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On Farm Phenotypic Characterization and Husbandry Practices of Indigenous Chicken keeping Households in Selected Districts of North Gojjam Zone, Amhara

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College of Agriculture and Environmental Sciences

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MSc. Thesis

By

Amarech Yimenu Getu

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE (Msc) IN ANIMAL PRODUCTION

Advisor: Wossenie Shibabaw (PhD)

June, 2025

Bahir Dar, Ethiopia

THESIS APPROVAL SHEET

As member of the Board of Examiners of the Master of Sciences (MSc.) thesis open defense examination, we have read and evaluated this thesis prepared by Amarech Yimenu entitled with"On Farm Phenotypic Characterization and Husbandary Practices of Indigenous Chicken keeping Households in Selected Districts of North Gojjam Zone, Amhara Region, Ethiopia". We hereby certify that, the thesis is accepted for fulfilling the requirements for the award of the degree of Master of Sciences (MSc.) in Animal Production.

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	Signature	Date

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DECLARATION

This is to certify that this thesis entitled"On Farm Phenotypic Characterization and Husbandry Practices of Indigenous Chicken Keeping Households in Selected Districts of North Gojjam Zone. Amhara Region, Ethiopia,submitted in partial fulfillment of the requirement for the award of the degree of Masters of Science in "Animal Production" to the graduate program of college of Agriculture and Environmental Science, Bahir Dar Universtiy by Amarech Yimenu ID. No.(B DU1501089/2015) is an authentic work carried out by me. The matter embodied in this title work has not been submitted earlier for award of any degree or diploma to the best of our knowledge and belief.

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ABSTRACT

The study of Phenotypic characterization of indigenous chicken is essential for sustainable genetic improvement, utilization, and designing conservation strategies of the breed at local, regional, national, and global levels. The objective of the study was to assess the husbandry practices and phenotypically characterize indigenous chickens. The study was conducted in three selected districts of the North Gojjam zone, Amhara region. Three kebeles from each district, a total of nine kebeles, were selected purposively, and the number of respondents and chickens from each village was determined proportionally. A total of 388 respondents were selected using simple random sampling techniques and interviewed using a semi-structured questionnaire. A total of 478 indigenous chickens were randomly selected for the characterization of quantitative and qualitative traits. Quantitative trait data were analyzed using the general linear model (GLM) procedure of SAS version 9.0, whereas qualitative trait data were analyzed using SPSS version 25. The result of the current study indicated that 22% of the respondents were males and 78% were females. The overall mean flock size of chickens in the study area per household was 6.9±1.12, 2.66±0.85, 2.29±0.69, 1.6±0.75, and 1.47±0.69 for young chicks, pullets, cockerels, hens, and cocks, respectively. Overall, 84.8% of the respondents provide supplementary feed for their chickens. All of the respondents (100%) provided water for their chicken with free access (64.2%), twice a day (26.8%), and once a day (8.9%). Majority of the respondents (97.4%) had poultry house within the housing system of separate shelter (21%), perch in the main house (42.7%), perch in other animal house (17.7%), perch in the kitchen (12.4%) and perch in the veranda (6.2%), on the other hand, 6.1% of the respondent had no poultry house. The major constraints of chicken production were disease, with an overall index value of 0.3. Regarding opportunities in chicken production, the market was ranked 1st with an index value of 0.47. Concerning breeding practice, 23.8% of respondents had breeding experience in improving their chicken productivity either by cross-breeding (22.6%), line breeding (45.2%), and by out-breeding (32.3%). The major criteria used for selection of breeding hens were egg number with an overall index value of 0.26, whereas body weight was for breeding cock with an overall index value of 0.36. About 95.8% of indigenous chickens were normal feathered, whereas the remaining 3.9% of indigenous chickens were naked-neck. The dominant plumage color of indigenous chicken was red (39.1%), followed by Grayish/Gebsema (26.4%), Teterma (12.8%), *White (9.6%), Black (7.1%), and Multicolor (5.0%). Quantitative measurements indicated that significant differences ($P<0.05$) were observed between agro-ecology with respect to traits such as wing span, body weight, comb length, comb width, wattle length, and earlobe length. Generally, the phenotypic diversity of indigenous chicken in the study districts indicated the existence of genetic variability and genetic resources, which vary from place to place, that might be due to the early introduction of chicken and various causes of variation in Ethiopia. Therefore, qualitative and quantitative variations were observed among the chicken population in this study area, which suggests that there is an opportunity to improve the genetic*

Key words: Indigenous chickens, Selection criteria, Husbandry practice, Phenotypic characterizat -ion, and Reproductive performance.

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LIST OF ABBREVIATIONS

CSA	Central Statistical Agency
FAO	Food and Agricultural Organization
GLM	General Linear Model
NCD	New Castle Disease
NGO	Non-Governmental Organizations
SAS	Statistical Analysis System
SE	Standard Error
SPSS	Statistical Package for Social Sciences
DOC	Day Old Chicken
HL	Highland
ML	Midland
LL	Lowland
m.a.s.l	Meters above sea level

CHAPTER ONE: INTRODUCTION

1.1. Back Ground and Justification

Poultry is the largest group of livestock in the world and is estimated to be about 23.4 billion, consisting mostly of chickens, turkeys, ducks, geese, ostriches, guinea fowl, doves, and pigeons (Litigebew *et al*., 2021). The total chicken population in Africa accounts for about 1.5 billion chickens (Amanuel and Tadesse, 2022). Ethiopia is estimated to have 57 million chickens with 44.94 million indigenous (78.85%), 6.85 million hybrid (12.02%), and 5.19 million exotic breeds (9.14%) (CSA, 2021), respectively. The total chicken population of the Amhara region is estimated to be 19.06 million chickens (33.44% of the national), with 16.30 million indigenous (85.52%), 1.62 million cross-breed (8.55%), and 1.13 million exotic (5.93%) (CSA, 2021).

Despite the large population and the great role of local chicken in the livelihood of resource-poor farmers in Ethiopia, the performance of chickens under a smallholder production system is poor and varies in different areas (Matawork, 2018). Indigenous chicken productivity is low compared to exotic breeds, with average annual egg production of 60 eggs/hen /year (Moges *et al*., 2010). This is due to low hatchability and high mortality of chicks (Getachew *et al*., 2016). In Ethiopia, the average chicken products consumed/ per capita/year is 0.5 kg, which is the lowest among the average of the world (14.9 kg) and sub-Saharan African countries (2.3 kg) (Ayalew *et al*., 2023). The consumption of chicken products in the Amhara region is estimated to be 14.8 million kg of meat and 105.7 million kg of eggs (Paulos, 2018).

Village chicken production system in Ethiopia is characterized by small flock size owned by individual households and is maintained under a scavenging system with little or no inputs for housing, feeding, or health care, low outputs, and periodic devastation of the flocks by disease (Dessie and Ogle, 2001). Phenotypic characterization of indigenous chicken is a systematic docu -mentation of the distinct qualitative and quantitative nature of animals with their production environment (FAO, 2011). Breed characterization includes all activities related to the description of the origin, development, structure, population, quantitative and qualitative characteristics of the breeds in defined management and climatic conditions (Melese, 2014). Indigenous chickens display significant phenotypic variation in feather distribution, plumage color, comb type, head shape, shank color, eye color, earlobe color, skin pigmentation, and body size, which can be attributed to the prevailing climatic conditions (Manyelo *et al*., 2020). Indigenous chicken breed characterization in Ethiopia is named based on their ecological or main habitats, including Jarso, Chefe, Tilili, Tepi, and Horro (Dessie *et al*., 2003); Guangua, Debre-Elias, Melo-Hamusit, Gelila, Gassay, and Mecha (Hassen *et al*., 2007b); Mandura, Horro, Farta, Konso, and Sheka (Dana *et al*., 2010b); Gasgie, and Gugut (Getu *et al*., 2014). Based on plumage colour type, chickens are named as Red. Gebsima, White, Black, Key Teterima, Grey, Kokima , Lebework, Tikur Gebsat, Brown, and Netch teterima (Bekele *et al*., 2021).

