halaba wereda of southern Ethiopia were 79.1%, 84.74%, 87.29% and 83.72% respectively. On the other hand, lower hatchability (22%) was reported for indigenous chickens in Gomma districts of Oromia region (Meseret, 2010).

(Markos *et al.,* 2015) reported that in western zone of Tigray the survival rate of chicken to weaning age were 73.06 with chick mortality rates ranging from 27% to 29.2% under extensive system. Clay pots, bamboo baskets, cartons or even simply a shallow depression in the ground are common materials and locations used for egg setting (Fisseha, 2009); (Tadelle *et al.,* 2003). Crop residues, usually teff, wheat and barley straws were used as bedding materials (Tadelle *et al.,* 2003).

(Markos *et al.,* 2015) also reported that clay pots with straw bedding (1%),ground with soil/sand/ash bedding (15.6%), bin with grasses/straw/cotton seed bedding (68.8%), plastic with grasses/soil/sand bedding (7.8%), bamboo cages with soil and straw breeding (0.3%),bin with straw bedding during rainy season and with sand bedding during dry season (3.9%), cartoon with grasses and clothes bedding (0.8%), dish with soil or clothes bedding (0.5%), ground / bin or dish with grasses bedding (0.3%) or plastic and bin with grasses bedding alternatively (1%) as egg setting materials were used in western zone of Tigray.

According to farm households, the number of eggs set per bird depends, in their orders of importance, on season, experience and size of the bird (Tadelle *et al.,* 2003). Related selection of broody hens, indigenous practice were that a culture of selecting broody hens used for breeding/ egg incubation purposes by looking hen's past egg incubation performance (73.9%), presence of big body size (7.9%), presence of thick feather (2.1%), size of eggs laid (2.5%), respectively (Tadelle *et al.,* 2003).

2.9. Breeding Objectives

(Mengesha *et al.,* 2008) reported that the purpose of keeping poultry in Jamma district was mainly for sale (38.1%), followed by home consumption (31.7%) and no defined (16.3%), at last for religious purposes (13.9%). In central highlands of Ethiopia the purpose of keeping poultry was 50%, 27% and 23% for hatching, sale and home consumption, respectively (Tadelle *et al.,* 2003). In another study conducted by (Aberra and Tegene, 2007), in Southern parts of Ethiopia, about 71.4% of chickens raised by the rural community were used for egg production while the rest 28.6% were used for meat production purposes.

(Nigussie *et al.,* 2010) also reported that, chickens are raised importantly as source of income and egg production for home consumption. Meat production for home consumption is second

in importance in Oromia (Horro) and Southern regions but the function of chickens as source of cash income was rated to be as important as (Horro) or more important than egg and meat production in Mandura district (Nigussie *et al.*, 2010).

2.9.1 Breeding and Selection Practices

Traditional chicken production system is characterized by lacks systematic breeding practice in Gomma district (Meseret, 2010). Furthermore, a study conducted in different parts of Ethiopia revealed that village chicken breeding is completely uncontrolled and replacement stock produced through natural incubation using broody hens (Negussie, 2011). In another study conducted by (Fisseha, 2009) revealed that about 92.2% of chicken owner farmers in Bure district had the tradition of selecting cocks for breeding stock.

According to (Fisseha, 2009), plumage color (45.4%) and comb type (8.6%) were some of selection criteria for breeding stock in Bure district. Another study conducted in mid Rift valley of Oromia revealed that 68% of the farmers select productive hen by its body size, 12% by finger accommodation between the pelvic bones and 20% by pedigree performance for replacement (Hunduma *et al.*, 2010).

2.9.2 Mating System and Culling Practices

According to the report of (Nigussie *et al.*, 2010) there was no systematic mating in different regions of Ethiopia. Another study conducted in the three districts of SNNPRS disclosed that the free-range feeding practice attributed to indiscriminate mating of cocks and hens (Mekonnen, 2007). (Bogale, 2008), who reported that the home consumption, selling (46.5%), old age and poor productivity (25%) and sickness (5.65%) were the main culling ways of chicken from their flock. Another study in Northwest Ethiopia by (Halima, 2007) also revealed that farmers cull poor productivity and old age chickens via selling. The breeding practice, mating system and culling practice have not been studied in the study areas thus stimulating to investigate these through participation of the communities.

2.9.3. Trait Preference of Local Chickens

(Nigussie *et al.*, 2010) reported morphologic traits such as plumage colour and comb type were found to have significant economic values beside other quantitative traits related to growth and egg production. (Mearg, 2016) reported that farmers in midland agro ecology of

central Tigray prefer traits such as comb type, plumage colour, egg size, broodiness, disease resistance, meat quality, fertility, growth, egg number, body size, mothering ability and temperament traits have high preference for improvement. (Fisseha *et al.*, 2010) reported that red was the most preferred (83%) color type in North West Ethiopia. Also plumage color and double comb cocks were the most preferred chickens (81.1%).

According to (Aklilu *et al.*,2007) double combed bird were preferred than single combed birds but black colour chickens were believed to bring bad fortune and Farmers select double comb cocks for reproduction purpose in order to fulfill their ritual interest and to fetch higher price at market. In terms of adaptive traits and consumption the indigenous chickens were considered favorable. (Nigussie *et al.*, 2010) reported that most of the respondents claimed that the exotic breeds were poor in disease and stress tolerance (86%) and ability to escape predators prevalent in their village conditions (96%).

The exotic breeds generally required higher level of management (83%), often hard to afford, and are poor scavengers (86%) compared to indigenous chickens. In addition, 77% of the farmers in Horro and 90% in Sheka claimed that hatchability of eggs obtained from the modern breed is inferior to eggs from indigenous chickens.

2.10. Phenotypic Trait Variation in Chicken Populations

Phenotypic characterization of AnGRs is used to refer the process of identifying distinct breed populations and describing their characteristics of production environment (FAO, 2011). Understanding the diversity, distribution, basic characteristics, comparative performance and the current status of each country's animal genetic resources is essential for their efficient and sustainable use, development and conservation.

Complete national inventories, supported by periodic monitoring of trends and associated risks, are a basic requirement for the effective management of animal genetic resources. Without such information, some breed populations and unique characteristics they contain may decline significantly, or be lost, before their value is recognized and measures are taken to conserve them (FAO, 2007). Wherever evaluation schemes were implemented, indigenous chicken breeds/ecotypes were found to be highly productive and large between-breed and

within-breed variations were reported (FAO, 2007). The phenotype, morphological measurements and production performance studied showed a large variation among different ecotypes. Remarkably some ecotypes show high performance, for example, a large variation in growth, egg production and other traits among individuals within ecotypes can be seen from high coefficients of variation (CV) observed within ecotypes. Although local chicks are slow growers and poor layers of small sized eggs, they are, however, ideal mothers and good sisters (Tadelle and Ogle, 2001). A good number of local ecotypes have been characterized in Ethiopia and the results are summarized in table 3.

Table 3: Morphological Characterization of Local Chicken Ecotypes in Ethiopia

Ecotypes (Districts)	Peculiar feature	Dominant location(sites)	Authors
Jarso	Red plumage color, No black eye color.	East Hararghe zone	
Tepi	Naked neck, black eye, single combed red skin	Tepe	Dguma, (2006)
Tilili	Pea comb, lack of shank feather	West Gojjam zone	
D/Elias	Plain head, pea comb and v-shaped comb, do not have shank feather	East Gojjam zone	
Guangua	Crest and plain head, pea comb, no shank feather, yellow shank	AgewAwi zone	Halima, (2007)
Mecha	Plain and crest head shape, pea comb	West Gojjam zone	
Horro	Flat head shape, pea comb type, blocky body yellow shank color	East Welega zone	
Farta	Crest head shape, pea Comb type. blocky body shape and yellow shank	South Gondar zone	
Konso	Flat head shape, pea comb type, blocky body shape,yellow shank	SNNP region	
Sheka	Flat head, pea comb, blocky body shape, yellow shank color.	SNNP region	
Mandura	Crest head, pea comb type, blocky body type and yellow shank color	Amahara, Gumuz, Agew and Oromia	Nigussie, (2011)
Gugu	Muffed, absent of wattle in hen	Tache Armacheh	
Gasgie	Long necked and red in color	Alefa	
Nacked Neck	Aggressive, absent of feather at neck	Quara	
Shewa	White shank colour, Rose comb type, plane hade shape	Northshewa zone	Agide,(2015)
Tigray	Flat plain head, Red Comb color, Rose hade shape	Central Zone Tigray	Merge, (2016)
Jimma	White plumage colour, Naked-neck, Feather shank	Jimma Zone	Taju, (2017)

Source: Addisu and Aschalew, (2014)

2.11. Variation in Qualitative Traits

According to (Reta, 2009) there was morphological diversity within and between the indigenous chicken ecotypes. Their plumage colour is quite variable even within ecotype (pure black, white, silver white, grey, red and various combinations of several colors). (Halima, 2007) reported that predominant colour was white (25.49 %) followed by a greyish mixture (22.23 %) and red (16.44 %) and considerable numbers of chickens showed heterogeneity and have diverse plumage colour in North West Gojam.

The large variations in plumage colours may be the result of their geographical isolation as well as periods of natural and artificial selections. (Reta, 2006) also found similar results for the Horro, Tepi and Jarso indigenous chickens with regard to plumage colour.

(Aberra and Tegene, 2011) also indicated that 55% of chicken populations were single combed followed by rose (28.5%) and pea (15.2%) combs. They further reported that, about 46.4, 34.2 and 19.4 percent of chicken populations exhibited red, white and yellow earlobes, respectively. They further reported that the predominant plumage colour was red (*Kei*; 36.6%) followed by black (*tikurr*; 20.7%), grayish mix (*Gebsima*; 15.3%), white (Netch; 12.3%), partridge or red brownish (*Kokima*; 8.4%), mixture of white and red with varying shades of multi-colours (*Woser;* 3.7%), black and white spotted feather (Zigrima; 1.7%) and white or red speckles on black background (Zagolima, 1.3%).

The common comb types of indigenous chicken are rose, pea, walnut/strawberry, single and V-shape. Most of the indigenous chickens have no shank feather (Halima, 2007); (Bogale, 2008) and (Nigussie *et al.,* 2010). A variety of plumage colours such as red, white, greyish mixture, black, brown and other mixed colors were also reported by different researchers in Ethiopia (Halima *et al.,* 2007); (Mengesha *et al.,* 2008) and (Fisseha *et al.,* 2010). It was reported that red plumage colour was dominant followed by white plumage colour.

(Alem *et al.,*2014) also reported that red color was the most dominant and accounted for 52.3% followed by greyish (segemo), which was accounted for 20.9% and multi-colour (Checheq) that accounted for 14.1%.

Some of the multi-coloured chickens were of brown color with white spots, red with white spots, deep red with black strips, and white with black spots. This multi colour plumage was

observed more in male chickens (cocks and cockerels) than in female chickens (hens and pullets) in central zone of Tigray (Alem, *et al* 2014).

2.12. Variation in Quantitative Traits

(Reta, 2009) reported that dwarf chicks were mainly dominated in Jarso ecotypes (31.1%) that dwell in eastern part of Ethiopia and the heavy ones in Horro ecotypes (56.4%) originated from western Ethiopia. Quantitative traits of chicken have high economic importance. These traits can be expressed by measuring production traits that can be affected by many genes and environment. Productivity figures of chicken in some parameters were reviewed in different part of the region In Horro ecotypes; few chickens with naked neck and feathered shank were observed (Reta, 2009).

(Aberra and Tegene, 2011) indicated that the highest adult body weight was found in Naked-neck chickens (1.7kg), followed by Red(*Kei)* (1.5kg), grayish mix (Gebsima)(1.45kg) and mixture of white and red with varying shades of multi-colours (*Wosera*) (1.46 kg). The Naked neck and Wosera males had the longest shank of about 15 and 13 cm, respectively. Kei male chickens had large body weight shank length ratio compared to other indigenous chickens (Aberra and Tegene, 2011). (Eskindir *et al.,* 2013) also reported that, the average body weight of local adult hens in Horro and Jarso were 1.29 kg and 1.12 kg, respectively was summarized in table 4 below.

(Halima, 2007) reported that the Guangua cock lines were heavier than the other indigenous chicken groups, while the other indigenous hens were relatively similar in body size. The Melo-Hamusit and Gassay cocks had shank lengths of 11.3 cm and 10.83 cm, respectively at 22 weeks of age which is relatively long compared to the other chicken populations. Among the local hens, chickens from Mecha had the shortest (7.50 cm) shank lengths (Halima, 2007).

Therefore, various qualitative and quantitative traits of indigenous chickens were identified in the different part of the country. But in rural backyard poultry production system, the qualitative and quantitative traits of indigenous chickens across the different agro-ecological zones have not yet addressed (Halima, 2007).

Table 4: Body weight and linear body measurements of some indigenous chickens

Sex of chicken	Quantitative traits					Source
	Bwt (kg)	Ws	Bl	Sl	Cc	
Cock	1.63	38.09	36.77	8.08	-	Addis.,2014
Hen	1.37	36.52	35.29	7.64	-	
Cock	1.35	39.93	37.27	10.4	25.72	melaku.,2016
Hen	1.19	37.63	35.77	9.68	24.98	
Cock	1.18	38.9	37.82	6.04	24.98	Agide.,2015
Hen	1.10	38.0	36.57	5.92	25.06	
Cock	1.39	36.7	32.1	9.7	30	Taju.,2017
Hen	1.36	33.3	29.4	8.8	28.5	
Cock	1.54	36.27	27.26	11.01	29.67	Mearg.,2016
Hen	1.31	32.17	26.14	9.43	28.69	

3. MATERIALS AND METHODS

3.1. Brief Description of the Study Areas

The study was conducted in Faggeta lekoma, Dangila and Zigom districts based on their altitude classification into three agro-ecologies of Awi zone, Amhara regional state, Ethiopia. Awi zone is bordered on the west by Benishangul-Gumuz Region, on the north by Semien Gondar Zone and on the east and on south east by Mirab Gojjam. The administrative centre of Awi zone is Injibara; other towns include Chagni, Adis kidame, jawi, gimjabet, ----Dangila. Topographically speaking, Awi zone is relatively flat and fertile; the altitude of the zone ranges from as low as 550 to 3100 m.a.s.l while the minimum and maximum annual temperature ranges between 5^{o}C and 27^{o}C. Daily temperature becomes very high during the months of March to May. Average mean annual rainfall for the area is about 1700 mm. The location map of the study site is presented in Figure 1.

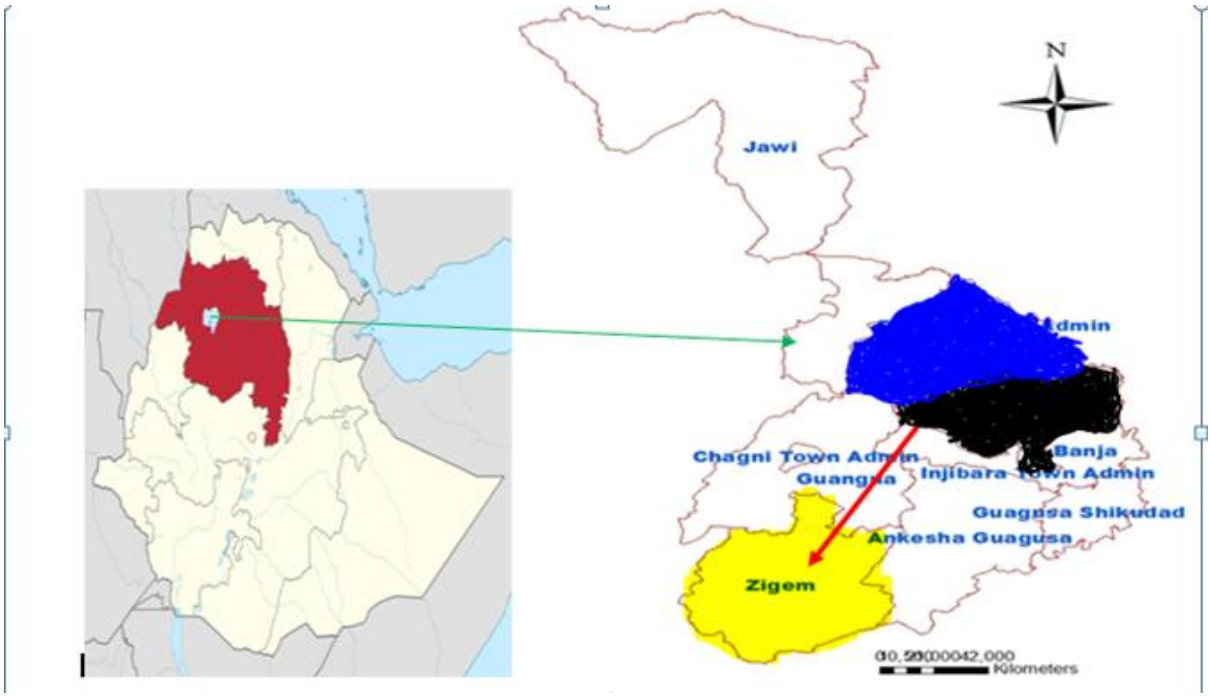


Figure 1: Location Map of the Study Site.

The Zone is crossed by about nine permanent rivers which drain into the Abay (or Blue Nile); other water features include two crater lakes, Zengena and Tirba. Awi zone has 1,231,447 cattle, 676,509 sheep, 162,576 goats, 206,035 equine (Horse 96,136, Donkey 93,052, mule 16,667), 1,151,708 poultry and 128,906 bee colonies (CSA, 2017). The Samples were collected from three districts, Faggeta lekoma, Dangila and Zigom.

3.1.1. Faggeta Lekoma

Faggeta Lekoma: This District is named in part after two former districts: Faggeta, best known as the location for the Battle of Faggeta (9 December 1769), where Ras Mikael with the help of Goshu of Amhara and WandBewossen defeated Damot; and Lekoma, where Emperor Susenyos quashed a revolt of the local Agaw in 1614.Faggeta Lekoma is bordered on the south by Banja Shekudad, on the west by Guangua, on the north by Dangila, and on the east by the Mirab GojjamZone. Towns in Faggeta Lekoma include AddisKidame and Faggeta. This districts has alititude and longitudes between a point of Latitude: 11º01'14.2" North and Longitudes: 36º54'21.6" East. The altitude ranges from 2530 to 2556 meters above sea level **(**Ayele, 2016).

3.1.2. Dangila

This District is named after the former district, Dangila, which James Bruce notes was in his day known for its breed of sheep. Dangila is bordered on the south by Faggeta Lekoma, on the southwest by Guangua, on the northwest by the Jawi, and on the north east by the Mirab Gojjam Zone. Towns in Dangila include Addis Alem, Dangila and Dek. Part of the Dangila was separated to create Jawi woreda. The district is located in Awi zones of the Amhara region; this district has alititude and longitudes between $11^0$16' North latitude and $36^0$40' East longitude with an Elevation of 2137 to 2538 meters above sea level.

3.1.3. Zigom

This district is bordered on the south by west Gojam on the west by, Benishangul-Gumuz Region on the north by Guangua woreda, and on the east by the Ankesha. This district has a latitude of 10º34'18" North and Longitudes: 36º12' East. The altitude ranges from 1325 to 1541 meters above sea level.

3.2. Sample Size Determination and Sampling Techniques

The study was conducted in Faggeta lekoma, Dangila and Zigom districts of Awi zone. Purposive sampling was employed to select districts based on distribution of chicken population and Agro-ecological variations. Thus, three sample districts and six rural *Kebeles* (2 from each district) were selected, for the study, as under:

Stage I ✓ 3 Districts with highest poultry population and AEGs variation was selected

Stage II ✓ 2 Kebeles /district with highest poultry population was selected

Stage III ✓ Households owning poultry were identified; andfrom the households owning poultry,30HH/ Kebele were selected randomly for Focus Group Discussion (FGd).

The numbers of sampled households and total populations in the study area were determined the formula described by (Cochran, W. G. 1963)

$$no = \frac{Z^2 * (p)(q)}{e^2}$$

Where no= required sample size

Z^2 =is the abscissa of the normal curve

e^2 = is the margin of error (eg. ±0.05%, margin of error for confidence level of 95%)

p = is the degree of variability in the attributes being measured refers to the distribution of attributes in the population q = 1-p.

$$no = \frac{Z^2 * (p)(q)}{e^2}$$

$= 1.96^2 \times (0.136)\ (0.864) \div (0.05)^2$

$=3.8416 \times (0.136)\ (0.864) \div 0.0025$

$=180.56 \backsim 180$

The numbers of total population of chicken per single district was determined as below formula: $no = \frac{Z^2 * (p)(q)}{e^2}$

$N = (1.96)^2 \times (0.194)\ (0.806) \div (0.05)^2$

$N = 3.8416 \times 0.194 \times 0.806 \div 0.0025$

$N = 240.275 \backsim 240$

This is for one district, for the three districts 3×240= 720. Therefore totally 720 indigenous chickens used for collecting data of quantitative and qualitative traits.

Table 5: Sampled house hold and chicken sample in the study area

District	Agro-ecology	Kebele	Household Inter-viewed	Number selected chicken		
				Male	Female	Total selected chicken
Faggeta Lekoma	**Highland**	Tafoch Danbull	30	36	84	120
		Wazi	30	36	84	120
		Sub-total	60	72	168	240
Dangila	**Midland**	Afesa	30	36	84	120
		ligaba	30	36	84	120
		Sub-total	60	72	168	240
Zigom	**Lowland**	Gisayta	30	36	84	120
		Kilaji	30	36	84	120
		Sub-total	60	72	168	240
Overall Total			**180**	**216**	**504**	**720**

3.3. Data Collection Procedure

For this study, both primary and secondary data sources were used. In order to collect primary data, the Participatory Rural Appraisal (PRA) involves local communities as active analysts of their own situations where they estimate, quantify, compare and list priorities of resources and constraints of poultry based on their circumstances.

Data generated by the survey includes the respondent socio-demographic, economic characteristics and characteristics of livestock such family size, age, educational status, sex, income, livestock size per household, and flock composition Actual recording of linear body measurements (such as; body weight, shank length, earlobe length, body length, wing span, chest circumference, comb length, comb width, beak length, wing length, neck length, wattle length, shank Circumference, wattle width), and data related to managemental practice (feeding, housing, watering, health managements and breeding practices), was organizing group discussion.

Qualitative data such as plumage color, comb type, feather distribution, shank colour, earlobe color, eye colour, beak colour, comb colour, shank feather and head shape was gathered based on standard format breed descriptor list (FAO, 2012). The management practices were assessed through observation the incorporation of recommended scientific husbandry packages applied for each household.