1.2. Statement of the problem

Phenotypic characterization of indigenous chicken studies is essential for planning sustainable improvement, utilization, and conservation strategies of a breed at local, regional, national, and global levels (FAO, 2012). Different researchers have conducted studies on the phenotypic chara -cterization of indigenous chickens covering large areas of Ethiopia and the Amhara Region. North Gojjam zone has a huge number of indigenous chicken populations distributed within the existing different agro ecological zone. However, there was no recent research study carried out on the phenotypic characterization, husbandry practices, and reproductive performanc -e of indigenous chickens under farmers' management systems in North Gojjam zone, Amhara region, particularly in Bahir Dar Zuria, Yilmana Densa, and Gonji Kolela districts. In addition, if there are previous characterization studies supposedly done in the area, updating of the previous results is necessary since genetic resources and husbandry practices are not static, since quantitative and qualitative traits may change due to genetic and nongenetic (nutrition, environm -ent, management practices) factors. Therefore, it is necessary to obtain baseline information on indigenous chicken phenotypic characteristics, productive and reproductive performance, husbandry practices, as well as constraints and their opportunities that are required for designing planning, and developing agro ecological based holistic genetic and performance improvement st -rategies. This may ensure sustainable improvement, utilization, and conservation of indigenous chicken genetic resources, which are essential to improving the livelihood of farmers. Therefore, the present study is designed to address the following objectives:

1.3. Objectives

1.3.1. General objective

To assess husbandry practices, productive and reproductive performance, and to phenotypically characterize the existing indigenous chickens in selected districts of North Gojjam Zone, Amhara Region, Ethiopia.

1.3.2. Specific objectives

- To identify the constraints and opportunities of indigenous chicken production in the study area.
- To describe the indigenous chicken breeding practices and selection criteria of farmers in the study area.
- To assess the productive and reproductive performance of indigenous chickens in the study area.
- To characterize phenotypic traits of indigenous chickens in the selected districts of North Gojjam, Amhara Region, Ethiopia.

1.4. Research Questions

- What are the main constraints and opportunities for indigenous chicken production in the study area?
- What breeding practices and selection criteria are used by smallholder farmers for indigenous chickens in the study area?
- What is the productive and reproductive performance of indigenous chickens in the study area?
- What are the key morphological traits of indigenous chickens in the selected districts of North Gojjam, Amhara Region, Ethiopia?

CHAPTER TWO: LITERATURE REVIEW

2.1. Origin and Classification of Chicken Population

2.1.1. Origin and domestication of chicken

The domestic chicken (Gallus gallus) is believed to have descended from the wild Indian and Southeast Asian red jungle fowl (Taye, 2019).The domestication of fowl in theregion of the Indu -s valley is believed to have occurred by 2000 BC, but more recent archaeological evidences showed that a much earlier domestication occurred in China during 6000 BC Getu *et al.*, 2014). Four species of Gallus have been considered as progenitors of the domesticated fowl: Gallus gallus (Red jungle fowl), Gallus lafayettei (Ceylon jungle fowl), Gallus sonnerrati (Grey jungle fowl) and Gallus varius (Green jungle fowl) and all found in regions of Southeast Asia (Taye *et al*., 2023). Gallus varius, include the Red Jungle Fowl, Grey Jungle Fowl, Ceylon Fowl, and Green Fowl. These species are examples of the Gallus family that conceivably played a role in domestication (Taye *et al*., 2023). The red jungle fowl is one of the oldest domesticated birds and its popularity quickly spread to Europe (Ergicho, 2017). Surprisingly, its original popularity untill the beginning of the 19th century was not for meat but for game of cock fighting and use in religious rituals (Asmamaw, 2016). The evolutionary history of the domestic fowl can be divided into three phases. The first phase started with the evolution of the genus Gallus, followed by the emergence of the domestic fowl from its progenitors, and lastly the appearance of a large number of the current breeds, varieties, strains, and lines (Omer, 2023).

2.2.2.Classification of indigenous chicken

The Ethiopian indigenous chickens are non-descriptive (they do not have a common, defined name) and are closely related to the jungle fowl and vary in plumage color, comb type, body con formation, and weight. They are characterized by a slow growth rate, late sexual maturity, low production, and low reproductive performance (Hailu and Melesse, 2018). Non-descriptive indigenous chickens in Ethiopia are found in huge numbers, distributed across different agro-ecology categories, under a traditional family-based scavenging management system (Teshome, 2018). A small portion of Ethiopian indigenous chickens has been identified and characterized

These include the ecotypes Tilili, Horro, Chefe, Jarso, and Tepi (Dessie *et al*., 2003); Gelila, Debre-Elias, Melo Hamusit, Gassay, Guangua, and Mecha (Hassen, 2007); and Farta, Konso, Mandura, and Sheka (Dana, 2011). These are among the major chicken ecotypes found in various regions of Ethiopia. According to Emebet *et al*. (2015), about four indigenous chicken ecotypes were identified and characterized, Dawo, Seden Sodo, Mehale Amba, and Mehurena Aklile chicken ecotypes were studied in South West Showa and Gurage Zones of Ethiopia.

Table 1: Some Indigenous chickens classified based on their location and special features

Ecotypes	Peculiar feature	Reference
Tilili	Red plumage color (29%), no naked neck black eye color (100%), single combed (57.7%) red skin color (83.8%)	Hassen, (2007
Mecha	Plain and crest head shape, all comb type (40%) 97% don't have shank feather. most have yellow shank color	Hassen, (2007
Horro	Flat head shape (44%), all comb type (56% pea), blocky body shape, most have yellow shank color (57%)	Dana, (2011)
Tepi	Red plumage color (29%), no naked neck, black eye color (100%), single combed (57.7%), Red skin color (83.8%)	Getu *et al.*, (2015)
Debre Elias	Plain head shape (70%),Comb type (40% pea), no-single and V-shaped, 97% don't have shank feather, 55% Yellow shank color	Hassen, (2007)
Farta	Crest head shape (75%), all comb type (52% pea), blocky body shape, most have yellow shank color (81%)	Dana, (2011)
Jarso	Red plumage color, no black eye color.	Aklilu *et al*., (2013)
Melo Hamusite	Crest head shape (72%), All comb type (57% pea) except Strawberry, 97% don't have shank feather, 55% Yellow Shank color strawberry no shank feather, most have yellow shank color	Hassen, (2007)
Konso	Flat head shape (64%), all comb type (49% pea), blocky body shape (82%), most have yellow shank color (54%)	Dana, (2011)
Sheka	Flat head shape (44%), all comb type (55% pea), blocky body shape, most have yellow shank color (60%)	Dana, (2011)
Gasgie	Long neked and red in color	Getu *et al.*, (2015)

Galila	Plain head shape (68%), all comb type (40% pea) 96% don't have shank feather, 59% yellow shank color	Hassen, (2007)
Mndura	Crest head shape (51%), all comb type (56% pea), blocky body shape, most have yellow shank color (57%)	Dana, (2011)

2.3. Chicken Production System in Ethiopia

The chicken production in Ethiopia can be categorized into three major systems based on some selected parameters, such as breed, flock size, housing, feeding, health care, biosecurity, and other technologies. These are traditional backyard local chicken production systems, small-scale commercial chicken production systems, and large-scale commercial chicken production systems (FAO, 2007).

2.3.1. Village or backyard chicken production system

Village chicken production system in Ethiopia is generally characterized by little or no inputs for housing, feeding (scavenging is the only source of diet) and health care with minimal level of bio-security, high off take rates and high level of mortality (often >70%) due to lack of proper health care and veterinary services (Murray *et al.,* 2017). In this system of chicken production, flock size (ranging from 5 to 50 birds) comprised of indigenous and/or crossbred chickens, and it is practiced by households with access to rural markets (Wodajo, 2021). Similarly, Abegaz and Gemechu (2016), Gorga *et al.* (2016) reported that 71.6%, 77.9% and 95% of the farmers practice traditional or extensive production system in South West and South part of Ethiopia in Yeki district SNNPRs of Ethiopia and on different across agro-climatic zones in Ethiopia, respectively. However, according to Asmelash *et al.* (2018), the major (99%) chicken production system was scavenging without additional supplementation in Eastern Ethiopia. There is no designed selection and controlled breeding. The average number of eggs produced per hen per year at farmers management conditions was 54.5 in Mezhenger, Sheka and Benchi-Maji zones of south western Ethiopia (Yadessa *et al*., 2017).

2.3.2. Small scale commercial chicken production system

This type of chicken production system is better than free ranging production system since it uses inputs like medium level of feed, water, recommended housing/shelter, and veterinary service inputs and minimal to low bio- security. The small-scale commercial chicken production system involves use of specialized, commercial day old chickens (DOC) or pullets (200-1,000 broilers, 50-500 layers (Fitsum, 2016). Producers in this system have full access to veterinary services and the mortality rates are low to medium (<20%) (Abebe *et al*. 2015). Currently several small-scale chicken farms have emerged and they are contributing to improvement of livelihoods food security and poverty reduction (Litigebew *et al*., 2021) Small scale intensive poultry production currently plays a significant role in the employment of youth.