3.4. Questionnaire Administration and Focus Group Discussion (FGd)

Focus Group discussion (FGD) was used to undertake discussion with groups composed of key informants were held in each of the selected Kebles by including youngsters, women, model farmers, village leaders, elders, extension workers, and socially respected individuals who are known to have better knowledge on the present and past social and economic status of the area.Based on the information generated through Participatory Rural Appraisal (PRA), the questionnaire and record sheets were developed. Aspects of considered trait preference, egg selection,Provision of housing, provision of additional feed, agricultural extension system used, marketing, vaccination practices and use of modern and traditional medication was assessed through questionnaire survey.

3.5. Participatory Identification of Breeding Practices and Farmers' Trait Preferences

Breeding practices, farmers' preferences to traits for breeding stock, farmers' preferences for production traits, selection and culling criteria for indigenous chicken identified in the interviews were presented to each respondent.Traits affecting consumer preferences in purchasing or selling chickens (live weight, plumage color, comb type), "traits" desired by farmers in improving village chickens adaptation (comprising disease and stress tolerance, flightiness/ability to escape predators, scavenging vigour), growth, egg production, plumage color, comb type, reproduction" (broodiness, hatchability of eggs) were presented. Then participants were asked to rank their first, second and third major trait preferences.

3.6 Data Management and Analysis

Data was collected from each site were coded and entered into the computer for further analysis. Data collected through questionnaires were entered into Statistical Package for Social Sciences (SPSS). The qualitative and quantitative data were entered into Microsoft EXCEL. Simple descriptive statistics such as average and standard error of the mean were

applied for quantitative data, or frequencies and tabulations for qualitative attributes. And chi-square was used to compare variables for significantly across the three agro-ecologies. Multivariate analyses variance technique was applied to determine the most interesting traits from a set of traits, in order to differentiate chicken population based on their nature of similarity. The results of the analysis of the data were presented as tables and figures.

3.7. Descriptive Statistics

Data collected through questionnaire were described by descriptive statistics using (SPSS, 2004). Chi-square was employed when required to test the statistical significance of indigenous chicken populations' managemental system. Quantitative data was analyzed following the frequency procedures of (SAS version 9.3, 2014). Indexes were calculated to provide ranks for purpose of major constraints, disease type, selection criteria and trait preferences by farmers for breeding of indigenous chickens associated with breeding females and males in the study area.Ranking analyses were used for computing data on farmer's traits preferences, and conformation traits as related to selection of chicken. Indexes were used to calculate the data by using collected from rankings using weighed averages by the following formula employed by Musa *et al.* (2006):

$$\textbf{Index} = \frac{\sum(R_n * C_1 + R_{n-1} * C_2 \ldots\ldots\ldots\ldots R_1 + C_n for individual birds}{\sum(R_n * C_1 + R_{n-1} * C_2 \ldots\ldots\ldots\ldots\ldots R_1 + C_n for all variable}$$

Index was calculated as Index = Sum of (3 X number of households who ranked first + 2 X number of households who ranked second + 1 X number of households who ranked third) given for an individual reason, criteria or preference divided by the sum of (3 X number of households who ranked first + 2 X number of households who ranked second + 1 X number of households who ranked third) for overall reasons, criteria or preferences.

3.8. The Effective Population Size and Coefficient of Inbreeding

The effective population size and inbreeding coefficients were calculated on the bases of individual household flock size and combining all the flocks of the community according to (Falconer and Mackay, 1996). Effective population size for a randomly mated population was

calculated as: $\mathbf{Ne} = \frac{4(Nm)(Nf)}{(Nm+Nf)}$

Where: N_e= effective population size,

N_m = number of breeding males and

N_f = number of breeding females.

The rate of inbreeding coefficient (ΔF) was calculated from Ne as: $\mathbf{\Delta F} = \frac{1}{2Ne}$

3.9. Quantitative Data

A general linear model procedure (PROC GLM) of the SAS was employed for quantitative variables to detect statistical differences among sampled indigenous chicken populations. For mature animals, agro-ecology and sex of the experimental indigenous chickens are fitted as fixed independent variables. The effects of class variables and their interaction is expressed as Least Square Means (LSM) ± SE. Mean comparisons of significant differences were carried made using Tukey test (studentized range test) method at $p<0.05$. The following Model was used for the least - squares analysis of local chicken.

$Y_{ijk}= \mu + A_i + S_j + AS_{ij} + E_{ijk}$; Where: Y_{ijk} = k^{th} observation under j^{th} sex and i^{th} Agro-ecology (Observed body weight or linear measurements)

μ = Overall mean

A_i = Fixed effect of i^{th} agro-ecology (I = High-Land, Mid-Land and Law-Land)

S_j = Fixed effect of j^{th}sex (j= Male and Female)

AS_{ij}= agro-ecology & sex interaction effect

E_{ijk} = Residual error corresponding to E_{ijk}

3.10. Multivariate Analysis

Multiple correlations were used to estimate the correlation between body weight and linear body measurements, and also multivariate analysis was used to investigate the morphological structure and quantify differences among the sub-populations.

Principal component analysis was carried out to study the linear relationships between characters and to correct a cluster analysis when the variables are not independent, by transforming them into uncorrelated variables.

Stepwise discriminate procedure was applied using PROCSTEPDISC to determine which morphological traits have more discriminating power than the others to gain information about traits particularly important in the separation of sub-populations for eventual use in cluster analysis. The degree of morphological similarity or divergence between the chicken was determined using PROC CUSTER procedures.

The degree of morphological similarity or divergence between the chicken was determined using **PROC Custer** procedures.The quantitative variables of local chicken was subjected to discriminant analysis (PROC DISCRIM of SAS) and canonical discriminant analysis/(SAS 9.3, version, 2014) to ascertain the existence of population level phenotypic differences in the study area.

4. RESULTS AND DISCUSSION

4.1. Household Characteristics of Respondents

Family size and age structure of the study households were presented in Table 6. Perusal of results showed that 85, 81.66 and76.66% of females in high-land, mid-land and low-land agro-ecology (AEG), respectively, was involved in poultry production.

The larger proportion of females involved in poultry production might be due to absence of traditional restrictions imposed on women vis-a-vis approaching outsiders; and small investment needed for poultry rearing. According to Gueye, (1998) in sub Saharan Africa about 80% of the chicken flocks were owned and largely controlled by women. Similar result was also reported by researchers such as Mekonnen, (2007) and Halima, (2007).

The overall educational status showed that 31.1, 25.6, 19.4, 18.9 and 5% HH had read up to primary, illiterate, reading &writing, Junior/ High school and diploma level in the present study.

The overall results showed that majority (66.70%) of HH heads were married, similar result was reported by Mekonnen, (2007).

The religious belief of respondent HH showed that majority of them practiced Orthodox Christian followed by Muslim and Protestants belief in decreasing order in all the three AEGs. The overall results showed that 78.89, 17.78 and 3.33% were Orthodox Christian, Muslim and Protestants, respectively.

The family size of respondent HH was 5.87, 5.85and 5.66, in high-land, mid-land and low-land, respectively. These results were almost smaller than southern Ethiopia (6.95 persons) reported by Mekonnen, (2007) and slightly similar to the national average of 5.2 persons and that of SNNPRS 5.1 persons per household CSA, (2003).

Table 6: Household Characteristics of Respondents

Variables	Agro ecology						Overall	
	Highland		Midland		Lowland			
	N	%	N	%	N	%	N	%
(I) Gender of HH Head:								
Male	9	15	11	18.33	14	23.33	34	18.9
Female	51	85	49	81.66	46	76.66	146	81.1
X2 / P value	**1.378/0.50**							
(II) Family Size:								**P value**
	5.87±2.12		5.85±2.10		5.66±3.07		5.8±2.59	**0.058**
(III) Age Structure of Family:								
<15years	28	47.5	26	43.3	20	33.3	74	41.3
15-30 years	21	35.6	23	38.3	30	50	74	41.3
31-60 years	8	13.6	10	16.7	10	16.7	28	15.6
>60 years	2	3.4	1	1.7	-	-	3	1.7
X2 / P value	**5.49/0.4**							
(IV) Educational status:								
Illiterate	14	23.33	10	16.67	22	36.66	46	25.62
Reading and writing	8	13.33	9	15	18	30	35	19.42
Primary(1-6)	22	36.67	18	30	16	26.66	56	31.14
Junior, High school	10	16.66	20	33.34	4	6.67	34	18.92
Diploma	6	10	3	5	-	-	9	5
X2 / P value	**28.53/ 0.00**							
(V) Marital Status:								
Married	46	76.64	40	66.67	32	53.33	118	65.56
Single	14	23.33	20	33.33	28	46.67	62	34.45
X^2 / P value	**7.28/0.026**							
(VI) Religion:								
Orthodox	58	93.33	48	80	36	56.66	142	78.89
Muslim	1	1.67	10	16.66	21	35	32	17.78
Protestant	1	1.67	2	3.33	3	5	6	3.33
X^2 / P value	**26.6/000**							

The average age of respondent HH family members were 44.59±4.08, 43.40±2.98, 40.48±2.01 and 42.82±3.56 years in high-land, mid-land, low-land and overall, respectivelyin (**Table 6**). This result

was slightly comparable with 43±10.9 year and 44.7 years reported by Worku, (2012) in west Amhara region and Mearg, (2016) in central zone of Tigray.

The majority age composition of household members (41.3%) were children (<15 years old age) while that of youth male and female (age class of 16-30) accounted for (41%) of the total household size, youth male and female (age class of 31-60) accounted for (15%) of the total household size. And also husband, wife and other members of the family above (>60) years old covered the remaining proportions (1.7%) Similarly, with the majority of household members in most developing countries, are children under14 years and age class 16-30 of age Speizer *et al., (*2015).

4.2. Species Composition

The mean values for livestock holding per household and Farming System are presented in Table 7. The mean flock and herd size per households were 2.99±0.23, 4.02±0.25, 3.0±0.18, 9.95 ±0.27, 0.75±0.06, 0.77±0.07, 1.72±0.07 and 0.54±0.03 in Cattle, Goat, Sheep, Chicken, Donkey, Horse, Bee hives and Mule, respectively. The differences in the herd and/or flock size per households were significantly different in goat, sheep, horse, bee hives and mules. The pair-wise comparisons among the three AEGs showed significant differences between HL-LL AEGS in goat, horse and Bee species whereas HL-ML and HL-LL differences were significant in goats. However the mules showed significant differences between HL-ML and HL-LL AEGs.

Village chicken production seems to be an important activity in all study areas as indicated by the high average chicken holding per household of the respondents Similarly, the mean respondent HH rearing chicken were 9.80±0.47, 10.9±0.5 and 10.20±0.43 in high-land, mid-land and low-land, respectively. The possible reasons might be for higher number of chicks. HH might be less capital requirement, less requirement of space/ feed, early returns in terms of eggs and meat.

This result was comparable with the reported mean flock sizes of 9.20±5.69 of Mearg, (2016) in central Tigray, 10.4±7.5 in Western Oromia Feyera, (2016), 11.9±0.97 in Eastern Oromia Negassa *et. al*.,(2014). But higher than the reported mean flock sizes of 6.3 and 6.23 chickens per household from Gomma woreda and Jarso woreda by Meseret., (2010); Eskindir., (2013), respectively.

Table 7: Livestock Holding Per HH (Mean±SE)

Variable	Agro ecology				P value
	Highland Mean± SD	Midland Mean± SD	Lowland Mean± SD	Overall Mean± SD	
(I) Livestock Composition:					
Cattle	2.46±0.30	3.47±0.32	3.05±0.44	2.99±0.21	0.067
Goat	3.28±0.34[b]	3.80±0.30[ab]	4.96±0.56[a]	4.02±0.25	0.001
Sheep	3.70±0.35[a]	3.30±0.30[a]	2. 0 ± 0.27[b]	3.0±0.18	0.001
Chicken	9.80±0.47	10.9±0.50	10.20±0.43	9.95 ±0.27	0.127
Donkey	0.56±0.08	0.93±0.13	0.76±0.09	0.75±0.06	0.06
Horse	1.46±0.14[a]	0.67±0.08[ab]	0.18±0.05[b]	0.77±0.07	0.00
Bee hives	2.37±0.23[a]	1.82±0.34[ab]	0.98±0.26[b]	1.72±0.07	0.05
Mule	0 .716±0.05[a]	0 .467±0.06[b]	0.45±0.06[b]	0.54±0.03	0.005

4.3. Farming Systems

The results of the study showed that the entire respondents were engaged in agricultural activities dominated by mixed crop-livestock production, which accounts 97.78% of the farmers and the rest 2.22% were concerned only in livestock production. Village chicken production is an important component of the mixed farming system for improving of poultry products like egg.The results in table 8 also showed that overall crop cultivation, livestock production, charcoal making contributed 37.7, 23.3 and 20.0% of capital required to finance chicken production in the study areas. However chicken production contributed least amount of 18.9% of money for chicken production.

Table 8: Table: Farming System

Variable	Agro ecology						Overall	
	Highland		Midland		Lowland			
	N	%	N	%	N	%	N	%
(I) Farming System:								
Mixed Farming	60	100	58	96.67	56	93.3	174	95.67
Livestock Production	-	-	1	1.67	3	5.08	4	2.22
x^2value/p value							**7.2/0.02**	
(II) Sources of income to finance chicken production								
Chicken	17	28.33	13	21.66	4	6.66	34	18.9
Crop	10	16.66	21	35	37	61.66	68	37.7
Livestock	10	16.66	15	25	17	28.33	42	23.3
Charcohol	23	38.33	11	18.33	2	3.33	36	20
						x^2value/p	**4.44/0.00**	

4.4. Flock Sizes and Structures

The overall mean average chicken flock size per household was presented in table 9. The overall flock structures of poultry in the study area per household were 4.11±0.18, 3.15±0.65, 1.27±0.09, 0.92±0.07 and 0.51±0.04 for chicks, hens, pullets, cockerels, and cocks respectively. The number of birds / respondent HH were 3.86, 3.11, 1.44, 0.83 and 0.56 for chicks, hens, pullets, cockerels, and cocks, respectively, in high-land;4.53, 3.15, 1.05, 0.90 and 0.47 for chicks, hens, pullets, cockerels, and cocks, respectively in mid-land and 4.25, 3.18, 1.16, 1.10 and 0.51 for chicks, hens, pullets, cockerels, and cocks, in low-land respectively.

The present results showed that chicks and hens were more numerous (number one and two, respectively) than other groups in all AEGs whereas cocks were lowest in number in all AEGs. The possible reason for higher number of chick and hens might be that higher number of chicks was essential as replacement stock whereas higher number of hens, being layers, ensures sufficient number of eggs for sale/ incubation and optimum culling.

This result is comparable with the reported mean flock sizes of 9.20±5.69 Mearg, (2016) Central Tigray**,** 10.4±7.5 Feyera, (2016) Western Oromia, 11.9±0.97 Negassa*et., al*., (2014) Eastern Oromia.

Table 9: Flock Structure in the Study Area (Mean±SE).

Variables	Agro-ecologies				p-value	Responding age of poultry
	Highland Mean± SD	Midland Mean± SD	Lowland Mean± SD	Overall Mean± SD		
Chicks	3.86±0.35	4.53±0.23	4.25±0.32	4.11±0.18	0.52	< 3 month
Pullet	1.44±0.16	1.05±0.16	1.16±0.16	1.27±0.09	0.13	> 3 month to1st brooding
Cockerel	0.83±0.12	0.90±0.12	1.10±0.13	0.92±0.07	0.71	> 3 month to1st mating
Hen	3.11±0.11	3.15±0.12	3.18±0.12	3.15±0.65	0.56	brooding until stopped egg
Cock	0.56±0.06	0.47±0.07	0.51±0.07	0.51±0.04	0.61	give service to the end

4.5. Purposes of Chicken Production

The results on purpose of chicken production were presented in Table 10. The results showed that respondent farmers were involved in chicken production for income generation (35%), egg production (30%), home consumption (19.4%), and meeting custom needs 15.56%.

This result was in agreement with the results of, Melese and Melkamu, (2014) with their studies in different areas reported that, income generation and household consumption are the main production objectives of keeping village chicken in Ethiopia. The income generation and egg production were one and two purpose of chicken rearing in all AEGs. The result was also consistent with the study of Fisseha *et al*., (2010) who reported that the sale of live chicken was the first important function of rearing chicken in Fogera area. According to Feleke,(2015), most of the respondents gave the highest priority for income generation (55%) followed by home consumption (22%).

Table 10: Purposes of Chicken Rearing.

Variables	**Agro-ecologies**							
	Highland		**Midland**		**Lowland**		**Overall**	
	N	%	N	%	N	%	N	%
Home consumption	15	25	13	21.67	7	11.66	35	19.4
Income Generation	18	30	20	33.33	25	41.66	63	35
Meet Custom Need	12	20	8	13.33	8	13.33	28	15.56
Egg Production	15	25	19	31.67	20	33.33	54	30.0

4.6. Managemental Practice of Local Chickens

4.6.1. Feed Resources and Feeding Practice

The major feeds and feeding practices of chickens in the study area as indicated by the respondents were reported in (Table 11). The results showed that 85, 93.33 and 78.33% of the respondents HH in high-land, mid-land, and low-land AEGs, respectively, feed their chicken with some kind of feed in addition to scavenging. The result was in agreement with the report of Halima, (2007) also reported that 99.3% of chicken owners in North West Amhara Region provided supplementary feeds to village birds. According to the results of this study, 13.9% were only scavenging around the backyard. In the current study farmers practiced supplementary feeding system use home grown crops such as 22.6%, 24.5%, 24.5%, 9.0% and 19.4%, like: Wheat, Sorghum, Maize, Barely and Mixture with leftovers respectively AEGs.

Table 11: Feed Resources and Feeding Practice

Variables	Agro-ecologies							
	Highland		Midland		Lowland		Overall	
	N	%	N	%	N	%	N	%
(I)Practice of Poultry Feeding								
Yes	51	85	56	93.33	48	78.33	155	86.1
No	9	15	4	6.66	12	20	25	13.9
X^2 value/ P value						**4.615 / 0.099**		
(II)Types of Feed Source with Leftover								
Wheat	21	41.18	9	16.12	5	10.42	35	22.63
Sorghum	7	13.72	9	16.12	22	45.83	38	24.51
Maize	8	15.68	20	35.72	10	20.83	38	24.52
Barely	6	11.76	5	8.91	3	6.25	14	9.01
Mixture	9	17.66	13	23.21	8	16.67	30	19.40
X^2 value/ P value						**13.56/ 0.000**		
(III) Frequency of Feeding								
Once /day	11	21.57	7	12.51	18	37.53	36	23.23
Twice / day	9	17.65	11	19.64	9	18.75	29	18.74
Three or >	31	60.78	38	67.86	21	43.75	90	58.13
X^2 value/ P value						**10.97 / 0.027**		
(IV)Types of Feeders Used								
Plastic	3	5.88	6	10.71	3	6.25	12	7.73
Clay pot	11	21.57	16	28.57	9	18.75	36	23.21
Wooden through	9	17.65	10	17.86	6	12.51	25	16.13
On ground	28	54.90	24	42.86	30	62.52	82	52.93
X^2 value/ P value						**5.21 / 0.517**		

The type of supplemental feeds varied based on the type of agricultural practice. Besides the frequency of feeding result showed that 58.1% (majority) of respondents recommend Feed chicken three times a day (morning, afternoon and evening), 23.2% and 18.7% were feed once and twice (morning and afternoon) respectively. The respondent farmers further reported that chicken were fed on ground (52.9%), clay pot (23.2%), wooden trough (16.1%) and plastic (7.7%) containers.

4.6.2. Provision of Water

The results on provision of water to the chicken, based on respondent farmers responses, was presented in Table 12.The results showed that 95% (Overall) of respondents provided water to their chicken. This result was related with Bekele *et al.*,(2014) who reported that 100% of chicken owners were provided water for their chicken.

The frequencies of watering showed that chicken were provided water ad-labium (free aces), three times/day, Twice/day and once/day by 85.4, 10.5, 3.5and 0.6% (overall figures) of respondent farmers in the study area. The study also showed that ad-labium water was provided to chicken in all AEGs, uniformly. Besides in mid-land a small proportion of farmers (1.79%) provide once /day water to chicken.

The major sources of household water were river, dam (pond),hand pump and spring water in high-land (88.33, 5 and 3.33/ 3.33%, respectively); river, hand pump, spring water and dam (pond) in mid-land (83.33, 6.66, 6.66 and 3.33%, respectively); and hand pump, river, dam (pond) and spring water in low-land (46.66, 36.66, 13.33 and 3.33%, respectively).

In contrast with Shishay, (2014) showed that well water (31.7%), tap water (29.1%), river (27.3%), tap water and well water (6.2%), river and tap water (4.2%) as well as river and well water (1.6%) sources of water in western Tigray. In this result higher proportion of respondents used river as main sources in high-land (88.33%) and mid-land (83.33%) due to many source of rivers in Awi zone. However, hand pump was major source of water in low-land (46.66%) agro-ecology.

In (**Table 12**) also showed that the watering troughs were available to 90, 91.6 and 96.67% of respondent farmers in high-land, mid-land and low-land AEGs respectively. The watering troughs in high-land and mid-land AEGs were, uniformly, made of clay pot (35.18, 40%), wooden (31.48, 34.55%), plastic (16.67, 12.73%), stone (9.26, 7.27%) and metallic (7.40, 5.45%). However, in low-land the watering troughs were made of plastic (36.2%), clay pot (29.3%), metallic (15.52%), wooden (15.5%) and stone (3.45%). This was in line with the report of Alem *et al*., (2013) in central Tigray; Mekonnen, (2007) in Southern Ethiopia and Fisseha *et al., (*2010) in Bure district.

Table 12: Provision of Water, Watering Frequency, Sources of Water and Watering Trough

Variables	Agro-ecologies							
	High-land		Mid-land		Low-land		Overall	
	N	%	N	%	N	%	N	%
(I)Provision of Water								
Yes	55	91.66	56	93.33	60	100	171	95
No	5	8.33	4	6.66	-	-	9	5
X^2 value/ P value							**4.33 /0.114**	
(II)Frequency of watering								
Once /day	-	-	1	1.79	-	-	1	0.6
Twice / day	2	3.64	2	3.57	2	3.33	6	3.5
Three / day	6	10.90	5	8.93	7	11.67	18	10.5
ad-labium	47	85.46	48	85.71	51	85	146	85.4
X^2 value/ P value							**4.68/ 0.322**	
(III) Source of water								
River	53	88.33	50	83.33	22	36.66	125	69.4
Hand pump	2	3.33	4	6.66	28	46.66	34	19.0
Dam (pond)	3	5	2	3.33	8	13.33	13	7.2
Spring water	2	3.33	4	6.66	2	3.33	8	4.4
X^2value/ P value							**6.74/0.000**	
(IV)Availability of watering through								
Yes	54	90	55	91.6	58	96.67	167	92.78
No	6	10	5	8.33	2	3.33	13	7.22
X^2 value/ P value							**2.236/ 0.327**	
(V)Types of watering through								
Clay pot	19	35.18	22	40	17	29.3	58	35.08
Plastic	9	16.67	7	12.73	21	36.2	37	22.16
Wooden	17	31.48	19	34.55	9	15.5	43	26.94
Stone	5	9.26	4	7.27	2	3.45	11	6.58
Metallic	4	7.40	3	5.45	9	15.52	16	9.58
X^2 value/ P value							**24.694 /0.002**	

4.6.3. Poultry Housing System

The results on poultry housing were presented in table 13 below. The study showed that poultry housing was provided by 96.66%, 93.33 and 85 of respondents in high-land, mid-land and low-land, AEGs respectively. The possible reason might be that housing was essential to chickens as it protects them against predators, theft, weather conditions like: (rain, sun, wind...) and Provide nesting place (egg laying place of laying hens).

The present study showed that five type of housing were provided and these were separate house, perch in kitchen, perch on veranda, perch inside main house and handmade basket but

proportion of respondents using these types of housing was different in the three AEGs. In high-land AEG the order of housing was, Handmade Basket, Separate house, Perch inside Main House, Perch on Veranda, and Perch in Kitchen (46.55, 29.3, 13.79, 6.9 and 3.45%, respectively).

Similarly the order of housing in mid-land was Perch inside Main House, Separate House, Perch in Kitchen, Handmade Basket and Perch on Veranda (33.93, 25, 19.64, 16.07 and 5.36%, respectively) and in low-land the order of housing was Separate House, Perch on Veranda, Perch in Kitchen, Perch inside Main House and Handmade Basket (37.25, 25.49, 21.57, 9.8 and 5.88%, respectively). The overall results showed that only 30.3% of respondents provided separate house for chicken. The possible reason for low proportion of farmers providing separate house for chicken might be lack of awareness of advantages of separate housing of poultry, lack of awareness of risks involved in keeping chicks in family house, is keep of theft and predator attack.

This result was much lower than Hassen., (2007), Bogale, (2008), (Shishay, 2014), Mearg, (2016), salo*et al.,(*2016) those who were reported that 50.77%, 59.7%, 59.5%, 65.7% and 76.7%, of the total respondents constructed separate chicken houses in Southwest and central zone of Tigray, Lemo District Hadiya Zone, North west of Ethiopia and Fogera district, respectively. However, this result was much higher than from a report of Meseret, (2010) in which only 3.6% respondents in Gomma district constructed separate chicken house.

(**Table 13**) Also review the poultry house was cleaned daily by majority of respondent HH in all AEGs (41.66, 38.33 and 26.66%, respectively) in high-land, mid-land and low-land areas.

Table 13: Poultry Housing System of the Study Areas

Variables	Agro-ecologies							
	Highland		**Midland**		**Lowland**		**Overall**	
	N	%	N	%	N	%	N	%
(I)Availability of Poultry Housing								
Yes	58	96.66	56	93.33	51	85	165	91.7
No	2	3.33	4	6.66	9	15	15	8.3
X^2 value/ P value						**5.673/ 0.059**		
(II)Types of Housing								
Separate House	17	29.3	14	25	19	37.25	50	30.3
Perch in Kitchen	2	3.45	11	19.64	11	21.57	24	14.4
Perch on Varenda	4	6.92	3	5.36	13	25.49	20	12.1
Perch inside Main House	8	13.79	19	33.93	5	9.81	32	19.4
Handmade Basket	27	46.55	9	16.07	3	5.88	39	23.6
X^2 value/ P value						**8.210 / 0.000**		
(III) Frequency of Cleaning								
Daily	25	41.66	23	38.33	16	26.66	64	35.6
In 2 Days	7	11.66	5	8.33	11	18.33	23	12.8
In 3 Days	3	5	8	13.33	-	-	11	6.1
Weekly	18	30	20	33.33	27	45	65	35.1
Monthly	7	11.66	4	6.66	6	10	17	9.4
X^2value/ P value						**16.323 / 0.038**		

4.6.4. Poultry Health Management

(A) Ranking of Diseases:

The ranking of diseases by respondents were presented in Table 14. Perusal of results showed that Newcastle (locally called as **"Wotetie")**, Parasitic infestation and diseases of unknown origin were ranked as number one, two and three with index values of 0.422, 0.306, 0.272 in high-land and 0.410, 0.295 and 0.295 in low-land areas.

However, in mid-land though Newcastle disease was ranked as number one (with index value of 0.436) but number two and three ranks were unknown origin (with index value of 0.292) and parasitic infestation (with index value of 0.272). Hasen, (2007), Kibret, (2009) and Adiss, (2013) also reported that the major cause of death in local chicken is seasonal outbreak of NCD.

Table: 14 Ranking of Diseases by respondent HH

Diseases	Agro ecology											
	High land				Mid land				Low land			
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
New castle Disease	42	8	10	0.422	35	22	3	0.436	45	10	5	0.410
Parasitic Infestation	10	15	35	0.306	10	30	20	0.272	10	35	15	0.295
Unknown	5	36	15	0.272	15	8	37	0.292	15	15	40	0.295

(B) Occurrence and Treatment of Diseases:

The results on occurrence and treatment of diseases were presented in Table 15. In the present study 96.66, 100 and 96.66% of respondents reported that diseases were occurring in high-land, mid-land and low-land, AEGs, respectively.

Regarding, to measures taken for sick chickens in the study area sick chicken in high-land, mid-land and low-land agro-ecologies, about 31.03,30 and 24.14% of the respondent treat by themselves, 18.97, 13.33 and 24.14% of the respondents treat by Slaughter for home consumption, 27.59, 36.66 and 17.24% of the respondents treat by Selling to market, 17.24 , 16.66 and 20.68 % of the respondent treat by no-action and but only 5.17, 3.33 and 13.79% respondent was tack to veterinary for treatment of sick chicken in 3 agro-ecologies respectively.

This result was similarly, Abdelqader*et al., (2007*) reported that only 5% of the farmers accessed veterinary extension service. The study showed that 96.66, 91.66 and 98.33% of respondents reported that vaccination was not available for control of some important poultry diseases. This finding was lower than that reported by Melaku, (2016) who stated that 87, 78% respondents did not vaccinated their birds in Wogdi, Borena and Legambo districts.

There could be many reasons reported by respondents for non-vaccination of chicken and these were: (i) Lack of attention (31.03, 49.09, and 50.85%); (ii) No access that requires more

than their costs (32.77, 10.91 and 20.34%); (iii) Lack of awareness (25.86, 34.55 and11.86%); and (iv) No information about vaccination availability (10.34, 5.45and 16.95%) in high-land, mid-land and low-land agro-ecologies, respectively.

Similarly, Fisseha *et al.*, (2010) also reported that lack of awareness about the presence of vaccine (71.4%), lack of attention to village birds (13.6%) and low availability of vaccines (15%) were the major reasons for lack of vaccination against diseases in Bure district, North West Ethiopia.

Table 15 : Disease Parasite and Vaccination Availability in the Study Area

Variables	Agro-ecologies							
	Highland		**Midland**		**Lowland**		**Overall**	
	N	%	N	%	N	%	N	%
(I) Prevalence of disease								
Yes	58	96.66	60	100	58	96.66	176	97.8
No	2	3.33	-	-	2	3.33	4	2.22
X^2 value/ P value						**2.883/ 0.237**		
(II)Nature of Treatment of sick chickens								
Tack to veterinary Clinic	3	5.17	2	3.33	8	13.79	13	7.39
Treated by Respondent Farmer	18	31.03	18	30	14	24.14	50	28.41
Slaughter for Home Consumption	11	18.97	8	13.33	14	24.14	33	18.75
Sale at market	16	27.59	22	36.66	10	17.24	48	27.27
No action	10	17.24	10	16.66	12	20.68	32	18.18
X^2 value/ P value						**4.681/ 0.322**		
(III) Availability of Poultry vaccination								
Yes	2	3.33	5	8.33	1	1.66	8	4.4
No	58	96.66	55	91.66	59	98.33	172	95.6
X^2value/ P value						**21.15/0.002**		
(IV)Reason for Non-vaccination of chicken								
Lack of Attention	18	31.03	27	49.09	30	50.85	75	43.6
No Access	19	32.77	6	10.91	12	20.34	37	21.5
Lack of Awareness	15	25.86	19	34.55	7	11.86	41	23.8
No Information about Vaccine Availability	6	10.34	3	5.45	10	16.95	19	11.1
X^2 value/ P value						**21.49/0.002**		

4.6.4.1. Source of Disease, Parasite and Control Measures

The sources of diseases, Parasite and control measures, in the study areas was presented in Table 16. According to respondents in the study area, the incoming flock (either neighbor's flock or immigrants) was the major source of chicken infection (46.66, 60 and 53.33%) in all high-land, mid-land and low-land, respectively.

Kibret, (2009) also reported that the major cause of death in local chicken was seasonal outbreak of NCD. And respondents from Quara discovered that the main sources of chicken disease were incoming and own flocks, respectively.

The present study showed that respondent farmers have experience about prevalence of diseases as indicated (65, 70 and 55% in high-land, mid-land and low-land, respectively). The respondent farmers further reported that indigenous practices were carried to treat sick birds and three types of indigenous practices were giving juice of leaves, bleeding under wing and Giving Juice of Leaf of Chikugni whereas a proportion of farmers took No prevention for treatment of sick birds.

The overall results showed that 30.70, 28.95, 20.17 and 20.17% of respondents treated sick birds by Bleeding under wing, No prevention, giving juice of leaves and Giving Juice of Leaf of Chikugni, respectively.Similarly, (Fisseha et al., Emebet, and Addisu, (2010), (2013) and (2014)) also reported that the major cause of death in local chicken in North West Ethiopia Bure district in South West and South Part of Ethiopia and North Wollo were seasonal outbreak of diseases, specifically Newcastle Disease.

The majority of respondents (85, 78.33 and 71.66%) knew about parasitic infestation in high-land, mid-land and low-land, AEGs, respectively. The indigenous practices, via: Smoking, Changing place, No intervention and spring medicine, were used to control parasitic infestation in the study areas. The overall results showed that 55.32, 17, 14.89 and 12.76% of respondents practiced Smoking, Changing place, spring medicine and No intervention, respectively, for controlling parasitic infestation.

Table 16: Source of Disease, Parasite and Control Measures

Variables	Agro-ecologies							
	Highland		Midland		Lowland		Overall	
	N	%	N	%	N	%	N	%
(I)Source of disease								
Incoming flock	28	46.66	36	60	32	53.33	96	53.33
Own flock	15	25	13	21.66	11	18.33	39	21.67
Unknown	17	28.33	11	18.33	17	28.33	45	25
X^2value/ P value								**4.002/ 0.406**
(II) Experience of Farmers about Prevalence of Disease								
Yes	39	65	42	70	33	55	114	63.3
No	21	35	18	30	27	45	66	36.7
X^2 value/ P value								**3.014/ 0.222**
(III) Indigenous Practices about Preventing Disease								
Giving juice of leaves	7	17.95	8	19.05	8	24.24	23	20.17
Bleeding under wing	12	30.76	13	30.95	10	30.30	35	30.70
Giving Juice of Leaf of Chikugni	13	33.33	10	23.80	-	-	23	20.17
No prevention	7	17.95	11	26.19	15	45.45	33	28.95
X^2value/ P value								**4.13/0.000**
(IV) Farmer experience about Parasitic Infestation among Chicken								
Yes	51	85	47	78.33	43	71.66	141	78.3
No	9	15	13	21.66	17	28.33	39	21.7
X^2 value/ P value								**3.142/0.208**
(V) Indigenous knowledge about prevention of external parasite								
Smoking	36	70.58	31	65.96	11	25.58	78	55.32
Changing place	7	13.72	7	14.89	10	21.66	24	17
No intervention	5	9.8	3	6.38	10	23.26	18	12.76
Spring medicine	3	5.88	6	12.76	12	27.9	21	14.89
X^2 value/ P value								**5.69 /0.000**

4.6.5. Occurrence of Predator

The occurrence of predators in the study areas was presented in Table 17; the majority proportion (98.33, 96.66 and 100% in high-land, mid-land and low-land, respectively) respondents reported that predators were occurring in the study areas. This result was in line with report of Halima, (2007) that predation was one of the major constraints in village chicken production in northwest Ethiopia.The most common predators mentioned by respondents were Vulture, wild Cat, Dog, Snake, Bee bitt and "**sulsuly/fotte**/" (locally available predators of wild animal in this area) in (**Table 17**) but the attack of predator was

vary from agro-ecology to agro-ecology. Vultures were common in all area that attack during the dry season December to June but June to October is covered scavenging areas by crops.

Snakes were common predators in low-land agro-ecology whereas Cat of wild and Dogs were in all agro-ecologies. Local name **sulsuly/fotte** were wild animal predators common in all agro-ecologies that attacks poultry in rainy seasons for the standing crops in the field were providing camouflage to these predators and poultry were becoming easy target due to this. Bee-bitt was more common in high-land and mid-land areas it might be bees present in backyard in both agro-ecology but in lowland bees live mostly on trees responding by the owners.

This result was in line with report of Halima, (2007) that predation is one of the major constraints in village chicken production in northwest Ethiopia. The average mean types of predators were 28.81%, 53.17% and 33.33% Vulture, 16.95%,10.34% and 16.66% Cat, 16.95%, 6.9% and 11.66% Dog, 0, 0 and 20% Snake,15.26%,10.34% and 0 Bee bitt and 22.03%, 17.24% and 20% **Sulsuly/fotte**/ of respondents were respond in high-land, mid-land and low-land areas respectively. This result was in agreement with Hunduma *et al., (*2010) reported that predators such as birds of prey (locally known as "Culullee") (34%), cats and dogs (16.3%) and wild animals (15%) were identified as the major causes of village poultry in rift valley of Oromia, Ethiopia.

Table 17: Availability and Types of Predator in the Study Area

Variables	**Agro-ecologies**							
	Highland		**Midland**		**Lowland**		**Overall**	
	N	%	N	%	N	%	N	%
(I)Occurrence of predator								
Yes	59	98.33	58	96.66	60	100	177	98.3
No	1	1.66	2	3.33	-	-	3	1.7
X^2value/ P value						**18.947/0.0001**		
(II) Types of predator								
Vulture	17	28.81	32	53.17	20	33.33	69	39
Wild Cat	10	16.95	6	10.34	10	16.66	26	14.7
Dog	10	16.95	4	6.9	6	11.66	20	11.3
Snake	-	-	-	-	12	20	12	6.8
Bee bitt	9	15.26	6	10.34	-	-	15	8.5
Sulsuly/fote	13	22.03	10	17.24	12	20	35	19.7
X^2value/ P value						**4.26 / 0.000**		

4.7. Marketing Practice of Local Chicken and Eggs

The results of marketing practice and methods of transportation were presented in Table 18. The results showed that all respondent farmers participated in sale of chicken in all AEGs. The results, based on respondent survey, showed that sale of chicks was conducted by women and their proportion was more than 70% in all AEGs. The children were next in order (>10% but < 20%) involved in selling of chicken in all AEGs.

The main markets preferred by farmers for sale of chicken were 55%, 60% and 46.66% of the nearest urban market followed by 40%, 26.66% and 28.33% district market and 5%, 13.33% and 25% Neighbor-hood market in high-land, mid-land and low-land agro-ecologies respectively (table 18).

Sale of chicken is an important source of income in all agro-ecologies. Regarding means of transportation of chicken to markets, the majority 53.33% in high-land,(76.66% in mid-land, and 65% in low-land) of the farmers transported **on foot carrying** their chicken by hand, hanging upside down on a piece of stick, 11.66% in high-land,6.66% in mid-land and 21.66% in low-land by **car** 30% in high-land, 13.33% in mid-land and 5% in low-land transported **In basket** and 5% in high-land, 3.33% in mid-land and 8.33% in low-land were transported by **embracing** one or two hens only were means of transportation.

This result was similar with Mearg, (2016) transportation of chicken to markets, the majority (74.5% in midland, 56.7% in highland) of the farmers transported on foot carrying their chicken.The respondent farmers reported that more than 75% of respondent practice egg selling. The proportion of respondents practicing egg selling in HL, ML and LL were 85.00, 78.33 and 95.00% in present study.

The result showed that in high-land, mid-land and low-land the eggs were stored: 52.94, 44.68 and 29.82% **in grain**, 27.45, 36.17 and 36.84% **in straw** and 19.61, 19.15 and 33.33% **in plastic** respectively. In addition to its use in storage of eggs until incubation and or marketing, the grain/straw also used to protect eggs from rupture during transportation. This result was in line with finding of Abdulkadir, (2007) reported that farmers sold chickens and eggs to their neighbors and in the main markets to other farmers and middle men.

Table 18: Marketing Practice and Methods of Transportation

Variables	Agro-ecologies							
	Highland		Midland		Lowland		Overall	
	N	%	N	%	N	%	N	%
(I)Prevalence of Chicken Sale								
Yes	60	100	60	100	60	100	60	100
(II) Role of Family Members in Selling								
Male	4	6.67	6	10	6	10	16	8.89
Female	49	81.67	45	75	43	71.66	137	76.11
Children	7	11.66	9	15	11	18.34	27	15
X^2 value/ P value	**2.56 / 0.617**							
(III) Marketing place of chicken								
district market	24	40	16	26.66	17	28.33	57	31.7
Neighbor –hood	3	5	8	13.33	15	25	26	14.4
Nearest market	33	55	36	60	28	46.66	97	53.9
X^2value/ P value						**11.397/0.022**		
(IV) Methods of transportation chickens								
Hanging by hand	32	53.33	46	76.66	39	65	117	65
By car	7	11.66	4	6.66	13	21.66	24	13.3
In basket	18	30	8	13.33	3	5	29	16.1
Embracing	3	5	2	3.33	5	8.33	10	5.6
X^2 value/ P value	**21.232 /0.002**							
(V) Practice of Egg Selling								
Yes	51	85	47	78.33	57	95	155	86.1
No	9	15	13	21.66	3	5	25	13.9
X^2 value/ P value				**7.061 /**	**0.029**			
(VI) Methods of transportation eggs								
Eggs in grain	27	52.94	21	44.68	17	29.82	65	41.94
Eggs in straw	14	27.45	17	36.17	21	36.84	52	33.55
Eggs in plastic	10	19.61	9	19.15	19	33.33	38	24.51
X^2 value/ P value						**14.167 /0.007**		

4.7.1 The Prices of Chicken and Price Determinant Factors

The results on sale prices of chicks and eggs and factors determining these prices were presented in Table 19and 20. The interview of respondent farmers showed that the sale prices were113.28$\pm$4.86, 113.48$\pm$5.48 and 97.9$\pm$4.28 average price of cock, 98.85$\pm$3.70, 93.97$\pm$3.55 and 91.63$\pm$3.99 average price of hen and 2.80$\pm$0.03, 3.07$\pm$0.37and 2.48$\pm$0.03 average price of egg in high-land, mid-land and low-land agro-ecologies respectively in (**Table 19**).The average price of eggs showed significant differences among the three AEGs and HL-ML AEG differed significantly in the average price of eggs.

The prices obtained in this finding were significantly higher as compared with Addisu G., (2014) who reported that 71± 2.14 for cock, 53.56 ±2.24 for hens and 1.70 ± 0.056 for eggs birr per matured cocks, hens and eggs, respectively, in north Gonder zone Amhara region.

Table 19: The Prices of Chicken and Price Determinant

Variable	Agro ecology				P
	High-land	**Mid-land**	**Low-land**	**Overall**	**Value**
	Mean ± SE	**Mean ± SE**	**Mean ± SE**	**Mean ± SE**	**P value**
(I) Sale price of Chicks and Eggs:					
Average price of cock	113.28±4.86	113.48±5.48	97.9±4.28	108.23±2.87	0.134
Average price of hen	98.85±3.70	93.97±3.55	91.63±3.99	94.82±2.16	0.134
Average price of egg	2.80 ^{a}±0.03	3.07 ^{b}±0.37	2.48 ^{ab}± 0.03	2.78 ±0.126	0.000

Regarding to price determinant factors the result of the study in (**Table 20**) indicated that almost all the respondents' reported that the price of live chickens varies based on different determinant factors. According to the result of overall 'interview was plumage color and body weight 33.3%, Body weight 27.2%, plumage color 14.4%, comb type13.4%, sex of chicken 7.8%, Breed of chicken 3.9%, were the major factors that cause variation in the price of live chickens in high-land, mid-land and low-land AEGs respectively.

This result was in line with finding of Addisu *et al., (*2013) who reported that the prices of live chickens were determined based on body weight (41.83%), combination of comb type and plumage color (32.35%) and plumage color (25.82%) in buying and selling marketing system in North Wollo zone of Ethiopia. And Markos, (2014) who reported that plumage color, body weight, comb type, shank color, smoothness of shank, sex, length of legs, head shape and market site were the major factors that cause variation in the price of live chickens in western zone of Tigray. The current finding was also in agreement with report of Fisseha *et al., (*2010).

Table 20: The Prices of Chicken and Price Determinant

Plumage colour	11	18.33	9	15	6	10	26	14.4
Comb type	5	8.33	7	11.66	12	20	24	13.4
Sex of chicken	2	3.33	4	6.66	8	13.33	14	7.8
Breed of chicken	5	8.33	2	3.33	-	-	7	3.9
Body weight	16	26.66	18	30	15	25	49	27.2
Weight and plumage	21	35	20	33.33	19	31.66	60	33.3
X^2value/		**P value**		**14.526/**		**0.15**		

4.8. Management of Egg and Incubation Practice

The results on management of egg and incubation practice of indigenous chicken, based on respondent survey, were presented in Table 21.The availability of egg management practices are very important for incubation and quality egg transformed to consumers. The results (Table 21) showed that more than 70% of respondent farmers were aware of proper management of eggs in the three AEGs (80, 90 and 70% in HL, ML and LL AEGs, respectively).In this study 27.08%, 35.19% and 26.19% of the farmers collected eggs daily; 37.5%, 31.48% and 23.81% collected every two day;25%,18.52% and 21.43% collected every three day; and 10.42%, 14.81% and 28.57% did not collect eggs until incubation in high-land, mid-land and low-land agro-ecologies, respectively.