2.3.3. Large scale commercial chicken production system

This type of chicken production system is highly intensive production system involves an average of greater or equal to 10,000 birds kept under indoor conditions with a medium to high bio-security level. This system heavily depends on imported exotic breeds that require intensive inputs such as feed, housing, health, and modern management systems (Tolasa, 2021). It is estimated that this sector accounts for nearly 2% of the national poultry population. This system is characterized by higher level of productivity where poultry production is entirely market oriented to meet the large poultry demand in major cities (Abebe *et al,*2015). The existence of some how better biosecurity practices has reduced chick mortality rates to merely 5% (Bush, 2006).

2.4. Husbandry Practices of Indigenous Chicken Production in Ethiopia

2.4.1. Feeding and feed resources

In Ethiopia free range scavenging production system is the most commonly practiced type of local chicken production system (Abdi *et al.*, 2023). Under a scavenging system, most chickens are raised in small flocks where under household refuse, crop residues, homestead pickings, herbage, earthworms, insects and seeds are provided by the flock producers as feed resources for chickens (Abdi *et al.*, 2023). According to Birhanu (2020) the major supplementary feeds provide for their chicken in Awi zone was maize (39.8%), wheat (30.7%), barley (16.9%) and a mixture (12.7%) of them. Not only does their availability vary with the seasons of the year and the localities but also the nutrients available to locally scavenging chickens are generally deficient. 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. There is no planned feeding of rural household chicken in Ethiopia and the scavenging feed resources are almost the only source of feed (Teklay, 2019), in two district of Central Tigray. According to Asmamaw (2016), study almost all of the respondents (88.8 %) reported that scavenging system with a little supplementary feed is the two feed resources. According to Fitsum (2016), 95-98% of the small scale household poultry producers in centeral zone of Tigray offer supplementary feeding to their chickens.

2.4.2.Watering practice

Water plays an important part in the digestion and metabolism of the fowl in addition it serve as a media to administer some important vaccines. According to Teshome (2018), the water given to chickens was drawn from rivers (37%), pond (35%) and borehole (28%) and about 75% of the farmers provided water for their chicken twice a day usually in the morning and evening and 25% once a day at any time Dale, Poncho and Loka Abaya Weredas of Southern Ethiopia. According to Tizazu, (2017) farmers provided water for their chickens of Adlibutem (5.8%), morning only (61.7%), morning and evening (11.7%), morning and afternoon (18.3%) and morning, evening and afternoon (2.5%) in Debark and Dabat districts of North Gonder Zone.

2.4.3. Housing practice

Housing is the most important to chickens as it protects them against predators, theft, and rough weather and to provide shelter for egg laying and brooding. According to several studies in Ethiopia chicken house is highly important, but the attention given by chicken producer very small. As Teklay (2019), reported that 93.33% of respondents in Bench Maji Zone have no separate poultry house. According to Omer (2023), who indicated that only 18.33% and 15% of the respondents from low land and midland are of the study respectively had separate shelters for their chickens around Dire Dawa, Ethiopia. Similarly, the report of Aklilu (2017), reported 97.6% in Dale, Wonsho and Loka Abaya district of SNNPRS, 94.4% in Gomma district and 92.06% in both Horro and Jarso district respectively.

2.4.4. Health management practice

Health care is one management aspect of village chicken production to improve productivity of chicken they should be kept healthy. The major causes of death were seasonal outbreaks of chicken diseases, particularly Newcastle disease (locally known as 'fengele') (Alebachew *et al*., 2022). The majority of farmers (82%) used traditional medicine to cure chickens when they are infected. Farmers used traditional medicine such as simza, fito, and garlic with feeds (Teshome, 2018). On the other hand; 18% of respondents applied modern medicine prescribed by veterinarian. According to Fitsum (2016), 93.8% of the respondents confirmed the presence of dangerous disease outbreak in the midland and highland agro ecologies in centeral zone of Tigray. They reported that access to veterinary services appeared to be quite limited. In different parts of Ethiopia, no vaccination practice against poultry diseases (Ergicho, 2017).

2.5. Constraints and opportunities of indigenous chicken production

2.5.1. Opportunities of chicken production

Indigenous chickens provide major opportunities for increase protein production and income for smallholders. Indigenous chickens are good scavengers as well as foragers and have high levels of disease tolerance, possess good maternal qualities and are adapted to harsh conditions and poor quality feeds as compared to the exotic breeds (Yihun *et al*., 2021). To improve village chicken production and productivity for the future such as market availability credit service , feed access and training and extension service. Market was the primary opportunities (36%) for the sector improvement followed 28%, 16% and 20% of opportunities for chicken production credit, training and feed access respectively, (Bezabih, 2013).

2.5.2. Constraints of indigenous chicken production

Ethiopian poultry production and breeds supply is in advancing way, there are still challenges which constantly face poultry farms and farmers. Like feed availability and quality, disease and predators, extension problems, exotic chicken adaptation challenges, genetic dilution of local breeds and veterinary service shortages are the major today's poultry sector headaches (Fulas *et al.*, 2018).

2.5.2.1. Lack of feed resource

Poultry feed and nutrition is one of the most critical constraints to poultry production under both the rural small holder and large-scale systems in Ethiopia. The problem is mainly associated with lack of processing facilities, inconsistent availability and distribution and sub-standard quality of processed feeds, when available (Teshome, 2018). In village chicken production systems, it is difficult to estimate the economic and/or physical value of feed resource input because there are no direct methods of estimating the scavenged feed input. According to Birhanu, (2020) feed is critical problems especially in wet season under village scavenging chicken production system that may be necessitate persuading the farmer to practice strategic supplementation to increase meat and egg production thereby to play role in food security. Getu *et al*. (2014), farmers had no cleared idea in terms of the quality and quantity of supplementary feeds in north Gondar zone, Ethiopia.

2.5.2.2. Disease and predator

Disease and predator were the main constraints of indigenous chicken production at farmer management conditions in Lemo district of Hadiya zone in southern Ethiopia (Salo et al., 2016). According to Abdi (2022), disease is ranked first as a major constraint that hinders the village chicken production in different locations, followed by husbandry practices like housing and feeding. According to Teshome (2018) study major causes of chickens' infections was weather conditions or temperature (hot or cold) 38.0%, from market chickens 13.1%, when farmers could buying new chickens from market which may infected by diseases and entered to normalch ickens flocks, from neighbors chickens (9.2%) that infected by diseases, toxicities/ contaminat-ed feeds 6.5% (killed rats body that was by toxic, drinking water that stagnant for long times and some chickens were eating snakes and other worms that may be toxic in natures) and 4.5% hygiene (chickens house and around chickens house like, toilet house) was cause of chickens infectious and the remaining sources of chickens infections was unknown (28.8%) by the chickens owners. Predators such as birds of prey (locally known as Culullee) (34%), cats and dogs (16.3%), and wild animals (15%) were identified as major causes of village poultry in the rift valley of Oromia, Ethiopia (Omer, 2023).

2.5.2.3. Lack of proper housing

Housing systems in backyard system 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 (Teshome, 2018). Lack of knowledge and awareness and poor attention to village chicken were some of the reasons for not constructing separate chicken house. Proper housing does not only provide an environment that moderates environmental impact but also provides adequate ventilation for the birds to lay eggs in next boxes, as well as to feed and sleep in comfort and for security purposes (Fentie *et al*.,2013).

2.6. Productive and Reproductive Performance of Indigenous Chicken

2.6.1. Productive Performance of Indigenous Chicken

The production performances of indigenous chicken ecotypes were relatively poor as compared to exotic breeds. The low production performance of indigenous chicken was expressed as slow growth rate, late maturity, produce small sized eggs, small clutch size, broodiness and high mortality of chicks (Markos, 2014; Geleta; 2017.

2.6.1.1. Number of eggs per hen per clutch

The low production and productivity of the chickens is attributed to the poor management practice for local chicken in central Tigray, Northern Ethiopia (Tadesse, 2014). According to Birara *et al*., (2022) the hen lays about 13.8 eggs /hen/ clutch in Enarj Enawga and Enemay District, East Gojjam zone, Amhara region. Geleta, (2017), who reported that the overall mean number of egg per hen per clutch in Bure district, North west Ethiopia, in Wolaita zone, Southern Ethiopia and in lume district, east shoa zone, Oromia regional state, Ethiopia was 15.7±3.21, 14.7 and 15.8±3.8, respectively. Other study Yadessa *et al.,* (2017) who reported that the overall mean number of egg per hen per clutch in Kaffa Zone, South Western Ethiopia was 14 eggs.