The overall mean proportion of respondents reported that 45.6% respondents stored eggs in mixed with grains; 27.2% stored in plastic container; 25% stored in clay pot mixed with left over of fruits; and 2.2% stored on ground with sand in the present study. It appeared that storing of eggs with grain was a relatively more common practice in the study area.

Table 21: Management of Egg, Frequency of Egg Collection and Storage of Egg in the Study Area

Variable	Agro-ecology							
	Highland		Midland		Lowland		Overall	
	N	%	N	%	N	%	N	%
(I)Availability of egg management								
Yes	48	80	54	90	42	70	144	80
No	12	20	6	10	18	30	36	20
				X^2value/ p- Value		**7.500/0.024**		
(II)Frequency of egg collection								
Every day	13	27.08	19	35.19	11	26.19	52	28.9
Every2da	18	37.5	17	31.48	10	23.81	57	31.7
Every3da	12	25	10	18.52	9	21.43	44	24.4
Until incubation	5	10.42	8	14.81	12	28.57	27	15
				X^2value/ p- Value		**8.633/0.195**		
(III)Place of storage eggs								
In grain	32	53.33	24	40	26	43.33	82	45.6
On flour	-	-			4	6.66	4	2.2
In plastic	20	33.33	12	20	17	28.33	49	27.2
In clay pot	8	13.33	24	40	13	21.66	45	25
				X^2value/ p- Value		**2.202/0.003**		
(IV)Purpose of egg storage								
For incubation	20	33.33	24	40	22	36.66	66	36.7
For consumption	12	20	10	16.66	21	35	43	23.9
For selling	28	46.66	26	43.33	17	28.33	71	39.4
				X^2value/ p- Value		**8.056/ 0.090**		

The results showed in (**Table 21**) that eggs were stored, based on respondents survey, for sale (46.66, 43.33, 28.33% in HL, ML and LL AEGs, respectively); for incubation (33.33, 40.00, 36.66% in HL, ML and LL AEGs, respectively); and for consumption (20.00, 16.66, 35.00% in HL, ML and LL AEGs, respectively) in the present study.

The overall durations of egg storage showed that eggs were stored until incubation (41.1% of respondents), less than one week (20.6% of respondents), two weeks (19.4% of respondents)

and 3 weeks (18.9% of respondents) in the present study. The majority of respondents stored eggs until incubation (43.33, 53.33, and 26.66% in HL, ML and LL AEGs, respectively).

The results (**Table 22**) bellow also indicated that more than 70% of respondent farmers selected eggs before incubation and proportion of these respondents for HL, Ml and LL AEGs were 73.33, 80.00 and 70.00%, respectively. The results on criteria of selection of eggs revealed that absence of Cracks and shape of eggs were number one and two criteria in all three AEGs as indicated by proportion of respondent farmers (56.82, 62.5, 59.52% respondents for absence of cracks; and 25, 18.75, 21.43% respondents for shape of egg in HL, ML and LL AGE, respectively). The study of Meseret (2010) also indicated that farmers select eggs for incubation based on certain criteria but the criteria observed in this study (body size, sufficient plumage cover and previous hatching history of the hen) were not same as observed in current study. This indicated that there was variation in the selection criteria of eggs for incubation from area to area depending upon perception of farmers in each area.

Perusal of table 22 indicated that natural incubation was the most commonly used method by majority of respondents (96.66, 93.3, and 100% in HL, ML and LL AEGs, respectively) for incubating and rearing chicks in the present study. The hay box brooder was used by a very small proportion of respondents in HL (3.33% of respondents) and ML (6.66% of respondents) agro-ecology only. This needs to be addressed, in view of the advantages of hay box brooder, by extension agencies.

Perusal of table 22 showed that different bedding material was used during incubation in the study area. The overall proportion of farmers using Clay pot with straw, Mud container with straw, Under holes with sand, Plastic material and Wooden made with straw were 31.03, 25.86, 22.98, 10.34 and 9.77% , respectively, in the present study.

Table 22: Incubation Practices in Study Areas

Variable	Agro ecology						Overall	
	Highland		Midland		Lowland			
	N	%	N	%	N	%	N	%
(I) Duration of eggs storage								
One week	12	20	10	16.66	15	25	37	20.6
Two week	9	15	9	15	18	30	36	19.4
Three week	14	23.33	9	15	11	18.33	34	18.9
Until Incubation	25	41.67	32	53.33	16	26.66	73	41.1
			X^2value/p value				**12.64/ 0.05**	
(II) Do you select eggs before incubation								
Yes	44	73.33	48	80	42	70	134	74.4
No	16	26.66	12	20	18	30	46	25.6
		X^2value/p value				**1.64/**	**0.441**	
(III) Criteria of egg selection								
Size of the egg	5	11.36	2	4.17	3	7.14	10	7.5
Shape of egg	11	25	9	18.75	9	21.43	29	21.6
Cleanness egg	3	6.82	7	14.58	5	11.91	15	11.2
Absence of Cracks	25	56.82	30	62.5	25	59.52	80	59.7
		X^2value/p value				**7.48/0.278**		
(IV) Methods used for incubation and rearing of chickens								
By natural	58	96.66	56	93.3	60	100	174	96.7
By box Brooder	2	3.33	4	6.66	-	-	6	3.3
		X^2value/p value				**4.14/ 0.126**		
(V) Materials used during incubation								
Clay pot with straw	22	37.94	20	35.71	12	20	54	31.03
Mud container with straw	11	18.96	20	35.71	14	23.33	45	25.86
Wooden made with straw	4	6.89	11	19.64	2	3.33	17	9.77
Plastic material	9	15.52	3	5.36	6	10	18	10.34
Under holes with sand	12	20.68	2	3.57	26	43.33	40	22.98
		X^2value/p value				**5.7/ 0.000**		

In HL AEG the order was Clay pot with straw, Under holes with sand, Mud container with straw, Plastic material and Wooden made with straw (37.94, 20.68, 18.96, 15.52 and 6.89% farmers, respectively) whereas in ML order was Clay pot with straw, Mud container with straw, Wooden made with straw, Plastic material, Under holes with sand (35.71, 35.71, 19.64, 5.36, 3.57 respondents, respectively). Likewise in LL AEG the order of bedding material for incubation was under holes with sand, Mud container with straw, Clay pot with straw, plastic material (43.33, 23.33, 20.00 and 10.00% of respondents, respectively). These results indicated that farmers were using locally and easily available material for bedding during incubation of eggs.

Mearg, (2016) and Markos et al., (2014) was reported that clay pots with grasses (straw) bedding, ground with soil/sand/ash/cow dung/chopped grasses /straw/sand filled sack bedding, bin with grasses/straw/cotton seed/sand & feather of brooding hen/sack sand /clothes/cow dung and straw/ bedding, clothes bedding alternatively were used as egg setting materials in western zone of Tigray.

4.9. Constraints of Local Chicken Rearing System

The results of the farmer's rankings of constraints in poultry production (**Table 23**) showed that disease, predator and feed shortage were the major economically important constraints for the existing chicken rearing system in all agro-ecology. The indication values for disease, predator and feed shortage were 0.306, 0.391 and 0.303 in high-land; 0.346, 0.308 and 0.346 in mid-land; and 0.392, 0.300 and 0.308 in low-land AEGs, respectively. Majority of respondents ranked diseases as the first chicken rearing constraint in mid-land and low-lands but in high-land predators were ranked first constraint by the respondents.

Constraints were not different from those reported by others in Ethiopia such as Solomon, (2007) who reported that the main constraint of traditional chicken production system was disease. In other study Hassen, (2007) who reported that diseases and predators were the first and the second major factors that causes loss of chicken in Northwest Ethiopia. Addis, (2013) also identified as diseases was the first ranked chicken production constraint in Tach Armachiho and Quara district.

Table 23: The Major Constraints in Poultry ProductionAgro-ecologies

Variables	Highland				Midland				Lowland			
	R1	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**
Disease	30	21	9	0.306	20	25	10	0.346	15	18	27	0.392
Predator	10	29	21	0.391	25	25	10	0.308	23	12	18	0.30
Feed shortage	20	10	30	0.303	25	10	40	0.346	22	30	15	0.308

4.10. Reproductive Performance of Local Chicken

The least square mean of various production and reproduction traits (mean age at first service for cockerel in month, age at first egg laying of hen in month, number of clutch per year of local chicken, number of egg per clutch of local chicken, length of clutch in days for local chicken, total eggs per year of local chicken, interval between two consecutive broody periods, number of egg incubate for hatching per year and number of egg set to broody hen)of local chicken populations in the study area was presented in appendix Table 15and the means of these traits was presented in Table 24.

The age at first service of cockerels was 5.23, 5.22 and 5.20 months in HL. ML and LL AEGs, respectively. The differences among the AEGs were non-significant. Similarly the age at first laying of egg in hen were 5.92, 5.74, and 5.67 in HL, ML and LL AEGs, respectively. The differences among the three AEGs were significant ($p<0.001$). The pair wise comparison of means showed significant differences between HL-ML and HL-LL pairs.

This result was in line with the report of (Mearg, (2016) overall mean age at first mating of male chickens and the age at first egg of female chickens were 5.29 and 5.96 months in central Tigray And smaller than with the report of Bogale, (2008) in which mean age of sexual maturity of indigenous chicken in Fogera district was 23.48 ± 0.1 and 23.6 ± 0.11 weeks for male and female respectively.

The overall mean number of clutches per hen per year of local chicken ecotypes were $4.29\pm0.031$with 4.36 ± 0.05 in high-land, 4.27 ± 0.04 in mid-land and 4.26 ± 0.03 in low-land agro-ecology respectively. The mean showed that AEG had significant influence on mean number of clutches per hen per year ($p<0.023$). The differences between HL:-ML and HL-LL AEGs were significant.

This result was in line with the findings of Markos *et al.,* (2015) who reported that the overall mean number of clutches per hen per year of local chicken ecotypes in western zone of Tigray was 4.42 and Mearg, (2016) who reported that overall mean number of clutches per hen per year of local chicken ecotypes was 4.58 in central Tigray. The overall mean number of egg per clutch of local chicken were14.44 ± 0.12 with averages in high-land 14.71 ± 0.20, in mid-land 14.38 ± 0.25 and in low-land 14.23 ± 0.12 agro-ecology the mean showed that AEGs did not affect this trait.

Table 24: Management of Some Reproductive and Productive Performance of Local Hens Recalled by Respondents of the Study Areas (Mean ±SE)

	Agro ecology				P
Variable	**Highland**	**Midland**	**Lowland**	**over all**	**Value**
Age at 1st service for cockerel (month)	5.23±0.04	5.22±0.03	5.20±0.05	5.21±0.03	0.94
Age at 1st egg laying of hen (month)	5.92±0.04[a]	5.74±0.05[b]	5.67±0.06[b]	5.77±0.03	0.001
Number of clutch per year of local chicken	4.36±0.05[a]	4.27±0.04[b]	4.26±0.03[b]	4.29±0.02	0.023
Number of egg per clutch of local chicken	14.71±0.20	14.38±0.25	14.23±0.17	14.44 ±0.12	0.247
Length of clutch in days for local chicken	15.16±0.27[a]	14.40±0.24[ab]	13.71±0.23[b]	14.42±0.15	0.04
Total eggs per year of local chicken	63.18±0.81	62.21±0.99	60.08±1.04	61.82±0.55	0.060
Interval B/NTwo consecutive broody period	2.96±0.12	2.82±0.11	2.78±0.08	2.86±0.08	0.15
Times egg incubate for hatching per year	2.78±0.08	2.80±0.10	3.03±0.09	2.87±0.05	0.147
Average egg set to broody hen	13.58±0.16[a]	12.50±0.3ab	10.20±0.23[b]	12.09±0.17	0.000

The present result showed in (**Table 24**),a number of egg per clutch was smaller as compared with findings of Mearg, (2016) who reported 15.20eggs/clutch in central Tigray; Tadelle, (2003) who reported 17.7 eggs/ clutch in five agro-ecology zones of Ethiopia; and Bogale, (2008) reported 16.6eggs/clutch in Fogera district. However, present results were higher than those reported by Meseret, (2010) and Addisu *et al.,* (2013), in which the mean egg number laid per clutch per hen of local chickens in Gomma wereda and North Wollo Zone were 12.92 and 12.64, respectively.

The overall mean length of clutch in days for cycle of local chicken were 15.16±0.27, 14.40±0.24 and 13.71±0.23 days in high-land, mid-land and low-land areas, respectively. The overall mean length of clutch in days was 14.42 days. The mean showed that AEGs had significant ($P< 0.05$) influence on length of clutch in days for cycle. There was a significant difference between high-land- low-land AEGs.

The overall total number of eggs per year per hen in high-land, mid-land, low-land and overall average was 63.18±0.81, 62.21±0.99, 60.08±1.04 and 61.82±0.55 of eggs, respectively. The least square mean revealed that AEGs had non-significant effect on total number of eggs per year per hen. This result was nearly similar with reports of Fisseha *et al.*, (2010) and Mekonnen, (2007) who reported that the mean annual egg yield per hen of indigenous chickens in Bure district and Wonsho district were 60 eggs and 62.95 eggs.

The interval between two consecutive broody periods was not affected by AEGs. The mean interval between two consecutive broody periods was 2.96, 2.82, 2.78, 2.86 months in HL, ML, LL and overall, respectively, in the present study.The number of egg incubated for hatching per year was not affected by AEGs significantly. The mean number of egg incubated for hatching per year were 2.78±0.08, 2.80±0.10 and 3.03±0.09 in high-land, mid-land and low-land agro-ecology, respectively.

The number of eggs set to broody hen was influenced highly significant ($P < 0.0001$) by AEGs. The number of eggs set to broody hen were 13.58±0.16, 12.50±0.30, 10.20±0.23, and 12.09±0.17 in high-land, mid-land, low-land and overall mean, respectively. This result was higher than Mearg, (2016) who reported that the number of eggs incubated in midland and highland agro-ecologies were 11.4 and 11.4, respectively in central Tigray.

4.11. Breeding Practice of Local Chicken

The results on breeding practices were presented in Table 25. The study showed that breeding practices were followed by 71.7, 63.3% respondent farmers in HL and ML AEGs, respectively, whereas no breeding practice was followed in LL as per report of 51.66% respondents.The majority, more than 75%, of respondent farmers reported that both male and female birds were selected as future parents and the proportion of farmers exercising this selection were 90.00, 83.33, and 78.33% in HL, ML and LL, AEGs, respectively. Nigussie *et al*., (2010) reported that beside other quantitative traits, morphologic traits such as plumage color and comb type have significant economic values.

The mating system showed that mating was uncontrolled in majority of birds as stated by 88.3, 81.66, and 83.33% of respondents in HL, ML and LL AEGs, respectively.This result is nearly similar with Addisu *et al.,* (2013) who reported that about 10.79% of respondents

control mating system. But this result is not in line with the report of Nigussie, (2011) who reported that breeding is completely uncontrolled and replacement stock produced through natural incubation using broody hens in different parts of Ethiopia. The possible reason for high prevalence of uncontrolled mating might be described to scavenging nature village chicken management.

The respondents who allow controlled mating in their flock stated that control mating was made possible by (i) culling unproductive poultry, (ii) culling for unwanted colour, (iii) retaining best cock, The study further showed that retaining best cock and culling for unwanted colour methods were followed by more number of respondents (42.8, 42.8% respondents in HL; 57.14, 36.36% respondents in ML; and 50.0, 30.0% respondent in LL AEGs).Chickens that were not retained for breeding purposes were culled through sale (42.86, 54.6, 50.00% of respondents in HL, ML and LL AEGS, respectively); home Consumption (27.27, 28.57, 20.00% of respondents in HL, ML and LL AEGS, respectively); and sales & consumption (28.57, 18.2, 30.00% of respondents in HL, ML and LL AEGS, respectively).

This result was similar with thefindings of Addisu *et al.*, (2013) who reported that slaughtering (53.27%), selling (41.18%) and devour or sell eggs of unwanted hens (5.56%) were a major means of culling less productive chicken from the flock in North Gonder.

Table 25: Breeding Practice of Chicken in the Study Area

Variable	Agro ecology						Overall	
	Highland		Midland		Lowland			
	N	%	N	%	N	%	N	%
(I)Are Breeding Practice followed?								
Yes	43	71.7	38	63.3	29	48.33	110	61.1
No	17	28.3	22	36.7	31	51.66	70	38.9
				X^2value/p value			**7.1/0.029**	
(II) Is Selection of Breeding Male and Female birds practiced?								
Yes	54	90	50	83.33	47	78.33	151	83.9
No	6	10	10	16.66	13	21.66	29	16.1
				X^2value/ P value			**3.042 /0.219**	
(III) Mating System:								
Controlled	7	11.66	11	18.33	10	16.66	28	15.6
Uncontrolled	53	88.3	49	81.66	50	83.33	152	84.4
				X^2value/p value			**1.1/0.577**	
(IV) Techniques of Controlling Mating:								
Culling unproductive poultry	1	14.3	2	18.2	2	20.00	5	17.9
Culling for unwanted colour	3	42.8	4	36.36	3	30.0	10	35.70
Retaining best cock	3	42.8	5	57.14	5	50.0	13	46.4
				X^2value/p value			**0.29/ 0.990**	
(V) Disposal of Culled Birds:								
Home consumption	2	27.27	3	28.57	2	20.00	7	25
For sale	3	42.86	6	54.6	5	50.00	14	50
Sale and consumption	2	28.57	2	18.2	3	30.00	7	25
				X^2value/p value			**0.61/ 0.961**	

4.12. Farmer's Ranking of Selection Criteria

The farmer's ranking of selection criteria for selection of male and female birds as future parents was presented in Table 26. The results showed that respondent farmers ranked egg number & size, growth rate, plumage colour as first three criteria, in descending order, for selection of hens in HL (with indices values of 0.383, 0.134 and 0.097, respectively); egg number & size, growth ratem disease tolerance as first three criteria, in descending order, in ML (with indices values of 0.348, 0.190, 0.168, respectively); and egg number & size, plumage colour, growth rate as first three criteria, in descending order, in LL (with indices

values of 0.372, 0.153. 0.137, respectively). The egg number together with size was ranked as number of criteria for hen selection in all AEGs and this showed the importance egg number and egg size. The possible reason might be that higher number of eggs together with bigger size ensures more economic return to the farmer.

Perusal of table 26 showed that disease tolerance of cocks was number one selection criteria in all AEGs (with index values of 0.289, 0.314, and 0.274 in HL, ML and LL, respectively). However the AEGs showed differences in the next two selection criteria for cocks. In HL plunage colour, fertility, growth rate were number two, three and four cock selection criteria (Index values of 0.179, 0.159, 0.125, respectively); in ML plumage colour, growth rate, comb type were two, three and four cock selection criteria (index values of 0.189, 0.189, 0,131, respectively); and in LL growth rate, plumage colour, comb type were two, three, four cock selection criteria (0.279, 0.162, 0.127, respectively).

This result of Abdelqaderet*et al.,* (2007) also reported that the most important traits of farmers in Jordan were growth rate, disease tolerance, egg yield, body size and fertility, The present finding were comparable with reports of Adiss, (2014) and Mearg, (2016)

Table 26: Farmer's Ranking of Selection Criteria's For Hen and Cocks

Variables	Agro-ecologies											
	Highland				Midland				Lowland			
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I
(I) Hens												
Egg number & size	25	20	23	0.383	24	20	16	0.348	24	20	22	0.372
Growth rate	13	3	3	0.134	10	15	10	0.190	11	5	3	0.127
Hatchability	1	5	4	0.047	1	5	3	0.043	3	0	8	0.047
Mothering ability	2	6	4	0.062	2	0	4	0.027	2	2	6	0.044
Brooding	3	8	2	0.075	2	2	2	0.032	8	5	7	0.114
Disease Tolerance	2	7	10	0.084	7	13	15	0.168	4	4	3	0.063
Plumage colour	8	3	5	0.097	10	3	7	0.117	5	16	8	0.153
Good scavenging	5	2	4	0.063	2	2	3	0.035	3	5	1	0.056
Fighting ability	1	6	5	0.055	3	1	2	0.035	0	3	2	0.024
(II) Cocks												
Disease tolerance	8	28	25	0.289	23	13	18	0.314	12	18	25	0.274
Growth rate	6	7	13	0.125	15	10	3	0.189	20	17	5	0.279
Comb type	10	2	5	0.107	5	15	2	0.131	9	3	12	0.127
Fighting ability	7	5	2	0.092	3	6	4	0.069	1	5	9	0.062
Plumage colour	19	4	0	0.179	8	12	20	0.189	16	4	1	0.162
Fertility	7	12	13	0.159	4	4	10	0.083	0	7	7	0.059
Temperament	4	2	2	0.049	2	0	3	0.025	0	6	1	0.037

4.12.1 Farmer's Selection and Culling Practices

The result on selection and culling practices in the study areas was presented in Table 27. The study on ownership of breeding cock showed that 68.33, 63.33, 66.66 and 66.11% of respondent farmers were rearing their own breeding cocks in HL, Ml, LL AEGS and overall, respectively. This indicated that more than 50% farmers rear own breeding cocks and thus effective population size would be good translating in low inbreeding. The remaining proportions of respondents did not own breeding cock.

The results further showed that respondent farmers not owning their breeding cock managed breeding of their hens by either shared with neighbors or communal cock or purchased from market or purchased from extension agencies. However, majority of these respondents (47.37, 50.00, 50.00 and 49.2% in HL, ML, LL AEGs and overall, respectively) managed mating of hens by shared with neighbors cocks.

This result was in agreement with the report of Nigussie *et al.*, (2010) who reported that from 31% to 55.6% of the farmers of different regions of Ethiopia did not own breeding males. Most of them shared breeding males with neighbors.The study of types/breeds of poultry in the study areas showed that more than 70% of respondent farmers reared local type of chicks. The proportions of respondents rearing local chicken were 92.67, 73.7, and 85.00% in HL. ML. LL AEGs, respectively. A very small proportion of respondents reared chicks of exotic breeds (0.0, 5.26, and 4.00% in HL, ML and LL AEGs, respectively).

The present study revealed that culling was practiced by all (100%) respondents in all AEGs. The respondents stated a number of reasons for culling and these were old age, low production, unwanted plumage, sickness and bad temperament. Out of these reasons results showed, based on respondent farmers interview, that sickness was main reason for culling in HL and LL AEGs (35.00 and 31.66%, respectively) whereas unwanted plumage colour was main reason (31.67%) of culling in ML AEG.

The overall figures showed that proportion of respondents attributing culling to sickness, low production; unwanted plumage, bad temperament and old age were 29.4, 23.3, 22.2, 14.4 and 10.6%, respectively. This finding was in line with Mearg, (2016) who stated that in high-land andmid-land agro ecologies low production of chicken, old age, unwanted plumage color, sickness, bad temperament of hens and cocks and low hatchability were the main culling criteria.

Table 27: Farmers Selection and Culling Practices

Variables	Agro-ecologies							
	High-land		Mid-land		Low-land		Overall	
	N	%	N	%	N	%	N	%
(I) Ownership of Breeding Cock								
Rearing own cock	41	68.33	38	63.33	40	66.66	119	66.11
Not rear own cock	19	31.66	22	36.66	20	33.33	61	33.89
				X^2 value/ P value			**0.347/0.841**	
(II) Source of Breeding Cock of Farmers not Owning Cock								
Shared with Neigh-bours	9	47.37	11	50.00	10	50.00	30	49.2
Communal Cock	5	26.32	3	13.6	7	35.00	15	24.6
Purchased from Market	3	15.79	6	27.27	3	15.00	12	19.7
Purchased from Extension Agencies	2	10.52	2	9.09	-	-	4	6.6
				X^2 value/ P value			**4.99/ 0.55**	
(III) Breeds of the Poultry in study area								
Local Types	38	92.67	28	73.7	34	85.00	100	84.00
Exotic breeds	-	-	2	5.26	2	5	4.00	3.4
Crossbreds	3	7.32	8	21.1	4	10	15.0	12.6
				X^2 value/ P value			**6.24/0.18**	
(IV) Do You Practice culling								
Yes	60	100	60	100	60	100	180	100
(V) Reasons for culling								
Old age	3	5	5	8.33	11	18.33	19	10.6
Low production	15	25	17	28.3	10	16.66	42	23.3
Unwanted plumage	10	16.66	19	31.67	11	18.33	40	22.2
Sickness	21	35	13	21.66	19	31.66	53	29.4
Bad temperament	11	18.3	6	10	9	15	26	14.4
				X^2 value/ P value			**14.40 / 0.072**	

4.13. Effective Population Size and Coefficient of Inbreeding

The overall mean effective population size (Ne) and the rate of inbreeding (ΔF) calculated for the indigenous chicken flock of the study area was 3.55 and 0.14, respectively (**Table 28**). The effective population size (Ne) was 3.71, 3.65 and 3.29 in high-land, mid-land and low-land agro-ecologies of the study areas. The possible reasons for low Ne might be a low number of male and female birds in general but a very low number of males in particular. Low Ne directly affects coefficient of in breeding.

The rates of inbreeding coefficient (ΔF), in the free-range scavenging chicken population, estimated were 0.13, 0.14, and 0.15 in HL, ML and LL AEGs, respectively. The inbreeding coefficient was not significantly different across the three AEGs. The possible reason of high inbreeding might be ascribed to low effective population size.

The present result were higher in terms of inbreeding than the reports of Mearg , (2016); Feyera, (2016); and Getachew, (2014) who stated that Ne and inbreeding were 3.99 and 0.113 in central Tigray ; and 4.41 and 0.12 in Western Oromia; and 4.13 and 0.122 Southern Tigray, respectively. However the present estimates of inbreeding were lower that the estimates of 3.9 and 0.195 in Fogera district by Bogale, (2008); and 2.66 and 0.18 in Jimma zone and 3.37 and 0.15 in Bench-maij zone byHailemikael, (2013).

Table 28: Effective Population Size and Coefficient of Inbreeding in the Study Areas

Variable	Agro-ecologies			
	Highland	**Midland**	**Lowland**	**Overall**
Nm	1.17	1.21	0.98	1.12
Nf	4.50	5.05	5.12	4.89
Ne	3.71	3.65	3.29	3.55
ΔF	0.13	0.14	0.15	0.14

4.14. Phenotypic Characteristics of Local Chickens

The results on phenotypic (Morphological) characterization of local chicken in the study areas were presented in **Table 29** and **Figure 2**. The phenotypic characterization was studied in terms of feather distribution, plumage colour, beak colour, eye colour, comb shape, comb colour, head shape, earlobe colour, shank colour and shank feather. The results are discussed as under:

(a) Feather Distribution and Plumage Colour:

The results showed that local chicken were either normal feathered or necked neck. Out of these two feather distribution, normal feathering was more numerous as indicated by proportion of birds (70, 59.2, 53.8% for female birds and 30, 28.3, 25% for male birds in HL, ML and LL AEGs, respectively). The naked-neck genotype is characterized by featherless skin on the neck and on the breast part of the body Khobondo et al, (2015). Similarly, the

naked-neck traits found in indigenous chicken population of the tropics considered to have desirable effect on heat tolerances Horst, (1989). The results showed that the plumage colours were red, white, black, gebsima, Tetrima and multi-colour. Out of these colours, red plumage colour was more numerous in both male and female birds in HL (28.8, 20.2) female and male, in ML (29.6, 19.2) female and male and in LL (19.2, 17.9%) in female and male birds, respectively). In LL red plumage colour was more numerous in only male (17.9%) birds where as in female birds gebsima was more numerous (24.6%).

This result was comparable with Addis *et al*., (2014) who reported that chicken having red (26.9%) white (15.60 %), *gebsima*(greyish) (14.2%) and black (11.5%) plumage colour were predominately found in North Gonder. However, this result is not in line with Mearg, (2016) who reported that white (19.5%), black (11.33%), and black with white stripes (10.17%) and *dira* (red wheaten) were the most predominant colour type was reported.

(b) Eye Colourand Beak Colour:

The various eye colours exhibited by the local chicks were red, orange, brown and blue. The overall percentages of orange, red, brown and blue eye color of chicken in all AEGs were 39.3, 36.00, 22.50 and 1.90% in the present study. The results showed that orange eye colour was more numerous in females in the three AEGs (28.3, 32.5, 29.2% in HL, ML and LL AEGs, respectively); whereas in males red eye colour was more numerous in HL (13.8%) and LL (16.3%) AEGs. However orange eye colour was more numerous in ML (13.3%).

The study showed that local chicks showed white, yellow and brown beak colour. The white beak colour was more numerous in HL (33.3, 17.1% in female and male birds, respectively); in ML yellow was more numerous in females (27.5%) whereas white was more numerous in males (13.8%); in LL females had white beak colour in more birds (26.7%) and male had more yellow beak colour (11.7%). The results also showed that white, yellow and brown proportions were generally number one, two and three in descending order of proportions.

(c) Comb Shape and Colour:

Regarding comb types rose, pea and single comb types was observed in all AEGs. The rose comb type was predominant in all agro-ecologies followed by pea and single. The overall average proportion of rose, pea and single combs were 52.78%, 30.97% and 16.25% in

present study. The comb colours observed in the studied population were red, brown and black. The dominant comb color was red 95.69% (Overall proportions) whereas the remaining 2.77% and 1.54% proportion (Overall) of studied birds had brown and black comb colors, respectively. The red comb colour was more numerous in all AEGs. This result was similar with Mearg, (2016) who reports that commonest comb color observed was red (hens 95%, cocks 97%), whereas the remaining 5% of hens and 3% of cocks showed brown and black colors in Centeral Tigray.

(d) Head Shape and Earlobe Colour:

The study of head shapes showed that local chicken had either plain or crest head shape. Out of these two shapes, the plain head shapes was more common in both sexes in all AEGs (40.00, 20.40% in female and male in HL; 36.30, 20.80% in females and males in ML; 50.00, 23.8% in female and males in LL AEGs). The overall mean values of head shapes were 63.75% plain head and 36.25% crest. This result agreed with Emebet, (2014) who reported 72.8% and 27.2% were plain and crest headed shape in Southwest Oromia and Gurage zone.

The earlobe colours found in the studied populations were either white or red or mixture of red + white olours. The overall proportion of earlobe colour showed that 36.30, 32.20 and 31.50% of birds had mixture of red+white, red and white colours. This result was more or less comparable to those of Eskindir, (2013) who reported that red and white earlobes showed 41.4% and 49.5% in Horro and Jarso ecotypes, respectively and also close to the reports of Bogale (2008) for Fogera chicken.

(e) Shank Colour and Feather:

Most of the indigenous chickens evaluated in scavenging management systems in the study area showed white (45.97%), yellow (33.6%), brown (17.08%), red (2.36%) and black (0.97%) shank colour (Overall proportions) were exhibited by these birds. This result was comparable with the findings of Mearg, (2016) who reported that yellow shank colour (41.17 %) was dominant over white (19.83 %) and black (15.5 %) shank colours in Centeral Tigray. And similarly, a study conducted in districts of North West Ethiopia also revealed that most indigenous chickens had yellow, white, red, black and grey shank colours by Halima et al., (2007).The results on presence / absence of shank feathers showed that all studied chickens in

mid-land and low-land agro-ecology were not having shank feather whereas only 2.5% hen and1.67% cock had shank feather in HL AEG in the present study.

Table 29: Phenotypic (Morphological) Characterization ofLocal Chicken in the Study Areas

Variables	Agro-ecologies						Over-all Mean
	Highland		Midland		Lowland		
	Fe-male	Male	Fe-male	Male	Fe male	Male	
	%	%	%	%	%	%	%
(I) Feather distribution							
Normal	70	30	59.2	28.3	53.8	25	88.8
Necked-Neck	-	-	10.8	1.7	16.3	5	11.2
			X^2 value/ P value			**5.4 / 0.00**	
(II) Plumage colour							
Red	28.8	20.2	29.6	19.2	16.2	17.9	43.2
White	3.3	1.7	5	1.3	2.9	0.4	4.9
Black	3.8	0.4	3.3	0.4	4.2	-	4
Gebsima	16.3	6.3	17.3	2.5	24.6	7.5	26.5
Tetrima	9.2	4.6	7.1	2.9	14.6	3.3	13.9
Multi-colour	8.8	0.4	7.9	-	4.6	0.8	7.5
			X^2 value/ P value			**4.46/ 0.00**	
(III) Eye colour							
Red	24.6	13.8	20	10.4	23.3	16.3	36.00
Orange	28.3	7.1	32.5	13.3	29.2	7.9	39.30
Brown	15.4	8.8	14.6	5.4	17.5	5.8	22.50
Blue	1.7	0.4	2.9	0.8	-	-	1.90
			X^2 value/ P value			**6.89 / 0.000**	

Variables	Agro-ecologies						Over-all Mean
	Highland		Midland		Lowland		
	Fe-male	Male	Fe-male	Male	Fe male	Male	
	%	%	%	%	%	%	%
(IV) Beak colour							
White	33.3	17.1	26.7	13.8	26.7	10.8	42.8
Yellow	27.9	8.3	27.5	11.7	25.8	11.7	37.6
Brown	8.8	4.6	15.8	4.6	17.5	7.5	19.6
			X^2 value/ P value			**3.5/ 0.000**	
(V) Comb shape							
Rose	34.2	18.3	40.4	20.8	27.5	17.08	52.8
Pea	24.2	10	20.8	7.1	22.1	8.8	30.9
Single	11.7	1.7	8.8	2.1	20.4	4.2	16.3
			X^2 value/ P value			**8.61 / 0.000**	

Table 29 (Continued)

Variables	Highland		Agro-ecologies		Lowland		Over-all Mean
	Female	Male	Fe-male	Male	Fe-male	Male	
	%	%	%	%	%	%	%
(VI) Comb colour							
Red	67	29.2	67.1	28.3	65	28.8	95.7
Brown	1.3	-	1.3	1.67	3.3	0.8	2.8
Black	1.7	0.8	-	-	1.7	0.4	1.6
			X^2 value/ P value			**8.61/ 0.07**	
(VII) Head shape							
Plain	40	20.4	36.3	20.8	50	23.8	63.75
Crest	30	9.6	33.8	9.2	20	6.3	36.25
			X^2 value/ P value			**16.43 / 0.000**	
(VIII) Earlobe colour							
White	15.42	14.6	20	15	15.8	13.8	31.5
Red	25.83	3.3	24.6	5.8	30.8	6.3	32.2
White & Red	28.8	12.1	25.4	9.2	23.3	10	36.3
			X^2 value/ P value			**15.2 / 0.000**	
(IX) Shank colour							
Yellow	27.5	6.3	23.3	6.7	24.6	12.5	33.6
White	25.8	17.1	30.8	20	31.7	12.5	45.9
Brown	13.8	4.6	12.1	2.1	13.8	5	17.1
Red	2.9	1.3	2.5	0.4	-	-	2.4
Black	-	0.8	1.3	0.8	-	-	0.9
			X^2 value/ P value			**4.11 / 0.000**	
(X) Shank feather							
Absence	67.5	28.3	70	30	70	30	98.6
Presence	2.5	1.7	-	-	-	-	1.4
			X^2 value/ P value			**2.8 / 0.000**	

White Plumage, single comb, yellow eye colour, and brown beak colour

Red Plumage, pea comb, white/some red ear lobe, red eye colour

Multi-colour plumage, rose comb, yellow beak, red earlobe

Red plumage, white & red earlobe colour, yellow beak crest head shape

Black with some red plumage black beak colour and plain head shape

Gebsima plumage colour necked- neck

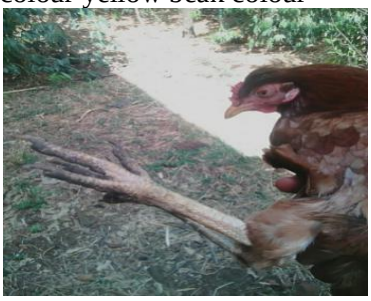
Tetrima (white with black) plumage and black eye colour

Multi-plumage, black eye colour and Rose comp

red plumage, white earlobe colour yellow beak colour

Brown shank colour

Red shank colour



White shank colour

Figure 2: Phenotypic Variation of Indigenous Chicken.

(*Remaining descriptions are shown in appendix at the end.*)

4.15. Characterizations of Quantitative Traits

The quantitative traits studied were Bwt (Body weight), Bl (Body length), Cl (Comb length), Cw (Comb width), Ww (Wattle width), Ws (Wing span), Bel (beak length), Wl(Wattle length), Cc (Chest circumference), El (Ear lope length), Sl (Shank length), Sc (Shank circumference), Nl (Neck length), and Wil (wing length) in the present study. The least square ANOVA for AEGS, sex and interaction between sex X AEGS was presented in **appendix table 1-14** and the least square means of these traits was presented **Table 30**.

The overall means of Bwt, Bl, Cl, Cw, Ww, Ws, Be, Wl, Cc, El, Sl, Sc, Nl, and Wil were: 1.59±0.02kg, 35.55±0.06, 2.29±0.02, 2.26±0.02, 2.24±0.0.03, 37.32±0.07, 2.25±0.03, 2.17±0.09, 26.87±0.06, 1.76±0.04, 9.26±0.05, 3.46±0.02, 11.85±0.04 and 12.25±0.06 respectively. The coefficient of variations (%) for Bwt, Bl), Cl, Cw, Ww, Ws, Be, Wl, Cc, El, Sl, Sc, Nl, and Wil were 2.45, 4.38, 9.79, 9.53, 12.49, 4.25, 3.95, 5.23, 5.36, 2.29, 7.39, 6.73 and 11.27, respectively.

(a)Agro-ecology Effect:

The least square mean showed that AEGs significantly (P<0.05) influenced all quantitative traits studied except **Bl, Cl, Ww, Bel, Wl and El.** The least square mean values of body weight, wing length, shank length, shank circumference, and chest circumference, were significantly (p<0.05) maximum in mid-land chicken but wing span and neck length were higher in low-land.

(b) Sex Effect:

The least square mean showed that sex significantly (P<0.05) influenced all quantitative traits studied except**Ww,Scand Bel.** The results showed that there was wide variation in these quantitative traits between two sexes.The average measurement parameters of female and male indigenous chickens were 1.51kg & 1.78kg for body weight, 35.26 cm & 36.23 cm for body length, 2.08cm & 2.82cm for comb length, 9.007 & 9.86 for shank length, 3.44 & 3.49 for shank circumference, 11.65 & 12.34 for neck length, 11.99 & 12.84 for wing length, 36.96 & 38.16 for wing span, 2.05 & 2.44 for wattle length and 26.59 & 27.53 for chest circumference in female and male local chickens, respectively.

The sex differences in live weight and most of the LBMs, observed in this study, showed that these parameters are sex dependent. The cocks had consistently higher

measurement value than hens across all the significantly affected variables except some variables, that was not significant ($p<0.05$).

The possible reason for higher values of studied quantitative traits in males (Cocks) might be ascribed to the effect of sex hormones, stress on hens during egg formation/ laying and brooding time (which reduce period spent on feeding/ scavenging). The present results were in good agreement with the report of Halima *et al*., (2007); Aberra and Tegene (2011); and Adiss, (2013) who stated that male chickens had better performance than females. These differences was also agreement with Eskindir *et al.,* (2013) in Jarso and Horro; Bogale, (2008) in Fogera; Halima, (2007) in Northwest Ethiopia; and Addisu, (2013); from North Gonder who reported that differences between sexes may be due to the differential effects of androgens and estrogens hormones on growth.

(c) Interaction Effect:

There was no significant ($P<0.05$) interaction observed between agro-ecologies and sexes with respect to quantitative traits studied except for **comb length and wattle length**.In these traits higher measurements were mostly observed in mid-land and low-land as compare to high-land. The significant interaction between agro-ecology and sexes with respect to these morphmetric traits might be due to the differences between the three agro-ecologies with respect to the degree of expression of sex dimorphism for the traits.

Table 30: Least Square Means for Body Weight (kg) and Body Measurements (cm) of Local Chickens

Effect	Traits				
	Bwt (kg)	**Bl (cm)**	**Cl (cm)**	**Cw (cm)**	**Ww (cm)**
Overall	1.59±0.02	35.55±0.06	2.29±0.02	2.26±0.02	2.24±0.02
R^2	0.18	0.08	0.67	0.64	0.52
Cv%	2.45	4.38	9.79	9.53	12.49
Agro-ecology	*	ns	ns	*	ns
Highland	1.48±0.01b	35.77 ± 0.14	2.46±0.04	2.42±0.01a	2.38±0.02a
Midland	1.75±0.02a	35.84 ± 0.13	2.44 ± 0.049	2.39±0.01a	2.06 ± 0 .2b
Lowland	1.71 ± 0.02a	35.62 ± 0.12	2.39±0.04	2.28±0.01b	2±0.02b
SEX	*	*	*	*	ns
Female	1.51±0.02[b]	35.26±0.07[b]	2.08±0.02[b]	2.06±0.01[b]	2.06±0.09
Male	1.78±0.02[a]	36.24±0.12[a]	2.78±0.02[a]	2.45±0.02[a]	2.73±0.02
Sex*AEGs interaction	ns	ns	**	ns	ns
HL x Female	1.36±0.02	35.24±0.12	2.06±0.01	2.06±0.02	2.23±0.02
HL x male	1.68±0.03	36.23±0.17	2.87±0.03	2.49±0.03	2.42±0.002
ML x Female	1.59±0.03	35.27±0.12	2.17±0.02	2.08±0.02	2.15±0.023
ML x male	1.85±0.04	36.27±0.17	2.71±0.03	2.46±0.03	2.58±0.03
LL x Female	1.61±0.03	35.26±0.13	2.05±0.02	2.05±0.02	1.9±0.01
LL x male	1.82±0.04	36.25±0.17	2.75±0.03	2.41±0.03	2.4±0.02

Effect	Traits				
	Ws	**Bel**	**Wl**	**Cc**	**El**
Overall	37.32±0.07	2.25±0.03	2.17±0.09	26.87 ± 0.06	1.76±0.04
R^2	0.19	0.02	0.52	0.12	0.12
CV (%)	4.25	3.95	5.23	5.36	2.29
Agro ecology	*	ns	ns	*	ns
Highland	36.85±0.1[b]	2 .24±0.02	2.29±0.02	26.75±0.09b	1.84±0.02
Midland	37.89±0.02[a]	2.25±0.02	2.25±0.01	27.27±0.07a	1.82 ± 0.02
Lowland	37.94 ±0.01a	2.24±0.04	2.19±0.01	27.15±0.06ab	1.85±0.02
Sex	*	ns	*	*	*
Female	36.96±0.1b	2.24±0.01	2.05±0.08b	26.59±0.06b	1.68±0.06b
Male	38. 26 ± 0.01a	2.25±0.02	2.44±0.01a	27.53±0.09a	1.96±0.02a
Sex*AEGs interaction	ns	ns	*	ns	ns
HL x Female	36.13±0.12	2.24±0.02	2.1±0.01	26.12±0.10	1.70±0.03
HL x male	37.59±0.18	2.24±0.01	2.5±0.02	27.38±0.16	1.98±0.04
ML x Female	37.31±0.17	2.25±0.02	2.03±0.01	26.81±0.11	1.66±0.03
ML x male	38.47±0.19	2.25±0.02	2.5±0.02	27.74±0.17	1.89±0.04
LL x Female	37.64±0.18	2.24±0.01	2.02±0.01	26.83±0.11	1.68±0.03
LL x male	38.43±0.19	2.25±0.02	2.4±0.02	27.47±0.16	2.10±0.04

Table 30 (Continued)

Effect	Trait			
	Sl	Sc	Nl	Wil
Overall	9.26±0.05	3.46±0.02	11.85±0.04	12.25±0.06
R^2	0.16	0.14	0.28	0.15
CV (%)	12.66	7.39	6.73	11.27
Agro-ecology	*	*	*	*
Highland	9.02±0.02b	3.47±0.05ab	11.71±0.02b	11.96±0.02*b*
Midland	9.61±0.03a	3.62±0.05a	12.07 ± 0.03*ab*	12.94±0.03a
Lowland	9.59±0.03a	3.29±0.05b	12.12±0.03a	12.36±0.04ab
Sex	*	ns	*	*
Female	9.10±0.05b	3.44±0.01	11.65±0.04 7b	11.99±0.06b
Male	9.95±0.08*a*	3.65±0.016	12.34±0.07a	12.64±0.09a
Sex*AEGs interaction	ns	ns	ns	ns
HL x female	8.88±0.08	3.45±0.014	11.26±0.08	11.86±0.11
HL x male	9.89±0.11	3.63±0.02	12.16±0.13	12.44±0.14
ML x female	9.17±0.09	3.62±0.032	11.71±0.09	12.20±0.12
ML x male	10.1±80.14	3.74±0.03	12.42±0.015	13.14±0.16
LL x female	9.33±0.09	3.29±0.014	11.96±0.09	12.03±0.12
LL x male	9.98±0.11	3.68±0.02	12.46±0.014	12.68±0.15

When, (*) shows significant and (ns) shows no significant.