2.6.1.2. Number of egg incubated, hatched and wasted eggs per clutch

The overall mean incubated eggs and hatched chicks per clutch of indigenous chicken were 11.21 and 8.44 respectively, in Centeral Ethiopia (Bekele, 2024). The number of incubated eggs and hatched chicks per clutch of indigenous chicken in South Omo Zone, Ethiopia was 9.03±.214 and 5.93±.123 respectively, (Gonta, 2021). According to, Tadele (2019) also reported the average number of eggs incubated and eggs hatched per clutch per hen of indigenous chicken in West Amhara region of Ethiopia were 10.2 ±.0 and 8.20 ±.2, respectively.

2.6.1.3. Annual egg production

The production performance of indigenous or local scavenging chickens of Ethiopia is low in case of low egg production potential with only about 36-60 small sized eggs produced per bird on an annual basis, high chick mortality and longer reproductive cycle or the low genetic potential. Regarding the production potential of indigenous chicken, studies carried out in Amhara region (Ayalew *et al*., 2023) indicated that the average annual egg production of the indigenous chicken was 61.91±5.70. Other studies reported that the overall annual egg productio -n per hen in central zone of Tigray as reported by Fitsum (2016), Hailu *et al.* (2017) and Geleta (2017), in Guji Zone of Oromia region, and in Lume district, East Shoa Zone, Oromia region was 69.6±15.57 eggs, 79.09±4.52 eggs and 76.4±3.4 eggs lay /hen /year, respectively.

2.6.2. Reproductive performance of indigenous chickens

Reproductive cycle takes longest time for indigenous chickens because they require long time to reach sexual maturity age and replace parent stock by traditional broody hens which require long time to recover the reproductive cycle.

2.6.2.1. Age at sexual maturity

According to Teklay (2019), the overall average age at first mating of local cock and hen of the two districts of central Tigray was 6.1 and 6.5, respectively. Zereu and Lijalem (2016), who reported that the overall mean ages at sexual maturity for male and female chickens were 5.6 and 5.5 months, respectively in Wolaita Zone, Southern Ethiopia. Similarly, Gebremariam *et al.*, (2017) reported that the mean age at first mating of cockerel was observed to be 22.64±0.17 weeks (5.66 months). Average age at first mating of local cock and hen of the two districts of in South Omo Zone, was 6.408±.09 and 6.808±.11, respectively, (Gonta, 2021).

2.6.2.2. Age at first egg laying

The overall mean age at first egg laying for female indigenous chicken was 6.69±0.36 month in West Guji, Ethiopia (Tesema *et al*., 2024). Tadele, (2019) also reported that respondents said that age at first egg laying for female indigenous chicken was 6.1±0.5 month. This variation in age at first egg-laying might be due to lack of proper supplementary feeds, availability of scavengable feed resources, disease outbreak and provision of clean water by the households.

2.6.2.3. Number of clutch per hen per year

Clutch numbers of Ethiopian indigenous chicken is different at different production and management systems. According to Welelew *et al.* (2016) studies, the clutch number of hens was 3.2 in West Amhara Region of Ethiopia under village chicken production system and the length of time it takes a chicken to mature depends mainly on feed availability. Abebe Hailu *et al*. (2017); Milkias *et al*. (2019) who reported that the overall number of clutch per hen per year in guji zone of Oromia region, Ethiopia and in Dawro Zone, Ethiopia was 2.79±0.13 and 3.04±0.10, respectively. The average number of clutch per hen per year for local chickens was 5.7±0.05 in East Gojam zone Amhara region (Birara *et al*., 2022).

2.6.2.4. Clutch length in days

According to Birhanu (2020), the overall mean clutch length of indigenous chicken in Awi zone was 22.36±0.12 days. According to Markos (2015); Kassa, (2018), and Tadele, (2019), who reported that the overall mean clutch length of local chicken in Central Tigray, in western Amhara, and in Kaffa Zone, South Western Ethiopia was 22.19±0.16, 23.98±0.61 and 20.0±5.3 days, respectively. Average clutches length of indigenous chicken was 21.6 days ranged from 15 -28 days in central Tigray northern, Ethiopia under rural household managements according to (Tadesse, 2014).

2.6.2.5. Hatchability percentage

Fertility and hatchability are major parameters of reproductive performance which are most sensitive to environmental and genetic influences. Hatchability is the percentage of fertile eggs that hatch. According to Tadesse (2014); Kassa (2018), studies the overall mean hatchability percentage of local chicken in Central Tigray and western Amhara, Ethiopia was 85.8%, and 85.75%, respectively. Other study the overall mean hatchability percentage of indigenous chicken was 79.90% in Amhara region (Ayalew *et al*., 2023).

Table 2: Summery of productive and reproductive performance of indigenous chicken**.**

Parameters	Quantity	Location	Reference
Reproductive performance			
Age at first mating (cockerel) in month	6.16, 5.1 respectively	Jimma Zone and East Gojjam	Teshome, (2018); Birara *et al*, (2022)
Age at first mating (pullet) in month	6.21, 5.13 respectively	Northwest Ethiopia and Centeral Tigray	Muluneh *et al*, (2024); Teklay (2019)
Age at first egg laying (pullet) in month	6.1, 6.26 respectively	Awi Zone and in Amhara Region	Birhanu, (2020); Ayalew *et al*, (2023)
Number of clutch per hen per year	3.2, 3.4 respectively	Western Amhara and Centeral Tigray	Zemene *et al*, (2016); Teklay (2019)
Clutch length in days	23.9, 17.7 respectively	Western Amhara and East Gojjam zone	Kassa, (2018); Birara *et al*, (2022)
Hactchability percentage	85.8, 85.75 and 59.6-82.83 respectively	Centera Tigray, Western Amhara and Ethiopia	Tadesse, 2014; Kassa, (2018) and Taye *et al* (2023)
Productiv performance			
Number of eggs per hen per clutch	13.8, 14	East Gojam	Birara *et al*.,(2022); Endale Yadessa *et al*., (2017)
Annual egg production	59, 50.39 respectively	Wolaita Zone and West Gugi	Gebre egziabher and Tsegay,(2016); Tesema *et al*, (2024)

2.7. Mating practice and selection criteria for indigenous chicken

Local chicken breeding practices is not undertaken through selection and cross breeding for most developing countries. According to Muluneh (2024), all farmers practiced uncontrolled (natural) mating system. Even though it is difficult to control mating of chicken in scavenging production system, farmers have their own criteria and strategies of selecting chickens for breeding (Ergicho, 2017). Birara (2022), reported that majority of the respondents 51.11% in Enemay and 28.89% in Enarj Enawga district were uses line breeding and 8.89% and 11.11% of the householders were use cross breeding in Enarj Enawga and Enemay districts, respectively. Other study, Teshome (2018), explained breed selection criteria of farmers such as body weight (55.6%), comb type (34.3%) and plumage color (10.1%) were the major selection criteria of farmers in genetic improvement for male chickens in Seka Chekorsa and Kersa District of Jimma zone.

2.8. Phenotypic characterization of indigenous chicken

2.8.1. Qualitative traits

Indigenous chickens vary morphologically in body size (small, medium and large), plumage color, comb type, comb color, earlobe color, eye color, egg shell color, head and body shape, shank feather, feather morphology, feather distribution and growth (Markos, 2014). This indicate the presences of a considerable diversity of phenotypic characters within and between indigenou s chicken ecotypes and used as a potential for genetic improvement of local chicken ecotypes thr -ough selection. According to the report of Bekele *et al.* (2015), 5% of feather distribution of local chicken was normal feathered while 5% of local chicken was naked neck in Bench Maji zone, South Western Ethiopia. Similarly also reported that 75.9-83.6% of feather distribution of local chicken ecotype was normal feathered while the rest 3.25 and Woldie *et al*. (2019) 12.3-20% was naked neck and crested, respectively in west Hararghe Zone, Oromia region, Ethiopia.