4.16. Correlation between Body Weight and LBMs

The Pearson's correlation coefficient between body weight and linear body measurements for male and female were calculated and presented in Table 31. The presence of strong correlation coefficients recorded between body weight and some of the linear body measurement, suggested that either of these LBMs variables or their combination could provide a good estimate for predicting body weight of indigenous chicken found in the study area. The Body weight had positive and significant ($P<0.05$) correlation with all continuous traits of both male and female indigenous chicken except Bel, Ww and El.

In this study, strong, Positive and significant correlation between body weight and Chest-Circumference, Wing span, Shank Length, Body Length, Neck Length And Wing Length suggested that this variables could provide a good estimate in predicting live body weight for the population in both sex for bloyler chicken. Even if different correlated coefficient value of traits with body weight was observed, the way estimation of body weight of chickens in the present study is similar to those reported by earlier workers (Gueye et al., (1998); Yang et al., (2006); Yakubu et al., (2009); and Melaku, (2016)).

Table 31:Correlation Coefficient of Body Weight and Body Measurements of Local Chicken

(Above diagonal for male and below diagonal for female

	Ws	Bel	Wl	Cc	Sl	Wbt	El	Bl	Cl	Cw	Nl	Wil	Ww	Sc
Ws		0.07^{ns}	0.28**	0.79**	0.81**	0.83**	0.13*	0.65**	0.32**	0.36**	0.78**	0.76**	0.005^{ns}	0.08*
Bel	0.06^{ns}		0.04^{ns}	0.06^{ns}	0.08*	0.06ns	-0.01^{ns}	0.10*	0.02ns	0.03^{ns}	0.05^{ns}	0.06^{ns}	0.04^{ns}	0.02^{ns}
Wl	0.28**	0.04^{ns}		0.28**	0.29**	0.25**	0.11*	0.29**	0.72**	0.76**	0.25**	0.25**	0.03^{ns}	0.12*
Cc	0.79**	0.07^{ns}	0.28**		0.89**	0.94**	0.09*	0.81**	0.31**	0.34**	0.86**	0.84**	0.02^{ns}	0.12*
Sl	0.81**	0.08*	0.29**	0.89**		0.92**	0.13*	0.77**	0.32**	0.35**	0.83**	0.83**	0.02^{ns}	0.13*
Wbt	0.83**	0.07^{ns}	0.25**	0.93**	0.92**		0.11*	0.84**	0.29**	0.32**	0.89**	0.88**	0.006^{ns}	0.11*
El	0.13*	-0.01^{ns}	0.11*	0.09*	0.13*	0.11*		0.11*	0.12*	0.12*	0.13*	0.14*	-0.04^{ns}	0.02^{ns}
Bl	0.65**	0.10*	0.29**	0.81**	0.77**	0.84**	0.11*		0.25**	0.31**	0.76**	0.73**	0.04^{ns}	0.09*
Cl	0.32**	0.02^{ns}	0.72**	0.31**	0.32**	0.28**	0.12*	0.25**		0.90**	0.29**	0.28**	0.02^{ns}	0.16**
Cw	0.36*	0.03^{ns}	0.76**	0.34**	0.35**	0.33**	0.12*	0.31**	0.90**		0.33**	0.32**	0.01^{ns}	0.12*
Nl	0.77**	0.05^{ns}	0.25**	0.86**	0.83**	0.89**	0.13*	0.76**	0.29**	0.33**		0.79**	-0.02^{ns}	0.09*
Wil	0.76**	0.06^{ns}	0.25**	0.84**	0.83**	0.88**	0.14*	0.73**	0.28**	0.32**	0.79**		0.02^{ns}	0.15**
Ww	0.005^{ns}	0.04^{ns}	0.03ns	0.02^{ns}	0.02^{ns}	0.01^{ns}	-0.04^{ns}	0.04^{ns}	0.02ns	0.01^{ns}	0.02^{ns}	0.02^{ns}		0.16**
Sc	0.08^{ns}	0.02^{ns}	0.12*	0.13^{ns}	0.13*	0.11*	0.02^{ns}	0.09*	0.16**	0.13*	0.09*	0.15**	0.16**	

When (**) shows about highly significant (correlated), (*) shows significant (correlated) and (ns) shows no significant (correlated) difference. Traits of wing span, beak length, wattle length, chest circumference, shank length, Earlobe length, body length, comb length, comb width, neck length, wing length, wattle width and shank circumference.

4.16.1. Multivariate Analysis

Multivariate analysis was conducted using quantitative variables for mature female and male indigenous chicken. Among the multivariate analyses, Principal component analysis (PCA), step-wise discriminate analyses and cluster component analysis were conducted.

The variables selected to describe the mature male and female chicken included continuous variables like body weights, wing span, beak length, comb length, comb width, wattle length, body length, chest circumference, shank length, shank circumference, wing length, neck length, earlobe length and wattle width.

General liner model (GLM) results from each groups at class level for different variables were significantly different ($P<0.05$) such as some variables showed variations from one group and also some from the others. But discriminate analysis model was reduced confused variations and the sampled populations were made available from its average accuracy rate or were predicted the known group memberships in the categories of dependent variables.

4.16.2. Principal Component Analysis (PCA) of Quantitative Traits of Local Chicken

In the current study can carried out Principal component analysis (PCA) a total of 14 variables for individuals' chickens were used with the weighting method of standardization. Four principal components' (PC) were extracted that accounted for 61.19 % of the total variation (**table 32,Figure 3 and Appendix Table 16).** The Principal component (PC) accounted of the variance in the 14 variables were; (PC1=34.104%, PC2 =11.416%, PC3 = 7.975%, PC4 = 7.701%.

Table 32: Eigen Values, Proportion of Variability and Cumulative Variability Explained by the First Four Principal Components.

	Initial Eigen values		
Components	Total	% of Variance	Cumulative %
1	4.78	34.104	34.104
2	1.59	11.416	45.520
3	1.12	7.975	53.496
4	1.08	7.701	61.196

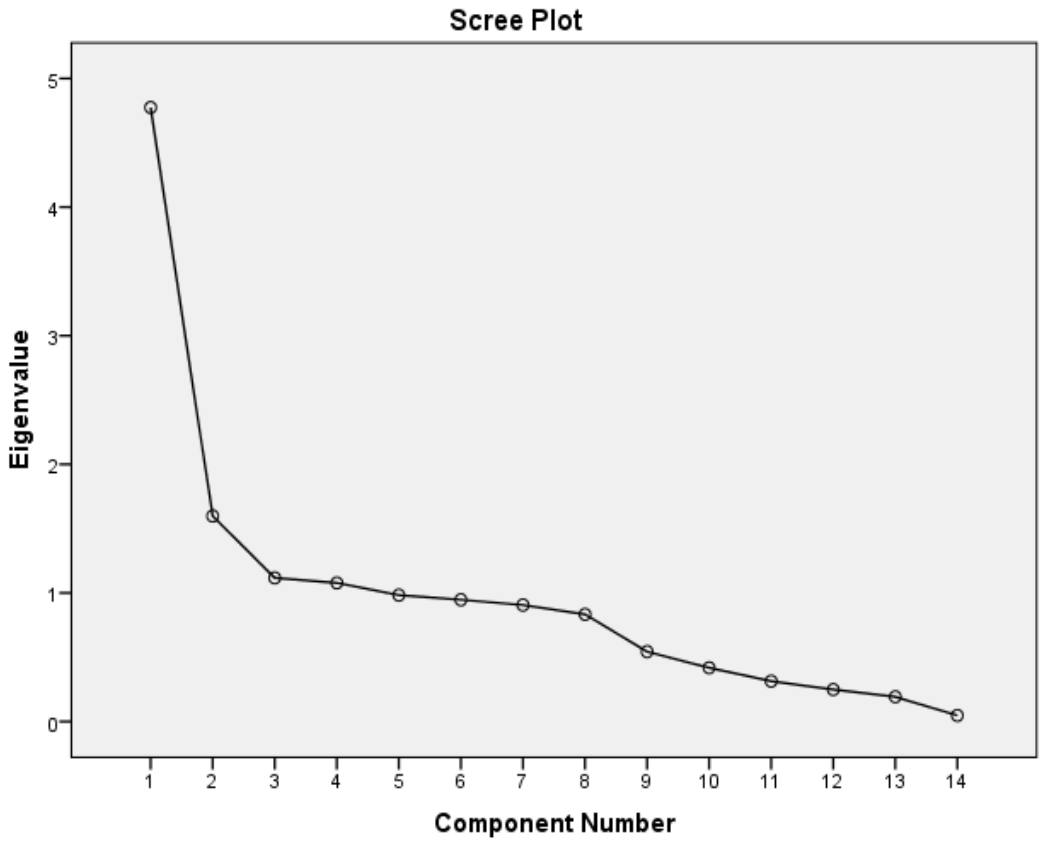


Figure 3: Scree Plot of Eigen Value to Component Number.

Bellow Table 33 shows the correlation between the original traits and the first principal components all are positive traits. Principal component one (pc1) was most strongly influenced by body weight (0.873), shank length (0.857), wing span (0.804), body length (0.733) and chest circumference (0.731)were respectively correlated. Principal component 2(pc2) was most strongly associated with comb width (0.577), comb length (0.571) and wattle length (0.561). Principal component 3 (pc3) was closely related to wattle width (0.720) and shank circumference (0.585). And principal component 4 (pc4) was highly related with beak length (0.764) and nick length (0.390) was correlated better than the others in each component respectively.

Table 33: Correlation between Principal Component Analysis and Qualitative Traits of Chicken

	Component or Eigen vector			
Traits	**1**	**2**	**3**	**4**
Ws	0.804	-0.396	-0.092	-0.012
Bel	0.083	0.021	-0.083	0.764
Wl	0.661	0.561	-0.054	- 0.023
Cc	0.731	- 0.191	0.122	0.038
Sl	0.857	-0.305	0.090	-0.026
Bwt	0.873	-0.362	-0.054	-0.041
El	0.193	0.023	-0.055	-0.394
Bl	0.733	-0.362	-0.029	0.061
Cl	0.529	0.571	-0.160	-0.001
Cw	0.525	0.577	-0.152	-0.010
Nl	0.246	- 0.064	- 0.033	0.390
Wil	0.189	- 0.015	0.397	- 0.281
Ww	0.033	0.113	0.720	0.301
Sc	0.281	0.197	0.585	-0.098

Note: BWT was in Kg and the others in cm

4.16.3. Step-wise Discriminate Analysis

Step-wise discriminate analysis were measures the potentially of the overall relationship between the linear composite of the predictor set of variables Minitab, (1998). Step-wise discriminant functions evaluated group means to discriminant distributions and graphic representations of the homogeneity of the local chicken ecotypes and were normally distributed from centroids of their Multi-variations. Step-wise discriminate analysis serves to identify variables that play significant role for clustering different group of chicken populations Ogah et al., (2011). The step-wise discriminate analysis for variables of indigenous chicken illustration population (**Table 34**) have sorted out the traits in the order of their contribution of separation. Step-wise selection indicates that all the variables in the data set are found to have highly significant ($P< 0.05$) discriminatory power. As a result chest-circumference, shank length and wing length were the most important traits to cluster the sampled home-grown chicken populations for dependent of body weight.

Most important variable for discriminating the chickens were ordered and those traits among the populations were chest-circumference shank length and wing length with the partial discrete R^2 value of 0.875, 0.039 and 0.0137, respectively. These results were showed that similar to melaku, (2016) in south Wollo. Other dissimilar report showed that

body weight, body width and body height was discriminating traits for chicken population Al-Atiyat, (2009): Rosario *et al*., (2008).

Table 34: Multivariate Tests and Summary of Discriminant Stepwise Selection among the Three Districts.

Step	Traits	partialR^2	Wilks'Lambda	Fstatistics	Significant
1.	Chest circumference	0.875	0.875	50.25	<.0001
2.	Shank length	0.039	0.9139	32.46	<.0001
3.	Wing length	0.0137	0.9277	13.58	<.0001
4.	Body length	0.0086	0.9362	9.6	<.0001
5.	Neck length	0.0058	0.942	7.17	<.0001
6.	Wing span	0.002	0.944	2.49	<.0001
7.	Wattle length	0.0017	0.9457	2.19	<.0001

4.16.4. Cluster Analysis

The Mahalanobis distance was the parallel coefficient used to develop the classification tree from which preferred number of clusters was obtained. The dendrogram shows three distinct groups (cluster) of chicken populations (**Table 35 and Figure 4**) these are blue, green and red colour in figure 4. In all-purpose, Minitab, (1998) a cluster with a high similarity percentage is more compact than one with a small similarity percentage. In the current study, the pair-wise squared Mahalanobis' distances between populations' shows smallest and largest distances between high-land, mid-land and low-land chicken ecotypes, respectively **(Table 35 and Fig.4)**.

Table 35: Squared distance between clusters centroids (Mahalanobis distance)

Cluster	Cluster1	Cluster2	Cluster3
Cluster 1	**	5.684	20.448
Cluster 2	5.684	**	19.853
Cluster 3	20.448	19.853	**

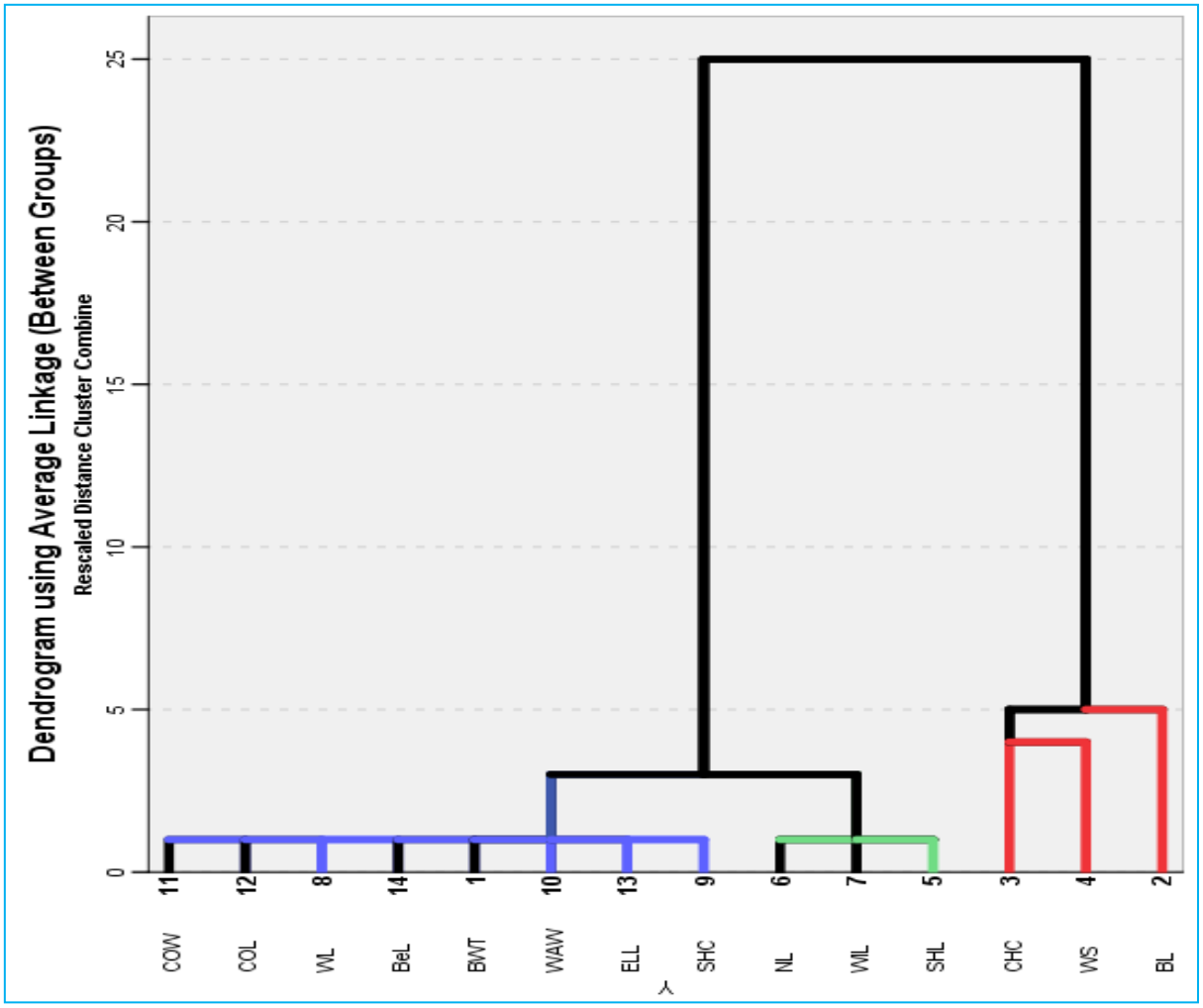


Figure 4: Clustering of Chicken in High-land, Mid-land and Low-land AEGs by Using Dendrogram.

Include Number: 1,2,3,4,5,6,7,8,9,10,11,12,13 and 14. Represents, Bwt, Bl, Cc, Ws, Sl, Nl, Wil, Ww, Sc, Cw, Cl, El and Bel. The arrangement of three large groups seen in table 35 and Figure 4 showed that the distribution of the populations influence by agro-ecology. Therefore, the current result of the study was in agreement with findings of Mearg, (2016) in Centeral Tigray for midland & highland and Tunon*et al., (*1989) who reported that classification of populations should take into account not only the genetic aspect, but also the ecological, morphological and productive aspects.

5. SUMMERY

In Ethiopia, the agricultural sector is a corner stone of the economic and social life of the people since they are used for generation of extra cash incomes, provision of animal protein and religious/cultural considerations. Understanding the situation of poultry rearing was crucial for improvement of poultry products and to design poultry breeding strategy. However, the existing knowledge on characterization of farm animal genetic resources showed information on breed level characterization is insufficient. The present study was therefore conducted to describe the existing chicken breeding practice and their management system, identify, characterize and describe the phenotypic variation in indigenous chicken populations.

The chicken rearing system in the study area was generally characterized by uncontrolled mating with scavenging production system that is free movement of birds. Natural broody hens were the key means of chicken replacement system of the population in the study districts and the average numbers of eggs incubated per hen were 13.58, 12.50 and 10.20 in high-land, mid-land and low-land areas, respectively. In the study area about 97.2% of the respondents stated prevalence of dangerous disease outbreak (NCD locally called as "**wotetie**") and other unknown disease in high-land, mid-land and low-land agro-ecologies of the study area. Out of the total participants, only 4.4% reported of getting veterinary advisory services. There is a need for a serious intervention in disease control and advisory services in order to minimize losses. Predators were also identified to be one of the most economically important problems in all studied districts.

Phenotypic characterization and multivariate analysis helped to describing the general uniqueness of the indigenous chicken populations. Body weight of adult males and females were varied among the studied agro-ecologies. In which adult males were significantly heavier compared with adult females in all study agro-ecology. And also variation for linear body measurements body length, wingspan, chest circumference, neck length, wing length, comb length, shank length and shank circumference in the study area.

6. CONCLUSION AND RECOMMENDATION

6.1. Conclusions

Generally chicken rearing system in the study area was mixed with crop- livestock production system using traditional management of indigenous chickens in the study area. The presences of various predators and diseases prevalence were two major economic important of chicken rearing constraints. There is diversity of indigenous chicken population and farmers' preference for specific traits that may invite to design community based genetic improvement. The study also showed that wide variations among the traits considered among the indigenous chickens in the study area. The study reveals phenotypic variability which is affected by both genetic and environmental factors.

6.2. Recommendation

i. Creation of adequate awareness should be carried out about chicken management system for the improvement of chicken products.

ii. Poultry breeding policy which focused on selection and trait preference should be designed.

iii. Government, research and developmental organizations should give attention to village poultry sector and its development.

iv. Government should train community chicken vaccinators to provide wide spread vaccination against major poultry diseases.

v. The finding of this study showed that there are varied indigenous chicken ecotypes in phenotypic characterization but there is not enough phenotypic characterization for indigenous chicken, Therefore studies on phenotypic characterization including egg quantity/quality together with molecular characterization need to be planned that will further clarify the genetic similarity and diversity among the ecotypes.

7. REFERENCES

Abdelqader, A., Wollny, C.B.A. and 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), 155-164.

Aberra, M. and Tegene, N., 2011.Phenotypic and morphological characterization of indigenous chicken populations in southern region of Ethiopia. Animal Genetic Resources/Resources génétiques animales/Recursosgeneticosanimales, 49, 19-31.

Addisu H., 2012. Phenotypic Characterization of Indigenous Chicken Ecotypes in NorthWollo Amhara Regional State.MSc Thesis, Wollo University, Wollo, Ethiopia.

Addisu, G. and Aschalew, T., 2014. A Phenotypic and Genetic Characterized Indigenous Chicken Ecotypes in Ethiopia. International Journal of Genetics, 4(1), 04-10.

Agegnehu, S., Getachew, A., Desalegn, Y., Adgo, E., Tewodros, Y., Germer, J., Asch, F., Merene, Y. And Freyer, B., 2014. Exploratory survey on climate change effects, value chain processes and supportive services: case study from potato based farming system of Awi-Zone, Ethiopia. IJAIR, 2; 19-73.

Aila, F.O., Oima, D., Ochieng, I., and Odera, O. 2012. Bio-security factors informing consumer preferences for indigenous chicken. Business and Management Review 1(2): 60-71.

Aklilu, H.A., Almekinders, C.J.M., Udo, H.M.J. and 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),; 15-17.

Al-Atiyat, R., 2009. Diversity of chicken populations in Jordan determined using discriminate analysis of performance traits. Int. J. Agric. Biol, 11; 374-380.

Alem, A.T., Yayneshet, G.T. and Aklilu, A.H., 2014. Socio-economic characteristics of poultry production in lowland and midland agro-ecological zones of central Tigray, Ethiopia. International Journal of Livestock Production, 5(4); 71-80.

Alemayehu A., Yilma T.,Shibeshi Z.,Workineh T. and Tesfaye D.(2013).Village chicken production in Benishangul Gumuz. Results of Livestock Research 2013.

Apuno, A.A., Mbap, S.T. and Ibrahim, T., 2011.Characterization of local chickens (Gallus gallusdomesticus) in Shelleng and song local government areas of Adamawa State, Nigeria. Agriculture and Biology Journal of North America, 2(1), pp.6-14.

Ayalew, W., Rege, J.E.O., Getahen, E., Tibbo, M., and Mamo, Y. 2004. Current state ofknowledge on characterization of farm animal genetic resources in Ethiopia. InProceedings of the 11th Annual Conference of the Ethiopian Society of AnimalProduction (ESAP), 28–30

Ayele, T., 2016. Technical Performance Evaluation and Redesigning of Small Scale Irrigation Scheme: Case of Guder Irrigation Scheme Awi Zone, Amhara Region (Doctoral dissertation, Harmaya University).

Bekele, N., Urge, M., Ameha, N. and Fereja, G.B., 2015. Study of production practices, and productivity of village chicken in Chelliya District, Ethiopia. Science, Technology and Arts Research Journal, 4(3), 117-122.

Besbes, B., Thieme, O., Rota, A., Guèye, E.F., Alders, R.G., Sandilands, V. and Hocking, 2012. Technology and programmes for sustainable improvement of village poultry production. Alternative systems for poultry: Health, welfare and productivity; 110-127.

Blackie, S., 2014. Village chicken production system in the greater Accra Region Ghana. Journal of Biology, Agriculture and healthcare, 4(9); 89-94.

Bogale K., 2008. InSitu Characterization of Local Chicken Eco-Type for Functional Traits and Production System in Fogera District, Amhara Regional State.MSc ThesisHarmaya University, Haramaya, Ethiopia.

Chebo, C. and Nigussie, H., 2016. Performances, Breeding Practices and Trait Preferences of Local Chicken Ecotypes in Southern Zone of Tigray, Northern Ethiopia. Asian Journal of Poultry Science, 10,; 158-164.

Chowdhury, S.D., 2013. Family poultry production in Bangladesh: is it meaningful or an aimless journey? World's Poultry Science Journal, 69(3); 649-665.

Cochran, W. G. 1963. Sampling Techniques, 2nd Ed., New York: John Wiley and Sons, Inc

CSA (central statistical agency).2016/17[2009 E.C.] livestock and livestock characteristics (private peasant holdings); agricultural sample survey volume 2, federal democratic republic of Ethiopia, Addis Ababa, Ethiopia.

CSA., (Central Statistical Agency). 2015. Livestock and Livestock Characteristics (Private Peasant Holdings): Agricultural Sample Survey volume 2, Federal Democratic Republic of Ethiopia, Addis Ababa, Ethiopia.

CSA., Central Statistics Authority. 2003. Agricultural sample survey 2010-20111. Report onlivestock and livestock characteristics, Vol. II.Statistical Bulletin No.505. Addis Ababa, Ethiopia.Development. 18, 56-61.

Dorji, N., Daungjinda, M. and Phasuk, Y., 2011. Genetic characterization of indigenous chickens compared with commercial lines. Tropical animal health and production, 43(4), pp.779-785.

Dueppen, S.A., 2011. Early evidence for chickens at Iron Age Kirikongo (c. AD 100–1450), Burkina Faso. Antiquity, 85(327), pp.142-157.

Emebet, M., Singh, H., Sisaye, T. and Johansson, A.M., 2014.Phenotypic characterization of indigenous chicken population in South West and South part of Ethiopia. Br. J. Poult. Sci, 3(1), pp.15-19.

Eshetu Y., E. Mulualem, H. Ibrahim, A. Berhanu K. Aberra. 2001. Study of gastrointestinal helminthes of scavenging chickens in four rural districts of Amhara region, Ethiopia. Rev. Sci. tech. Off. Int. Epiz. 20 (3), 791-796

Eskindir, K., Tadelle D., and Banerjee, A.K. 2013.Phenotypic Characterization of Indigenous Chicken Population in Ethiopia.International Journal. Ethiopia. African Journal of Agricultural Research, 8(11): 1014–1021.

Falconer, D.S. and Mckay, T.F.C. 1996.Introduction to quantitative genetics. 4th edition.

FAO, (Food and Agriculture Organization of the United Nations).2007.Global Plan of Action for Animal Genetic Resources and the Interlaken Declaration, Rome (availableat ftp://ftp.fao.org/docrep/fao/010/a1404e/a1404e00.pdf).

FAO, (Food and Agriculture Organization of the United Nations).2011.Draft guidelines on developing the institutional framework for the management of animal genetic resources. Commission on Genetic Resources for Food and Agriculture, Thirteenth, Regular Session, Rome, (CGRFA-13/11/Inf.22).

FAO, (Food and Agriculture Organization of the United Nations).2012.Phenotypic characterization of animal genetic resources.FAO Animal Production and Health GuidelinesNo.11.Rome.[Accessedon25.05.2014].availableathttp://www.fao.org/do creep/015/i2686e/i2686e00.pdf.FAO, Rome.

FAOSTAT Database, 2012.Retrieved October 10, 2014, from http://faostat.fao.org/faostat/,FAO, Rome.

Faruque, S., Afroz, M. A. and Islam, M. S. 2010. Evaluation of response to selection in chicken. International Journal of Biological Research, 1(4):01- 05.

Feleke Assefa Argaw. 2015. Assessment of common practices of egg incubation and chick brooding of backyard poultry production system in Wolaita Zone, Southern Ethiopia: Vol. 3 (3), 162-168

Feyera, B.E., 2016. Phenotypic Characterization of Indigenous Chicken and Their Production System in Gobu Sayo, Bako Tibe and Danno Districts of Western Oromia, Ethiopia(Doctoral dissertation, Harmaya University).

Fisseha, M.A., 2009. Studies on production and marketing systems of local chicken ecotypes in Burie Wereda, north west Amhara (Doctoral dissertation, HawassaUniversity).

Fisseha, M., 2010. Indigenous chicken production and marketing systems in Ethiopia: Characteristics and opportunities for market-oriented development (Vol. 24). ILRI (aka ILCA and ILRAD).

Gerima, G.T., Meseret, Y. and Teddy, A.A., 2016. Socio-economic characteristics of poultry production in lowland and midland agro-ecological zones of central Tigray, Ethiopia. Afr. J. Poultry Farming, 4(6), 149-158.

Getachew, B., Kefelegn, K. and Negassi, A., 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(1), 68-73.

Gueye EF (1998) Poultry plays an important role in Africa village life. World Poultry. 14: PP.14-17.

Gueye, E. F. 2010. The role of family poultry in poverty alleviation. World's Poultryry Science Journal, 39: 403-421.

Guèye, E.F., 2002. Family poultry research and development in low-income food-deficit countries: approaches and prospects. Outlook on Agriculture, 31(1), pp.13-21.

Gueye, E.F., 2005. Gender aspects in family poultry management systems in developing countries. World's Poultry Science Journal, 61(1), pp.39-46.

Gueye, E.F., 2009. The role of networks in information dissemination to family poultry farmers. World's Poultry Science Journal, 65(1); 115-124.

Habte, M., Ameha, N., &Demeke, S. 2013. Production Performance of Local and Exotic Breeds of Chicken at Rural Household Level in Nole Kabba Woreda, Western Wollega, Ethiopia. African Journal of Agricultural Research, 8(11): 1014–1021.

Hailemikael, N., 2013. On-farm phenotypic characterization of indigenous chicken and chicken production systems in southern zone of Tigray, northern Ethiopia.

Halima, H., Neser, F.W.C., van Marle-Koster, E. and De Kock, A., 2007. Phenotypic variation of native chicken populations in northwest Ethiopia. Tropical animal healthand production, 39(7), pp.507-513.

Hassaballah, K., Zeuh, V., Lawal, R.A., Hanotte, O. and Sembene, M., 2015.Diversity and origin of indigenous village chickens (Gallus gallus) from Chad, Central Africa. Advances in Bioscience and Biotechnology, 6(09), p.592.

Hassen, H., 2007. Phonotypic and genetic characterization of indigenous chicken populations in Northwest Ethiopia PhD Thesis. National and agricultural sciences departmentof animal Wild life and Grassland Sciences University of the Free State, Bloemfontein, South Africa.

Horst, P., 1989. Native fowl as reservoir for genomes and major genes with direct and indirect effects on the adaptability and their potential for tropically orientated breeding plans. Archive Gefluegelkunde (Germany, FR).household type and household composition on women's reproductive health outcomes in urban Uttar Pradesh, India. Decision-making, **6**, 8.

Hunduma, D., Regassa, C., Fufa, D., Andale, B. and Samson, L., 2010. Major constraints and health management of village poultry production in rift valley of Oromia, Ethiopia. Global Veterinaria, 5(1), pp.6-10.Kenana cattle breed production systems in Sudan. Livestock Research for Rural Development. 18, 56-61.

Khobondo, J.O., Okeno, T.O., Lihare, G.O., Wasike, C.B. and Kahi, A.K., 2014. The past, present and future genetic improvement of indigenous chicken of Kenya. Animal Genetic Resources/Resources génétiques animales/Recursos geneticos animales, 55, pp.125-135.

Kingori, A. M., Wachira, A. M., and Tuitoek J. K. 2010.Indigenous chickens production in Kenya. International Journal of Poultry Science, 9(4); 309-319.

Kingori, A.M., Wachira, A.M. and Tuitoek, J.K., 2014. Influence of energy intake on egg production and weight in indigenous chickens of Kenya. International Journal of Poultry Science, 13(3), p.151.

Kitalyi, A.J., 1998. Village chicken production systems in rural Africa: Household food security and gender issues (No. 142). Food & Agriculture Org...

Kyule, N.M., Mwangi, J.G. and Nkurumwa, O.A., 2014.Indigenous chicken marketing channels among small-scale farmers in Mau-Narok division of Nauru County, Kenya. Int. J. Soc. Sci. Entrepreneurship, 1(9); 55-65.

Lawal, J.R., Bello, A.M., Balami, S.Y., Wakil, Y., Yusuf, Z.B., Dauda, J., Mshelia, E.S., Mana, H.P., Adam, M.K. and Biu, A.A., 2016.Prevalence and economic significance of ectoparasites infestation in Village chickens (Gallus domesticus) Gombe, Northeastern Nigeria. Direct Res. J. of Agricul. And food Sci, 4(5), pp.94-103.Longman Group, Essex, UK. 463.

Lyimo, C.M., Weigend, A., Janßen-Tapken, U., Msoffe, P.L., Simianer, H. and Weigend, S., 2013. Assessing the genetic diversity of five Tanzanian chicken ecotypes using molecular tools. South African Journal of animal science, 43(4); .499-510.

Macharia, J .W.,Mberu, M .N., Wamuyu, L. T.,Imboma„J .K.,Lichoti, K. J., Ngeiywa and Ommeh, S .C. 2017.Phenotypic analysis of underutilized poultry species in Kenya. Livestock Research for Rural Development, 29(5); 12.

Magothe, T.M., Okeno, T.O., Muhuyi, W.B., and Kahi, A.K. 2012. Indigenous chicken production in Kenya: status.World's Poultry Science Journal of Animal Science, 21(11); 1680-1688.

Markos, S., Berhanu, B. and Tadelle, D., 2015. On Farm Performance Evaluation of Three Local Chicken Ecotypes in Western Zone of Tigray, Northern Ethiopia. Performance improvement, 5(7).

Mearg, F.E.A.R.G., 2016. Phenotypic characterization of local chicken ecotypes in the Central Zone of Tigray in northern Ethiopia (M.ScThesis, Jimma University).

Mekonnen, G., 2007. Characterization of the Small Holder Poultry Production and Marketing System of Dale, WonshoaNdola Abaya Woredaof SNNPRS, Ethiopia.MScThesis, Hawassa University, Hawassa, Ethiopia.

Melaku, T.A. and Negassi, A., 2016. On farm Phenotypic Characterization of Indigenous Chicken Population and Their Production System at Wogdi, Borena and LegamboDistricts in South Wollo Ethiopia (Doctoral dissertation, Harmaya University).

Melesse, A. and Negesse, T., 2011.Phenotypic and morphological characterization of indigenous chicken populations in southern region of Ethiopia. Animal Genetic Resources/Resources génétiques animales/Recursosgeneticosanimales, 49, pp.19-31.

Melesse, A., 2014. Significance of scavenging chicken production in the rural community of Africa for enhanced food security. World's poultry science journal, 70(3); 593-606.

Mengesha, M., 2012.Indigenous chicken production and the innate characteristics. Asian Journal of Poultry Science, 6(2), pp.56-64.

Mengesha, M., Tamir, B. and Dessie, T., 2011.Village chicken constraints and traditional management practices in Jamma District, South Wollo, Ethiopia. Livestock Research for Rural Development, 23(2).

Meseret, M., 2010. Characterization of village chicken production and marketing system in Gomma Wereda, Jimma Zone, Ethiopia (Doctoral dissertation, Jimma University).

Minitab. 1998. Minitab for Windows Release 12.21. Minitab Inc. USA.

Moreda, E., Hareppal, S., Johansson, A., Sisaye, T. and Sahile, Z., 2013.Characteristics of indigenous chicken production system in South West and South part of Ethiopia. British Journal of Poultry Sciences, 2(3); .25-32.

Moreki, J.C., 2013. Documentation of ethno veterinary practices used in family poultry in Botswana. Vet World, 6(1); 18-21.

Moreki, J.C., Dikeme, R. and Poroga, B., 2010. The role of village poultry in food security and HIV/AIDS mitigation in Chobe District of Botswana. Livestock Research for Rural Development, 22(3); 1-7.

Musa, L.M-A., Peters, K. J. and Ahmed, M-K.A. 2006. On farm characterization of Butana and Kenana cattle breed production systems in Sudan.

Mwacharo, J.M., Bjørnstad, G., Mobegi, V., Nomura, K., Hanada, H., Amano, T., Jianlin, H. And Hanotte, O., 2011. Mitochondrial DNA reveals multiple introductions of domestic chicken in East Africa. Molecular Phylogenetic and evolution, 58(2); 374-382.

Ndahambelela, E., 2016.Determination of Phenotypic Characteristics, Production Systems, Productivity, and Contribution of Local Chickens to Households in North-Ccenteral Namibia. MSc Thesis, University of South Africa, South Africa.

Nebiyu. Yemane, Tamir, B., &Belihu, K. 2014. Characterization of village chicken production Performance under Scavenging System in Halaba District of Southern Ethiopia. Agricultural Journal, 8: 212-216.

Nigussie, D., Vander, E., and Johan A.M. 2010. Genetic and phenotypic parameter estimates for body weights and egg production in Horro chicken of Ethiopia. Submitted to Trop Anim. Health Prod, Animal Breeding and Genomics Centre, Wageningen University Netherlands.

Nigussie, D., 2011. Breeding programs for indigenous chicken in Ethiopia: analysis of diversity in production systems and chicken populations. PhDDissertation, Wageningen University, the Netherlands.

Ogah, D.M., Alaga, A.A. and Momoh, M.O., 2009. Principal component factor analysis of the morph structural traitsofMuscovy duck. International Journal of Poultry Science, 8(11).

Okeno, T.O., Kahi, A.K, and Peters, K.J. 2012.Characterization of indigenous chicken production systems in Kenya. Tropical Animal Health and Production, 45(1), .193-203.

Reta D., 2006.Phenotypic characterization of some indigenous chicken ecotypes of Ethiopia.Livestock Research for Rural Development, 18.

Reta, D. 2009. Understanding the role of indigenous chickens during the long walk to food security in Ethiopia.Red, 19(29.9), 21-5.

Rosario M F, Silva M AN N, Coelho A D, Savino V J M and Dias C T S. 2008.CanonicalSecurity in Ethiopia.Red, 19(29.9), 21-5.

Shishay Markos, Berhanu Belay and Tadelle Dessie. 2014. Incubation and Brooding Practices of Local Chicken Producers in Ethiopia: The Case of Western Zone of Tigray. Journal of Biology, Agriculture and Healthcare.Vol.4, No.25.

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

Sonaiya E.B and Olori V.E. (1998).Village chicken production in South-Western Nigeria. In: Proceedings of an International Workshop on Rural Poultry Development inAfrica, IieIfe, Nigeria. 243–247.

Sonaiya, E.B., 2009.Sometechnicaland socio-economicfactorsaffecting productivity and profitability of smallholder family poultry. World's Poultry Science Journal, 65(2)

Speizer, I. S., Lance, P., Verma, R., & Benson, A. 2015.Descriptive study of the role of household type and household composition on women's reproductive health outcomes in urban Uttar Pradesh, India.Decision-making, **6**, 8.

Tadelle Dessie and Ogle, B. 2001. Village poultry production system in the central high lands of Ethiopia. Tropical Animal health and production, 33(6):21-37.

Tadelle, D., T. Million, and Alemu Yami& K.J. Peters 2003.Village chicken production systems in Ethiopia: Use patterns & performance evaluation and chicken products &socioeconomic functions of chicken. Livestock Research for Rural Development 15 (1).

Taju, S.,(2017) Phenotypic Characterization and Assessment of Management Practices of Indigenous Chicken in Jimma Zone, Master's Thesis, 2017, P-170 Jimma university, Jimma, Ethiopia.

Upton, M., 2004.The role of livestock in economic development and poverty reduction. Veterinary Journal, 17(1), 68-80.

Wondu, M., Mehiret, M., andBerhanu, T., 2013.Characterization of Urban Poultry Productionn System in Northern Gondar, Amhara Regional State, Ethiopia. Agriculture and biologygy journal of North America, 1(7).

Worku, Z. and Aberra Melesse, Y.T., 2012. Assessment of village chicken production system and the performance of local chicken populations in West Amhara Region of Ethiopia. Journal of Animal Production Advances, 2(4).World Science Research Journal, 1(February), 26–35.

Yakubu, A. 2010.Indigenous chicken flocks of Nasarawg State Nigeria: Their characteristics, husbandry, and productivity. Tropical and Subtropical Agro Ecosystems, 12(1):69-76

Yamaki M G S., Correa M A., Silva L B. and Torres R A. 2006.Evaluation of quail carcass traits using principal component analysis. Proceedings of the 8th World Congress on Genetics Applied to Livestock Production, August 13-18, Belo Horizontal, MG, Brazil.

Yang Y., Mekki D M., Wang S J., Yu JH.Xie K Z. and Dai G J. 2006.Canonical correlation analysis of body weight, body measurements and carcass characteristics of Jinghai Yellow chicken.J.Anim.Vet.Adv,5:980-984.

8. APPENDIX

Phenotypic Characterization and Their Managemental System of Indigenous Chicken Ecotypes in Awi Zone, Amhara Regional State Ethiopia.

Appendix8.1. GLM analysis output for sampled population of chicken.

Appendix Table 1: Dependent Variable of wingspan:

Source	DF	Sum of Squares	Mean Square	F Value	Pr> F
Model	5	432.51324	86.502659	34.48	<.0001
Error	714	179	1.085317	2.508523	
Corrected Tota	719	222	3.598611		
		R-Square	Coeff Val	Root MSE	WS Mean
		0.194511	4.243511	1.583832	37.32361
Source	DF	Type III SS	Mean Square	F Value	Pr> F
Agro-ecology	2	152.2977513	76.1488757	30.36	<.0001
Sex	1	0.00319462	0.00319461	0.40	0.5252
AE*SEX	2	0.00735307	0.00367653	0.47	0.6283

Appendix Table 2: Dependent Variable of Beak length:

Source	DF	Sum of Squares	Mean Square	F Value	Pr> F
Model	5	0.01522212	0.00304442	0.39	0.8592
Error	714	5.64475774	0.00790582	2.508523	
Corrected Tota	719	5.65997986	3.598611		
		R-Square	Coeff Val	Root MSE	WS Mean
		0.002689	3.959218	0.088915	
Source	DF	Type III SS	Mean Square	F Value	Pr> F
Agro-ecology	2	0.00715751	0.00357876	0.45	0.6361
Sex	1	0.00319461	0.00319461	0.40	0.5252
AE*SEX	2	0.00735307	0.00367653	0.47	0.6283

Appendix Table 3: Dependent Variable of Wattle length

Source	DF	Sum of Squares	Mean Square	F Value	Pr> F
Model	5	24.61719643	4.92343929	157.09	<.0001
Error	714	22.37767857	0.03134129	2.508523	
Corrected Tota	719	46.99487500	3.598611		
		R-Square	Coeff Val	Root MSE	WS Mean
		0.523827	8.169261	0.177035	2.167083
Source	DF	Type III SS	Mean Square	F Value	Pr> F
Agro-ecology	2	1.31890476	0.65945238	21.04	<.0001
Sex	1	23.03029167	23.03029167	734.82	<.0001
AE*SEX	2	0.36190476	0.18095238	5.77	0.0033

Appendix Table 4: Dependent Variable of Chest circumference

Source	DF	Sum of Squares	Mean Square	F Value	Pr> F
Model	5	194.065079	38.813016	19.66	<.0001
Error	714	1409.662698	1.974318	2.508523	
Corrected Tota	719	1603.727778			
		R-Square	Coeff Val	Root MSE	WS Mean
		0.121009	5.229375	1.405104	26.86944
Source	DF	Type III SS	Mean Square	F Value	Pr> F
Agro-ecology	2	30.6099206	15.3049603	7.75	0.0005
Sex	1	133.7357143	133.7357142	67.74	<.0001
AE*SEX	2	9.6099206	4.8049603	2.43	0.0884

Appendix Table 5: Dependent Variable of Shank length:

Source	DF	Sum of Squares	Mean Square	F Value	Pr> F
Model	5	187.513104	37.502621	27.24	<.0001
Error	714	982.830891	1.376514		
Corrected Tota	719	1170.343995			
		R-Square	Coeff Val	Root MSE	WS Mean
		0.160221	12.66541	1.173249	9.263417
Source	DF	Type III SS	Mean Square	F Value	Pr> F
Agro-ecology	2	51.4641731	25.7320865	18.69	<.0001
Sex	1	110.1653429	110.1653429	80.03	<.0001
AE*SEX	2	7.2068508	3.6034254	2.62	0.0737

Appendix Table 6: Dependent Variable of Body weight

Source	DF	Sum of Squares	Mean Square	F Value	Pr> F
Model	5	23.0710278	4.6142056	30.42	<.0001
Error	714	108.3178472	0.1517057		
Corrected Tot	719	131.3888750			
		R-Square	Coeff Val	Root MSE	WS Mean
		0.175593	24.45163	0.389494	1.592917
Source	DF	Type III SS	Mean Square	F Value	Pr> F
Agro-ecology	2	8.85851620	4.42925810	29.20	<.0001
Sex	1	10.67746296	10.67746295	70.38	<.0001
AE*SEX	2	0.65675231	0.32837616	2.16	0.1156