2.8.2. Quantitative traits

Quantitative traits of chickens have high economic importance for indigenous chickens. Body weight and other body measurements are useful parameters that are used to describe a breed or type jointly with the breed's morphological characteristics and the environment it inhabited (Fitsum 2016). According to Alebachew *et al*. (2019), studies the overall beak length of male and female chicken in Benishangul-Gumuz Region, Western Ethiopia was 1.6±0.25 and 1.5±0.21 cm, respectively. Other studies Woldie *et al*. (2019) the average chest circumference of male and female chicken in west Hararghe zone, Oromia region, Ethiopia was 25.42±0.26 and22.55±0 .07 cm, respectively. According to Hailu Assefa and Aberra Melesse (2018), reported that the average body weight of male and female chicken in Ethiopia and in Sheka Zone nwas 1.69±0.03 and 1.29±0.02;1.68±0.2 and 1.42±0.2 kg, respectively. Other studies revealed that the mean values of body weight (1.40 ± 0.02), chest circumference (27.8± 0.10) and wing span (40.44 ± 0.02) were obtained in Kuyu district while keel length (10.5 ± 0.09) and neck length (14.68± 0.12) were better in Girar Jarso district North Shewa zone, Oromia region (Tamirat *et al*., 2023).

CHAPTER THREE: MATERIALS AND METHODS

3.1. Description of the study area

North Gojam zone is one of the 11 zones of Amhara region, which is located in the NorthWest at 446.5 km from Addis Ababa.The area covers about 1,431,360 ha. This Zone is delimited with the North borders by South Gondar administrative Zone; the South by Oromia National Regional State, East Gojjam administrative Zone and Awi nationality administrative Zone, (Source: Bahir Dar zuria district office). Bahir Dar zuria is one of the districts of North Gojam zone of Amhara region. It is situated at an altitude ranging from 1700-2300 meters above sea level and has area coverage of 151,119 ha. The area receives an average annual rainfall ranging from about 820 to 1250 mm. The minimum and maximum daily temperatures of the area are 10^0C and 20°C, respectively. The district has a total human population of 41219, among those 35464 are men and 5749 are women (CSA, 2022). The livestock population of the area is estimated to be 371, 769 cattle, 32564 goats, 62320 sheep, 159667 poultry, 71 horse, and 1713 mules (DOA, 2022). Bahir Dar zuria district has 36 kebeles which falls into the three climatic zones: highland, midland and lowland.

Gonji Kollela Distict is one of the districts of North Gojam Zones of Amhara region. The altitudinal range of the district is 1400-4300 meters above sea level. The mean annual temperature of the woreda ranges from 20^0C to 30^0C. It receives a mean annual rainfall of 1700 mm to 2000 mm. The district has a total human population of 20750, of which 17383 are men and 3375 are women (CSA, 2022). The livestock population also includes cattle (62356), sheep (46280), goats (35617), poultry (131935), equine (15092), honey bee hives (12722) including traditional (12453), modern (231), and transitional hive (38). Gonji Kollela districts has 36 kebeles which falls into three agro-climatic zones: highland, midland, and lowland.

Yilmana Densa District is one of the districts of North Gojam Zones of Amhara region. The district has a total human population of 44436, out of these, 29436 are men and 15000 are women (CSA, 2022). Its altitude is in the range of 1552 to 3535 m.a.s.l and average annual rainfall of 1270 mm with the main rainy season from May to October.The mean annual temperature ranges from 8.8 to 25.2°C. The livestock population of the area is estimated to be cattle (128,559), sheep (81089), goats (51996), poultry (105895), donkeys (24611), horse (684) and mules (4627). Major crops grown in the districts are teff, wheat, maize, barley, potato, field pea, faba bean, and finger millet.The district has 33 rural and 3 town kebeles which falls in to three agroecologis those are lowland, midland and high land.

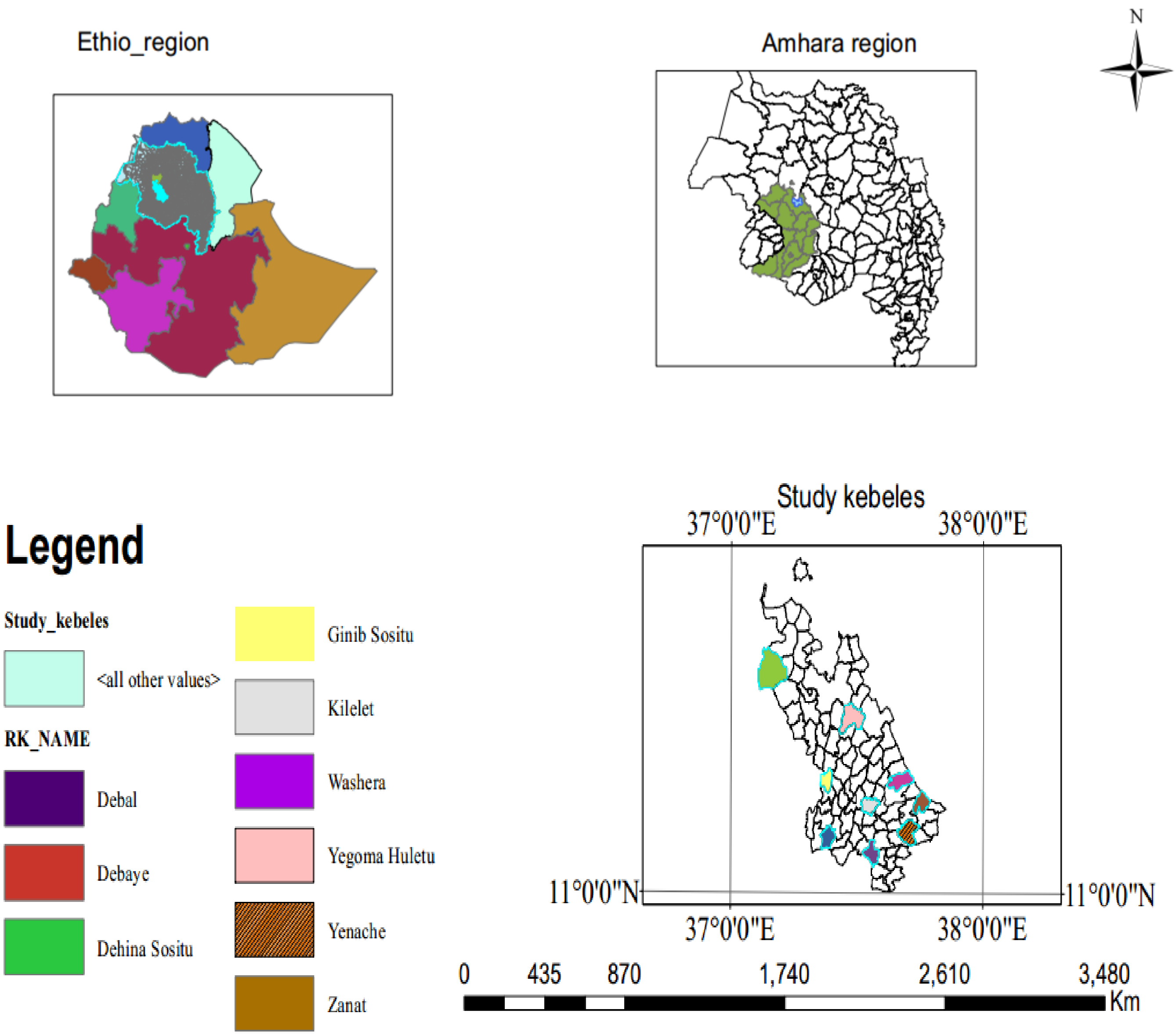

Figure 1. Map of the study area

3.2. Sample size determination and sampling technique

North Gojjam Zone has a total of seven districts; among the seven districts, three districts, namely Bahir Dar Zuria, Yilmana Densa, and Gonji Kolela, were selected purposively based on indigenous chicken production potential and road accessibility. In each district, three kebeles were selected based on agro-ecology and chicken production potential, and thus a total of nine kebeles, i.e, Washra (HL), Yinach (ML), and Zanat (LL) from Gonji Kolela, Ginib Sositu (HL), Yegoma Huletu (ML), and Dehina Sositu (LL) from Bahir Dar Zuria, Daval (HL), Devay (ML), and Kilelet (LL) from Yilmana Densa, were selected purposively for the study. For survey data, a total of 388 households (132 from highland, 136 from midland, and 120 from lowland agro-ecologies) were selected using a simple random sampling technique. For the household survey, a semi-structured questionnaire was developed and used to collect data.