Appendix Table 7: Dependent Variable of Earlobe

Source	DF	Sum of Squares	Mean Square	F Value	Pr> F
Model	5	12.4666409	2.4933282	19.42	<.0001
Error	714	91.6560119	0.1283698		
Corrected Tot	719	104.1226528			
		R-Square	Coeff Val	Root MSE	WS Mean
		0.119730	20.29158	0.358287	1.765694
Source	DF	Type III SS	Mean Square	F Value	Pr> F
Agro-ecology	2	20.55636640	0.27818320	2.17	0.115
Sex	1	11.83952447	11.83952448	92.23	<.0001
AE*SEX	2	0.18042196	0.09021098	0.70	0.4956

Appendix Table 8: Dependent Variable of Body length

Source	DF	Sum of Squares	Mean Square	F Value	Pr> F
Model	5	150.840278	30.168056	12.41	<.0001
Error	714	1735.458333	2.430614		
Corrected Tot	719	1886.298611			
		R-Square	Coeff Val	Root MSE	WS Mean
		0.079966	4.385664	1.559043	35.54861
Source	DF	Type III SS	Mean Square	F Value	Pr> F
Agro-ecology	2	24.9969577	2.4984788	1.03	0.3583
Sex	1	143.8905423	143.8905424	59.20	<.0001
AE*SEX	2	4.6469577	2.3234788	0.96	0.3849

Appendix Table 9: Dependent Variable of Comp length

Source	DF	Sum of Squares	Mean Square	F Value	Pr> F
Model	5	72.2801429	14.4560286	286.16	<.0001
Error	714	36.0689683	0.0505168		
Corrected Tot	719	108.3491111			
		R-Square	Coeff Val	Root MSE	WS Mean
		0.667	1049.788696	0.224759	2.29611
Source	DF	Type III SS	Mean Square	F Value	Pr> F
Agro-ecology	2	0.58541799	0.29270899	5.79	0.0032
Sex	1	69.67572487	69.67572487	1379.26	<.0001
AE*SEX	2	1.84930688	0.92465344	18.30	<.0001

Appendix Table 10: Dependent Variable of Comp width

Source	DF	Sum of Squares	Mean Square	F Value	Pr> F
Model	5	68.0966806	13.6193361	292.43	<.0001
Error	714	33.2526389	0.0465723		
Corrected Tot	719	101.3493194			
		R-Square	Coeff Val	Root MSE	WS Mean
		0.671901	9.534299	0.215806	2.263472
Source	DF	Type III SS	Mean Square	F Value	Pr> F
Agro-ecology	2	0.24098016	0.12049008	2.59	0.0759
Sex	1	67.72100595	67.72100596	1454.10	<.0001
AE*SEX	2	0.25198016	0.12599008	2.71	0.0675

Appendix Table 11: Dependent Variable of Neck length:

Source	DF	Sum of Squares	Mean Square	F Value	Pr> F
Model	5	118.76106	23.7522123	21.00	<.0001
Error	714	807.7402579	1.1312889		
Corrected Tot	719	926.5013194			
		R-Square	Coeff Val	Root MSE	WS Mean
		0.128182	8.968869	1.063621	11.85903
Source	DF	Type III SS	Mean Square	F Value	Pr> F
Agro-ecology	2	26.85461243	13.42730622	11.87	<.0001
Sex	1	72.43136574	72.43136575	64.03	<.0001
AE*SEX	2	4.00416799	2.00208399	1.77	0.1711

Appendix Table 12: Dependent Variable of Wing length

Source	DF	Sum of Squares	Mean Square	F Value	Pr> F
Model	5	234.289341	46.857868	24.58	<.0001
Error	714	1361.121270	1.906332		
Corrected Tot	719	1595.410611			
		R-Square	Coeff Val	Root MSE	WS Mean
		0.146852	11.27434	1.380700	12.24639
Source	DF	Type III SS	Mean Square	F Value	Pr> F
Agro-ecology	2	100.4547659	50.2273829	26.35	<.0001
Sex	1	110.3668810	110.3668810	57.89	<.0001
AE*SEX	2	3.1695992	1.5847996	0.83	0.4359

Appendix Table 13: Dependent Variable of Wattle width:

Source	DF	Sum of Squares	Mean Square	F Value	Pr> F
Model	5	61.1516270	12.2303254	155.59	<.0001
Error	714	56.1261508	0.0786081		
Corrected Tot	719	117.2777778			
		R-Square	Coeff Val	Root MSE	WS Mean
		0.521426	12.49179	0.280371	2.244444
Source	DF	Type III SS	Mean Square	F Value	Pr> F
Agro-ecology	2	53.89967063	26.94983532	342.84	<.0001
Sex	1	0.02142857	0.02142857	0.27	0.6018
AE*SEX	2	0.23333730	0.11666865	1.48	0.2274

Appendix Table 14: Dependent Variable of Shank circumference

Source	DF	Sum of Squares	Mean Square	F Value	Pr> F
Model	5	14.80426984	2.96085397	54.57	<.0001
Error	714	38.74234127	0.05426098		
Corrected Tot	719	53.54661111			
		R-Square	Coeff Val	Root MSE	WS Mean
		0.276474	6.729665	0.232940	3.461389
Source	DF	Type III SS	Mean Square	F Value	Pr> F
Agro-ecology	2	12.65873942	6.32936971	116.65	<.0001
Sex	1	0.30044709	0.30044709	5.54	0.0189
AE*SEX	2	0.18429497	0.09214749	1.70	0.1837

Appendix Table 15:**ANOVA Table** for reproductive performance of local chicken.

		Sum of Squares	df	Mean Square
ageat1stmating	Between Groups	.014	2	0.007
	Within Groups	12.568	177	0.071
	Total	12.582	179	
ageat1stlaying	Between Groups	2.009	2	1.005
	Within Groups	31.870	177	0.180
	Total	33.879	179	
no of clutch per year	Between Groups	0.327	2	0.163
	Within Groups	18.906	177	0.107
	Total	19.233	179	

no of egg per clutch	Between Groups	7.344	2	3.672
	Within Groups	483.100	177	2.729
	Total	490.444	179	
length of clutch in day	Between Groups	63.144	2	31.572
	Within Groups	682.917	177	3.858
	Total	746.061	179	
Total eggs per year	Between Groups	301.911	2	150.956
	Within Groups	9735.750	177	55.004
	Total	10037.661	179	
interval between 2consicative brooding period	Between Groups	1.144	2	0.572
	Within Groups	101.100	177	0.571
	Total	102.244	179	
Egg incubate for hatching per year	Between Groups	2.344	2	1.172
	Within Groups	93.717	177	0.529
	Total	96.061	179	
Average egg set of broody hen	Between Groups	358.211	2	179.106
	Within Groups	627.183	177	3.543
	Total	985.394	179	

Appendix Table 16: Total Variance Explained

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.775	34.104	34.104	4.775	34.104	34.104
2	1.598	11.416	45.520	1.598	11.416	45.520
3	1.117	7.975	53.496	1.117	7.975	53.496
4	1.078	7.701	61.196	1.078	7.701	61.196
5	.983	7.021	68.217			
6	.947	6.764	74.981			
7	.906	6.471	81.451			
8	.834	5.954	87.405			
9	.543	3.881	91.285			
10	.418	2.986	94.272			
11	.314	2.241	96.513			
12	.249	1.775	98.288			
13	.192	1.374	99.662			
14	.047	.338	100.000			

Extraction Method: Principal Component Analysis.

Appendix8.3: **Questionnaires for Phenotypic Characterization, their Managemental system and Breeding Practices of Indigenous Chicken ecotypes in Awi zone, Amhara regional state, Ethiopia.**

1**. Questionnaires**

Questioner number (code) _____Date: _____ Enumerator:

Region: _____ Zone: _____ Woreda: _____ Kebele: _____

I. Questionnaires for phenotypic characterization, breeding and manage mental practices of indigenous chicken in Awi zone, Amhara regional state of Ethiopia.

1. What is a local name of the dominant chicken population? _____

2. Do you know the history of their origin and time of introduction of indigenous chickens? __

3. Describe good and undesirable attributes of the chickens and other special attributes
3.1. Other special attributes
3.2. Specific quality of products
3.3. Specific health characteristics
3.4. Adaptability to specific environment & scalping from predator etc.
3.5. Special reproductive characteristics
4. Do you know any extinct breed type?
4.1. Or any loss in genetic diversity?
4.2. Do you know the distribution and specific geographical areas and location?
4.3. Is the population increasing or decreasing
4.4. Any change in the utility /usefulness/ of chicken population, why?
5. Do you can estimate the total population of the ecotype?
6. How looks like your management system for?
6.1. Feeding _____
6.2. Housing _____
6.3. Water availability and watering material _____
7. What are the major constraints in your management system?
   1. _____
   2. _____
   3. _____ etc.
8. Do you have habit of improving your chicken _____
9. Which trait you prefer _____
9.1. Which practice you do _____
10. Do you have culling practice underproductive chicken? _____
When _____
II. Semi structured questionnaires (40 respondents per districts)
Enumerator's Name ---------- age, ----------district ----------
District (Woreda) ----------, Peasant Association (Keble) ----------
Date of interview----------
Identified number of the respondent----------
1. Socio-economic characteristics of the house hold
1.1. Sex and age of the respondent A. Male B. Female
1.2. Major Occupation_____
1.3. Educational level of the respondent
Illiterate Read and write Primary Secondary Preparatory

1.4 Religion
Orthodox Muslim Others

1.5. Economic status of the householder
Poor Medium Rich
1.6. Marital status:
marred unmarred widowed/r
1.7. Land size /ha/ _____

Appendix Table 17 : Family size of the respondent

	Male	Female	Total

a) Ages under 14 years _____ _____ _____
b) Ages between 15 to 30 years _____ _____ _____
c) Ages between 31 to 60 years _____ _____ _____
d) Ages above 60 years _____ _____ _____
e) Total number _____ _____ _____

1.9. Prioritizing the advantage of poultry product in family nutrition and way?
a. Children b. Women c. Pregnant Women d. Men
e. Involved in breast feeding f. Adults g. Old people
2. Chicken types
2.1. Flock size and structure (local and exotic)

Appendix Table 18: Indigenous chickens:

Chicken Stock Type	No of chicken		total source of foundation stock	source of replacement	responsible members of family
	M	F			
Chicks					
Cocks					
Pullet					
Hens					
Cockerels					
Exotic					
Hybrids					

2.2. Sources of foundation or replacement stock
1. Purchase ____ 2. Gift _____ 3. Hatched _____ 4.Other, specify
2.3. The extent of exotic chicken distribution in the area
2.4. What are the constraints in ordering to consume poultry product at family level?
3. Chicken management system
3.1. Housing
3.1.1. What type of management system do you practice for your chicken rising?
a. Extensive b. Semi-intensive c. Intensive d. Others, specify
3.1.2. Do you have separate poultry house from your family?
1. Yes 2. No
3.1.3. If your answer to question 2 is no, what is a problem in the construction of separate poultry house (Prioritize them)
3.1.4. If your answer to question 2 is yes, where do your birds (rest) stay at night? (a) In the kitchen (b) Family dwellings (c) Perch on trees or house
(d) Hand woven basket (e) In Bamboo cages (f) in the house purposely made for chicken (g) I don't know where they rest (h) others specify _____
3.15. If they rest in separate house, do you practice cleaning of poultry house**?**
Yes _____ no _____
3.1.6. If yes, how many days in a week do you clean? _____
3.2. Feed Resources and Feeding Strategy

3.2.1. Do your chickens scavenging (forager) in?
1. Yes _____ 2.No _____
2. Do you provide supplementary feed for your chicken?
1. Yes _____ 2. No _____
3**.** If yes, indicate the ingredients you provide supplementary feed for your poultry**:**
1. Wheat _____ 2. Barely _____ 3.Sorghum _____
4. Maize _____ 5.Mixture _____ 6. Others _____
3.2.2. If you provide feed, how frequently do you feed your chickens daily?
Morning only
(a) Once _____ (b) Twice) _____
(C) Three times or more ____ (d) _None _____
Evening only
(a) Once _____ (b) Twice _____
C) three times or more _____ (d) – None _____
Afternoon only
(a) Once _____ (b) Twice _____
(C) Three times or more _____ (d) – None _____
Any time during the day----------
Morning and evening---------- ----------
Morning and afternoon---------- ----------
Morning, evening and afternoon----------
3.2.3. If you give feed how do you feed your chickens? 1. in a feeding trough
2. on the bare ground 3. Others specify
1.1. How to feed your chicken? A. in group B. separately
3.2.4. Why you give supplementary feed? (a) To increase egg yield (b) to increase
Meat yield c. Aging (d.) Broodiness (during incubation) (e) others
3.2.5. Indicate at which season you provide extra feed for your chicken?
A. Short-rainy (Feb- March) B. Short-dry (Apr-May) C. Long-rainy (June-Sep)
D. Long-dry (Oct-Jan)
3.2.6. At which season chicken feed shortage is most serious?
A. rainy season B. dry season
3.2.7. If you do not give feed, reasons out why not giving supplementary feeding
1. Lack of awareness about feed 3. Expensive
2. Unavailable 4. Time shortage
5. Lack of cash/credit 6. Others, specify
3.2.8. Prioritizes for which classes of chickens you provide supplementary feed?
a. Chicks _ b. Pullet c. Hen d. Cooks e. Cockerel & why?
3.3. Do you give water to your chickens? 1. Yes 2.No (Why?), if yes…
Frequency of watering---------- least type of container----------Availability of watering through, Types of watering through.
3.3.1. Where do you get the water source from? (a) Hand pump (b) River (c) Tap water (d) .Other, specify---------
4 Egg production characteristics:
• Age at first egg (months) ----------
• Annual egg production per hen----------
• Clutch sizes----------

• Clutch interval (days)

Daily	one day interval	Two day interval	Or more days

5. Hatching and Brooding

1. What do use during incubating and hatching eggs? A. By natural B. By Artificial
2. If you use natural incubation, what type of chickens do you use? A. broody hen b. non broody hen c. others specify how long natural hen finishes for one incubation cycle…….
3. If you incubate eggs by natural what type of material do you use?

a) Clay pot & straw bedding b) clay pot only/without bedding
c) Teff straw d) wheat straw e) other (Specify)

4. If you use artificial incubator what type of incubator you use? a. Electrical incubator b. Kerosene incubator c. Sun power incubator d. Straw incubator
5. At which season you are practicing incubating eggs? a. Rainy season b. Dry season
6. Do you select egg for incubation? A. yes B. No C. specifies ----------
7. How long do you store eggs before incubation?

4.2.1. Where do you store eggs before incubation? ----------

8. What do you use as hatching eggs storage materials? ----------
9. What kind of materials used during the incubation of eggs? ----------
10. Where do you store eggs until sale & incubate? a. Grain b. clay pots c. plastic materials D. cartoons e. Floor depression F. Others ----------
11. Do you select eggs at a time or before incubation? 1, Yes 2, No
12. If yes which size and color do you select?

A. small b. medium c. large b. color (white) (brown) (other) ----

13. What are the selection criteria used in deciding which male and female chickens to become the parents of the next generation?

14. Do you select size of hens for brooding? a) Yes b) No c) Do not consider

The size since any hen that manifested broody behavior is allowed to bath

15. If yes, which one do you prefer? 1) Bigger 2) Medium size 3) Smaller
16. Do you select the mother hen incubating the eggs? 1. Yes 2. No
17. Do you clean external part eggs before setting? a. Yes b. No.
18. How many eggs do you set/broody hens? ----------
19. If broody hen used, how many chicks grow?
20. When is the chicks death and at what time? a. First week b. Second week c. Third week d. Forth week e. Six –eight week of after hatching
21. What are the main causes of chicks' death? a. Disease and type b. predator's c. birds d. others
22. Do you prepare laying place nest for the layer? A. yes b. No. The laying nests. a. Common for all layer b. Individual
23. Do you prepare place for the incubating hen? a. Yes b. No.
24. Do you collect the laid eggs? a. Yes b. No
25. Egg for setting and market are stored in a. the same containers b. Different containers
26. For how long do you store hatching or marketing egg? Max ----- days, Min ----days

Appendix Table Yes Rank Breeding cocks Yes Rank **19Breeding hens**

1	Egg number	Egg number
2	Body size	Body size
3	Growth rate	Growth rate
4	Hatchability	Hatchability
5	Mothering ability	Mothering ability
6	Broodiness	Broodiness
7	Disease resistance	Disease resistance
8	Egg size	Egg size
9	Plumage colour	Good scavenging
10	Fighting ability	Plumage colour
11	Good scavenging	Fighting ability
12	Longevity	Fertility
13	other specify	Other specify

2. How long has poultry been kept in the household? ----------

3. What chicken type do you raise? **1.** Starter/layer/ chicken **2.** Finisher **3.**grower

4. Approximate age of female sexual maturity months? (Hen (age at 1st egg) ----- months?

Appendix Table 20: Reproductive performance

age at 1st mating (crevice)	
age at 1st laying (crevice)	
no of clutch per year	
no of egg per clutch	
length of clutch in day	
Total eggs per year	
interval between 2 consecutive brooding period	
Egg incubate for hatching per year	
Average egg set of broody hen	

5. Culling and breeding practice

1. Do you have breed improvement practice? How -----

1. Importing 2. Improving indigenous chicken by itself?

2. What factors determine which bird you will cull? ----- And which trait you prefer?

For conception or income or selection (Rank) way? For

2.1. Male a. wt. b. color, c. comp, d. breeds of the parents.

2.2. Female a. wt. b. color c. comp, d. breeds of the parents.

.2.3. Which trait is more selected for breeding practice under your capacity?

3. Why do you cull chicken? 1. Culling under productive 2. Lack of broodiness

3. Frequent broodiness 4. Sickness 5. Other specify ------

4. How do you cull chicken? 1. Culling at young stage 2. Dealing the best cock and hen during conception period 3. Preventing unwanted cock to mate hen

5. for what purpose (breeding objective) and select trait?

1. Meat 2. Egg 3.Color 4. Others

6. How do you get (improved spps) ----------?

6. Constraints of poultry production

1. Health and disease control a. Do you understanding serious disease outbreaks? 1. Yes 2.No

b. What do you do when chickens fall to sick? 1. Treat them in yourself 2. Call in veterinarian 3.Cull/Kill them immediately 4. Call in development agents 5. Consume them immediately 6. Sell those 7. Other, specify_____

2. Discuss the major economically important disease?

No	Disease name(local)	Common symptoms of the disease	Age of birds mostly affected	Occurrence (month/season)	Local treatment	Prognosis(diagnosis)

Rank the severity of disease first, second, third, fourth-------

3. Least main disease cause of chicken death? And their orders 1st----- 2nd ----- 3rd ---4th---

4. How did the disease affect your flock and which disease name and type is more serious?

A. wiped out the all flock b. more than half c. destroyed less than half the flock

5. Source of infection? 1. a. Own flock b. Incoming chicken c. Neighboring household Neighboring village d. Unknown

6. Do you control free movement of chicken? A. yes b. No If yes, mentions the reason?

a) To protect from predators attack b) To avoid risk of contagious diseases

c) To protect from mixing with the village flock

d) To protect birds from picking and destroying crops/ vegetables

7. Marketing

1. What are the problems relating to chicken marketing in your experience ordering them according to their importance? 1. Instable Chicken price 2. Poor sales (demand seasonality), 3.Lack of market place, 4.Availability of substitute 5.Poor infrastructure (road, market…), 6.Others specify

2. How far the market place from the home area? _____

3. Please fill the table according to the instruction?

Current Market Price	Type of chicken and egg products					
	Male chicken			Female chicken		
	Small Size	Medium Size	Large Size	Small size Egg	Medium Size	Large Size

4. Who are responsible for chicken marketing? A. man B. Women C. children

5. How you can transport chicken to the market place?

A. by pack animals B. hanging by hand C. hanging with stick

6. To whom you sell your chicken? A. for consumer B. for retailer C. Intimidators

9. Extension contact and services

1. Have you ever discussed your chicken related problems with (DA)? 1. Yes 2.No

2. If yes, where do you meet the developmental agents? 1. at farm 2. At house 4.At fortunately meetings 4.At co-operative meetings 5. At the demonstration site 6.Others, specify

3. If yes how frequently do you contact the DA (days in a month) ----------

4. If no, state the reasons for not contacting the extension agent 1. Have not heard about the extension in chicken 2.Cannot easily reach them 3. There is no need to contact with the DA 4. Other, specify----------

5. Have you ever heard about improved chicken production practices 1.Yes 2.No?

6. If yes, what is your major source of information on improved chicken production practices?

1. Extension agents 2.Market 3.Relatives 4. Neighbors 5. Other farmers

6. Co-operative leader 7. Radio 8. Newspaper 9.Television

II. Quantitative and qualitative characteristics (the principal of 106 female to 54 male identified) of chicken

1. Quantitative and qualitative variation districts Dangila ---- Zigom ---- Fagita lekoma -----

A. Qualitative variation

1**.** Age (days/wks) of chickens---------- District ----------

2. Sex of chickens

1. Male 2.Female

3**.** Feather distribution 1.normal 2.naked neck 3 shank feathered & feet;

4**.** Plumage color1.Completely white 2.Completely black 3.Completely red 4. Grayish/Gebsema 5.Multicolor/Ambesma 6.Black with white tips/Tetrima 7.Red brownish.8.White with red stripes 9. Others/Specify

5**.** Beak color 1.Black 2. Red 3.White 4. Others/specify

6. Eye colour1.Orange 2.Red 3.yellow 4.pear 5.Grey6. Others

7. Comb type 1.Rose 2.Pea 3.Watnut/strawberry 4. Single. 5. V shape

8. Head shape 1.Plain 2.Crest /Gutya 3. Others, specify ----------

9. Ear lobe colour 1.White 2.Red 3.Black 4.White and red 5. Others,

10. Shank feather 1. Present 2. Absent

11. Shank color 1. Yellow. 2. Black. 3. White. 4. Blue. 5. Green.6.Grey-blue

Appendix Table 21: Quantitative variation (Measurable traits per chicken)

1. Wing span (arrested) /cm/	
2. Wattle lengths (cm)	
3. Beak length (cm)	
4. Chest circumference(cm)	
5. Shank length (cm)	
6. Body weight (kg)	
7. Ear lobe length (cm)	
8. Body length (cm)	
9. Comb length (cm)	
10. Comb width (cm)	
11.Neck length (cm)	
12. Wing length (cm)	
13.Shank circumference(cm)	
14.Wattle width (cm)	
15. Egg number