The numbers of households used for questionnaries survey in the study area was determined using the formula given by Yamane (1967) with a 95% confidence level.

$$\mathrm{n} = \frac{\mathrm{N}}{1 + \mathrm{N}(\mathrm{e})^2}$$

Where:

$N =$ is the population size/ households having indigenous chicken

$n =$is the sample size

$e =$is acceptable estimated error (0.05)

$$\mathrm{n} = \frac{\mathrm{N}}{1 + \mathrm{N}(\mathrm{e})^2} = \frac{13326}{34.315} = \quad 388$$

The number of respondents (farmers) per single selected kebeles were determined by using the formula derived by Bellhouse (2005) of proportionate sampling technique as follows:

$W = [A/B] x No$

Where:

W = Number of respondents required per kebele

A = Total number of households (farmers) having indigenous chicken in the kebele

B = Total number of households having indigenous chicken in the nine kebeles and

No = The total required calculated sample size.

Table 3: Number of respondent households selected per each kebele within agrocology

District	Sampled kebeles	Agro-ecology	Total HHs	Requierd HHs
Bahirdar Zuria	Ginib Sositu	HL	1213	35
Yilmana Densa	Dabal	HL	2007	58
Gonji Kolela	Washera	HL	1325	39
Total			**4545**	**132**
Bahirdar Zuria	Yegoma Huletu	ML	1693	49
Yilmana Densa	Kilelet	ML	1930	56
Gonji Kolela	Yenache	ML	1075	31
Total			**4698**	**136**
Bahirdar Zuria	Dehina Sositu	LL	1066	31
Yilmana Densa	Debay	LL	2117	62
Gonji Kolela	Zanat	LL	900	27
Total			**4083**	**120**
Overall total			13326	**388**

The representative sample chicken population was determined by the formula given by Cochran' s (1977) as recommended by (FAO, 2012) for phenotypic characterization of livestock for simple random sampling.

$$n = Z^2 \times \frac{(p)(q)}{(e)2}$$

Where:

n =sample size for finite population

Z =standard normal deviation (1.96 for 95% confidence interval)

$p = 0.13$(estimated population variability proportion, 13% the conservative population variability)

$$q = 1 - p\ i.e\ (1 - 0.13) = 0.87(87\%)$$

$e = (0.03)$level of precision (sampling error).

$$n = Z^2 \times \frac{(p)(q)}{(e)2} = 1.96 \times (0.13)(1 - \frac{0.13}{(0.03)2}$$

$$3.8416 \times \frac{0.1131}{0.0009} = \mathbf{483}$$

Corrected n can be calculated as: $n = n/\ (1 + (\frac{n}{N})$

Where:

n =corrected number

N = total poultry population

$$n = n/(1 + \left(\frac{n}{N}\right) = \frac{483}{1} + \frac{483}{43433} = \mathbf{478}$$

Based on this formula, a total of 478 samples of indigenous chicken were used for measurement and observational data. A proportionate sampling technique was used to determine sample size from each agro-ecology. 148 (99 female and 49 male) chickens from highland, 231(154 female and 77 male) chickens from midland, and 99 (66 female and 33 male) chickens from lowland were used in both sexes for observational and measurement data. Sample chickens aged six months and older are selected from each of the nine kebeles using a simple random sampling technique.

Table 4: Number of sampled chicken selected per kebele within agroecology

District	Sample kebeles	Agro-ecology	Total No of chicken	Requierd sample chicken
Bahirdar Zuria	Ginib Sositu	HL	6641	73
Yilmana Densa	Dabal	HL	3426	38
Gonji Kolela	Washera	HL	3380	37
Total			**13447**	**148**
Bahirdar Zuria	Yegoma Huletu	ML	6289	69
Yilmana Densa	Kilelet	ML	10496	116
Gonji Kolela	Yinach	ML	4192	46
Total			**20977**	**231**
Bahirdar Zuria	Dehina Sositu	LL	5254	58
Yilmana Densa	Debay	LL	2211	24
Gonji Kolela	Zanat	LL	1544	17
Total			**9009**	**99**
Overall total			43433	478

3.3. Methods of Data Collection

Primary data was gathered using a semi-structured questionnaire from sampled respondents, observation and measurement data and from secondary data sources like zonal and district livestock and fishery development office reports, non-governmental organization publications, and other published and unpublished data sources.

3.3.1. Questionnaire data

Asemi-structured questionnaire was conducted for household survey and translated in to Amharic and pre-tested before the actual survey. The questionnaire survey was enabled us to investigate socio-economic characterstics of households, flock size and structure, husbandry practices, opportunities and constraints of chicken production, and productive and reproductive performance of chickens including age at first mating (month), age at first egg laying (month), average number of egg laid per clutch, clutch length in days, number of clutch per hen per year, hatchability percentage, number of eggs incubated, number of eggs hatched, number of eggs wasted, annual egg production of indigenous chickens was collected using questionairy survey.

3.3.2. Observational and body measurements data

Phenotypic data used for characterization was collected by observation and measurements adapted from chicken breed descriptor lists developed by FAO (2012). Data collected on observation and measurement were grouped as qualitative and quantitative data, respectively.

3.3.2.1. Qualitative data collection

From direct observation of adult chickens and additional information obtained by asking the owner, a total of 478 six-month-old or older chickens (148 chickens from highland, 231 chickens from midland, and 99 chickens from lowland agro-ecologies) were collected. Qualitative data, such as feather distribution, plumage color, comb type, shank feather, beak color, shank color, earlobe color, eye color, and head shape, were collected. This data was observed and recorded through visualization using a standard format breed descriptor list (FAO, 2012). Additionally, pictures of each observed chicken were taken in order to collect data on qualitative features.

3.3.2.2. Quantitative data collection

Based on typical breed characteristics, a total of 478 indigenous chickens were selected from mature chickens that were six months old or older, as identified by chicken owners. Out of these, 159 were males (cocks) and 319 were females (hens) sampled from each of the selected agro-ecologies in accordance with FAO (2011) recommendations. Linear body measurements includin

-g body length (BL), wing span (WS), Chest circumference, shank length (SL), shank circumference (SC), wattle length (WL), wattle width (WW), beak length (BL), earlob length (EL), comb length (CL), and comb width (CW) were measured from both females and males using a rubber tape centimeter (FAO, 2012). Body weight (BW) was measured by weighing the chicken in a standing position using a hanging spring balance (kg). Measurements were taken early in the morning to minimize the effects of feeding and watering on the chicken's size and conformation, as well as to facilitate catching the birds when they are resting in nests or within their house.

3.4. Data Analysis

All collected data were entered and recorded in a Microsoft Excel sheet. Collected data on qualitative traits of indigenous chickens were entered and coded in SPSS (version 22) for analysis. The qualitative data were described and analyzed by using descriptive statistics and chi-square ($\chi 2$) test was used to compare categorical variables for significance across agro-ecologies. General Linear Model procedure (PROC GLM) SAS 9.0 was used for analysis of liner body measurements with the fixed effects of agro- ecology, sex and their interactions. Means were compared using Duncan's multiple range test and values were considered at significance level $P<0.05$.

$$\mathbf{Y_{ijk} = \mu + A_i + S_j + A_{iSj} + e_{ijk}}$$

Where:-

Y_{ijk}: The observed body weight or linear body measurements in the i^{th} agro-ecology, j^{th} sex and ij^{th} interaction effects of agro-ecology by sex

μ: Overall population mean for the corresponding quantitative trait

A_i: Fixed effect of i^{th} agro-ecology (i = highland, midland and lowland)

S_j: Fixed effect of j^{th} sex (j=male and female)

A_{iSj}: Interaction effect of i^{th} agro-ecology and jth sex

e_{ijk}: Residual error

3.5. Ranking data analysis

Ranking analyses were used for computing data on the purpose of raising chickens, selection criteria of breeding hens and cocks, constraints and opportunity of chicken production, following the ranking formula developed by Kosgey (2004).

$$Index = \Sigma[\text{n} * \text{number of HHs ranked 1st} + \text{n} - 1 * \text{number of HHs Ranked 2nd} + 1 * \text{HHs Ranked last}] \text{ for individual traits divided by}$$

$$\Sigma[\text{n} * \text{number of HHs Ranked 1st} + \text{n} - 1 * \text{number of HHs Ranked 2nd} + 1 * \text{number of HHs Ranked last}] \text{ for all traits}$$

$$Where: n = number\ of\ traits\ under\ cosideration$$

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.1. Household Characteristics

The household characteristics of interviewed village chicken owners are presented in Table 5. From the total respondents, 21.6% were males, while 78.4% were female households. This result indicated that poultry management was primarily the responsibility of women, and they were also well informed about all aspects of chicken rearing across the study areas. In addition to that, during the time of data collection, most of the time contact for the interview was made with women in the house because women spent more time inside the house than men. The predomina-nce of female respondents in smallholder chicken production is attributable to cultural norms positioning it as a woman's domain, women's availability for daily management tasks, and their access to control over chickens as women’s assets that can generate household income(Adz -itey *et al*., 2020). This result was in disagreement with Kefale and Mitiku (2023), who reported that the majority of respondents were males in Fogera district, Amhara region. However, the current result is in line with the research findings of Ayalew *et al*. (2023), who revealed that the majority of respondents involved in poultry production were female (78.33%) in West Gojjam, Central Gondar, and South Wollo Zone. This result was also in agreement with the research finding of Begna *et al*. (2025), who indicated that the majority of respondents involved in poultry production were females (68.8%) in West Shewa Zone, Oromia region.

Regarding the educational status of respondents, 53.8% were illiterate, 16.7% could read and write, 14.2% had completed primary school, and 10.8% had attended secondary school, respectively. This study in line with Kefale and Mitiku (2023), who noted that 50 % of respondents were illiterate in Fogera district, Amhara region. The proportion of illiterate respondents in/ the midland areas (36.8%) was lower than in highland (49.2%) and lowland (79.2%) areas, due to a lack of awareness in the lowland and highland areas. This variation in educational attainment aligns with findings that smallholder farmers' access to education can differ based on their geographical location, which may influence their adoption of improved chicken management practices, as more educated farmers tend to be more receptive to new technologies and information (Mwaura *et al*., 2020).

The survey revealed that all respondents (100%) in the study area were followers of the Orthodox Christian faith, indicating that the predominance of Orthodox religious practices in the area might influence poultry meat consumption. Regarding occupation, 85.8% of the interviewed households were engaged in farming, while 6.2%, 0.5%, and 7% were employed, unemployed, and involved in carpenter work, respectively. The high proportion of farmers participating in village chicken production may be due to their livelihoods relying on livestock and crop production. The result of the current study was nearly similar with the research finding of Tizazu (2017), who revealed that 90% of respondents were fully involved in farming activities in North Gonder Zone of Amhara region. Regarding the marital status, 89.9% of the respondents were married, while 5.9% were single and 4.2% were widowed. This result was in agreement with the finding of Birhanu (2020), who reported that the majority of respondents were married (70.6%) in Awi Zone, Amhara Region. This indicated that married individuals may have access to shared labour within the household (children or relatives), which motivates them to engage in income-generating or subsistence activities such as indigenous chicken rearing. This makes managing chickens more feasible and efficient, especially in rural settings where family-based labour is common.

Concerning age distribution, the majority of respondents (40.9%) were in the age group of 31-40, while 36.9% were in the 41-50 age group, 10.8% were between 15 and 30 years, 9.3% were between 51 and 60 years, and 1.8% were over 60 years old. The respondents categorized under the 31-40 age group are considered the most active and productive stage of life, and contribute to a higher level of production compared to other age groups. This indicated that the majority of respondents were physically active, adopting new technologies (feeding techniques, disease control, etc.) and access to training all of which contribute to higher levels of production compared to other age groups, whereas respondents age beyond 40 especially after 51-60 and above there is physical limitations and health concerns resulting reduced engagement in poultry activities. This study was in agreement with the research findings of Tizazu (2017), who indicated that the majority of respondents (32.5%) were within the age group of 31-40, while 25% were within the age range of 41-50 years in North Gonder Zone. This was also in line with Teshome (2018), who documented that the largest proportion of respondents (48.3%) belonged to the 31-40 age group in Jima Zone.

The average family size in the study area was 5.6±1.45. The higher family size was exhibited in lowland (6.0±1.23) than midland (5.47±1.6) and highland (5.33±1.52) agro-ecologies. These differences might be attributed to variations in awareness and practice of family planning among households. The overall family size observed in the study area was lower than the value reported by Kassa *et al*. (2020), who documented that the average family size of the respondents in West Gojjam and Awi Zone was (5.75± 1.91). It is established that household size impacts the available labor force and resources for investment in poultry production and influences the income earned from poultry farming (Gauchan *et al*.,2020). The overall mean landholding per household in the study area was 1.27±0.73 hectares per household. The average land size per household in lowland (1.6±1.47) was higher than in midland (1.29±0.39) and highland (0.93±0.32) agro-ecologies. This result was in agreement with the finding of Begna *et al*. (2025), who reported that lowland areas had the largest average land size per household (2.34±0.22ha) than midland and highland (1.73±0.1ha), (1.54±0.12ha), respectively, in West Shewa Zone, Oromia region. This might be due to the topography of the lowland area, which is steep and unsuitable for settlement, resulting in a low population density, while highland and midland agro-ecologies were found to be more suitable for both crop and animal production (Desta, 2023).

Table 5: House hold characterstics of respondents in the study area

Parameter	Agro-ecology			
	Highland (N=132)	Midland (N=136)	Lowland (N=120)	Overall (N=388)
Sex				
Male	29 (22%)	28 (20.6%)	28 (23.3%)	28 (22%)
Female	103 (78%)	108 (79.4%)	92 (76.7%0	101 (78%)
Age				
15-30	14 (10.6%)	18 (13.2%)	10 (8.3%)	14 (10.7%)
31-40	35 (26.5%)	82 (60.3%)	43 (35.8%)	53 (40.9%)
41-50	61 (46.2%)	25 (18.4%)	57 (47.5%)	48 (37%)
51-60	17 (12.9%)	10 (7.4%)	9 (7.5%)	12 (9%)
> 60	5 (3.8%)	1 (0.7%)	1 (0.8 %)	2 (1.8%)
Educational background				
Illiterate	65 (49.2%)	50 (36.8%)	95 (79.2%)	70 (53.8%)
Read &write	28 (21.2%)	38 (27.9%)	16 (13.3%)	20 (16.7%)
Primary school	23 (17.4%)	28 (20.6%)	7 (5.8%)	17 (14.2%)
Secondary school	16 (12.1%)	20 (14.7 %)	2(1.7%)	13 (10.8%)
Religion				
Muslim	-	-	-	
Orthodox	132(100%)	136 (100%)	120(100%)	129 (100%)
Occupation				
Farmers	113 (85.6%)	109 (80.1%)	110 (91.7%)	111 (85.8%)
Carpenter	10 (7.6%)	13 (9.6%)	4 (3.3%)	9 (6.8%)
Unemployed	2 (1.5%)	-	-	0.7 (0.5%)
Employed	7 (5.3%)	14 (10.3%)	6(5%)	9 (6.9%)
Marital status				
Married	114(86.4%)	118 (86.8%)	113 (94.2%)	115 (89%)
Single	10 (7.6 %)	12 (8.8%)	1(0.8%)	7.67 (5.7%)
Widow	8 (6.1%)	6 (4.4%)	6 (5%)	6.76 (5%)
Average family size (Mean±SD)	5.33 ± 1.52^{b}	5.47 ± 1.6^{b}	6 ± 1.23^{a}	5.6±1.45
Average land holding (Mean±SD)	0.93 ± 0.32^{c}	1.29 ± 0.39^{b}	1.6 ± 1.47^{a}	1.27±0.73

Note: Values outside brackets represent the number of observations, while values inside brackets indicate the percentage (%), N= Number of respondents

The average mean values for livestock holding per household in the study area are indicated in Table 6. The average herd sizes per household were 4.4 ± 1.7 for cattle, 3.9 ± 2.13 for sheep, 3.2±2.5 for goats, 0.05±0.25 for mules, 0.07±0.28 for horses, 0.47±0.97 for beehives, and 0.97±0.77 for donkeys. Among the large livestock species, cattle dominated across all agro-ecologies. In this study, the average number of cattle per household was higher in lowland (5.3±2.3) than midland (4.1±1.6) and highland (3.69±1.3) agro-ecologies. The mean number of sheep was highest in highland (6.3±1.5) areas compared to midland (3.0±1.9) and lowland (2.3±3.0) agro-ecologies, whereas average numbers of goats (5.3±2.9) were greater in lowland areas. This variation might be attributed to differences in grazing behavior, ecological adaptation of the environment, household size, feed resources, and priority of farmers' preference to rear according to the relative importance of the animals. This finding was in line with the results of Tizazu (2017), who reported that cattle was the dominant large livestock species in North Gonder Zone, Amhara region.

Table 6: Average (Mean ±SD) number of livestock per household in the study area

Species	Agro-ecology Highland	Midland	Lowland	Overall	P-value
Cattle	3.69 ± 1.3^{c}	4.1 ± 1.6^{b}	5.3 ± 2.3^{a}	4.4±1.7	< .0001
Sheep	6.3 ± 1.5^{a}	3 ± 1.9^{b}	2.3 ± 3^{c}	3.9±2.13	< .0001
Goats	1.2 ± 1.3^{c}	3 ± 2.3^{b}	5.3 ± 2.9^{a}	3.2±2.5	<.0001
Donkeys	0.9 ± 0.7^{b}	0.8 ± 0.7^{b}	1.2 ± 0.9^{a}	0.97±0.77	.0004
Mules	0.07±0.3	0.18±0.4	0.13±0.3	0.05±0.25	.0234
Horse	0.07±0.3	0.07±0.3	0.07±0.25	0.07±0.28	.999
Beehive	0.86 ± 1.1^{a}	0.26 ± 0.9^{b}	0.3 ± 0.9^{b}	0.47±0.97	<.0001

^{abc} when different superscripts are indicated in the same row it means that there is mean difference between agro-ecologies.

4.2. Flock Size

The average flock size of indigenous chicken per household in the study area was 6.9±1.12, 2.66±0.85, 2.29±0.69, 1.6±0.75, and 1.47±0.66 for chicks, pullets, cockerels, hens, and cocks, respectively. A higher proportion of chicks (6.9±1.12) per household was recorded compared to other chicken flocks in all agro-ecologies. The average number of chicks per household in midland (7.31±1.15) was higher than highland (6.86±1.35) and lowland (6.54±0.87) agro-ecologies. This variation might be due to stable environmental conditions, provision of supplementary feed, disease prevalence, and predator pressure, as well as the economic status of the owners across agro-ecologies. According to the report of respondents, the flock size and structure may vary from season to season depending on feed availability, disease, predators, and during cultural and religious festivals due to the selling and consumption of chickens. This finding was not in line with Ayalew *et al*. (2023), who revealed that the dominant flock composition per household was hens (2.44 ± 0.92), followed by pullets (2.07 ± 1.21) in West Gojam, Central Gondar, and South Wollo Zones, Amhara region. However, this result was in agreement with Ergicho (2017), who revealed that the dominant flock composition per household was chicks (6.72 ±0.29), followed by hens (2.94 ±0.42) in Eastern Hararghe Zone.

About 53.1% of the respondents obtained their chicken from a hatchery, whereas 39.1% and 7.06% of respondents reported that the source of chicken was from the market and a gift from family, respectively. Hatching was the most important source of chickens across all agro-ecologies, which might be due to farmers' perception. This result was not in line with Birhan Kassa *et al*. (2020), who noted that the major sources for foundation stock were purchases for local exotic and cross-breeds in West Gojjam and Awi zone. However, the current study was in line with the finding of Wario Duba (2018), who noted that almost all of the respondents (58.35%) obtained source of foundation stock from their own hatched chickens for both sexes in Borena zone, Oromia region.

Table 7: Flock composition of indigenous chicken in the study area

Variable	Agro-ecology				
	Highland Mean±SD	Midland Mean±SD	Lowland Mean±SD	Over all Mean±SD	P-value
Chicks (0-8wks)	6.86±1.35^{b}	7.31±1.15^{a}	6.54±0.87^{c}	6.9±1.12	< .0001
Pullet (8-20wks)	2.71±0.99	2.65±0.84	2.63±0.71	2.66±0.85	0.3269
Cockerels (8-20wks)	2.10± 0.79^{c}	2.23±0.61^{b}	2.54±0.66^{a}	2.29±0.69	< .0001
Hen (>20wks)	1.6±0.74^{b}	1.87±0.84^{a}	1.32±0.66^{c}	1.6±0.75	.0017
Cock (>20wks)	1.23±0.45^{c}	1.42±0.63^{b}	1.77±0.89^{a}	1.47±0.66	< .0001
Overall chicken flock per household	14.50	15.48	14.80	14.92	
Source of foundation (N(%)					
Purchase	57 (43.2)	48 (35.3)	50 (41.6)	155 (39.9)	
Hatched	70 (53.03)	78 (57.4)	58 (48.3)	206 (53.1)	
Gift from family	5 (3.78)	10 (7.4)	12 (10)	9 (7.06)	

4.3. Husbandry practice of indigenous chicken

4.3.1. Feed and feeding practices

The major feeds and feeding practices of indigenous chickens in the study area are presented in Table 8. Overall, 84.8% of the respondents reported providing supplementary feed to their chickens, while the remaining 15.1% did not provide supplementary feed. The provision of suppl -ementary feed was a significant difference ($P<0.05$) between agro-ecologies. A higher proportion of households in the midland area (90.4%) provided supplementary feed compared to in highland (84.8%) and lowland (79.2%) areas. The lower percentage of feed supplementation in lowland areas might be a lack of awareness and a resource problem. This finding was in line with the study of Abdi (2022), who reported that the majority of respondents (92%) provided supplementary feed to their chickens in West Hararghe Zone, Oromia Region. Similarly, the current result was also in agreement with the study by Ayalew *et al*. (2023), who documented that the majority of the households (71.00%) were providing supplementary feed to their chicken in West Gojjam, Central Gondar, and South Wollo Zone.

The major types of supplementary feeds provided to their chickens in the study area were maize (45.6%), wheat (29.2%), barley (15.6%), and mixed grains (9.6%). The types of feed offered showed significant differennce ($p <0.05$) among agro-ecologies. The dominant feed in lowland agro-ecology was maize (60.8%), compared to midland (44.9%) and highland (31.1%). In contrast, wheat (40.2%) and barley (18.2%) were the primary supplementary feeds used in the highland areas. These finding was in agreement with Yihun *et al*. (2023), who revealed that widely used supplementary feed ingredients were maize (65.67%) followed by wheat (48.33%) and sorghum (35.33%) in West Gojjam, Central Gondar and South Wollo Zone. This result also in line with Tesema *et al*. (2024), who indicated that maize (59.3%) was the major supplementar-y feed used in West Guji, Zone of Oromia Region.

The overall frequency of chicken feed supplementation per day in the study area was distributed as follows: 42.1% of respondents provided feed in the morning only, 10.8% in the evening only, 20.5% in the afternoon only, and 20.5% both in the morning and afternoon. The frequency of daily feed supplementation was significantly different ($P<0.05$) across agro-ecologies. The possible reason for more frequent feed supplementation by some households may have been to enhance the egg-laying potential of hens and improve the growth performance of chicks. This result was in line with Tizazu (2017), who indicated that the majority of respondents, 61.7% offer supplement feed in the morning in the North Gonder zone. However, the current study disagrees with the research finding of Kefale and Mitiku (2023), who reported that the respondent provide supplementary feed three times per day at mooring and evening, morning andafter noun, morning, after noun and evening in the33.33%,6.67% and 53.33%, where as 6.67% provide feed atmorning only respectively, in Fogera district Amhara region.

Overall, 57.8% of respondents in the study area provided feed to their chickens using feeding troughs like plastic or metallic containers, while the remaining 42.2% distributed feed directly on the ground (by scattering it on clean surfaces). The reason for providing feed for their chicken by using a feeding trough might be to reduce feed contamination and reduce waste. The form of feed provision for chicken had a significant difference ($P<0.05$) between agro-ecologies. This result was in line with Birhanu (2020), who reported that 62% of households used feeding troughs, while 38% provided feed on bare ground in Awi Zone. A total of 78.6% of respondents reported that feed shortage happened during the rainy (summer) season, while the remaining 21.4% indicated that feed shortages occurred in the dry (winter) season. The occurrence of feed shortages varied significantly ($P<0.05$) across agro-ecologies. Thise study was disagree with Kefale and Mitiku (2023), who ndicated that 96.6 % of respondents reported feed shortages occurred during the rainy season in Fogera district, Amhara region.

Overall, (31.2%), (25.8%), (18.6%), (12.1%), and (11.3%) of respondents reported that priority given classes of chicken provided supplementary feeds were for five classes of chicken, such as chick, hen, pullet, cockerel, and cock, respectively. Classes of chicken given supplementary feeds showed a significant difference ($P<0.05$) across agro-ecologies. Chick was the first priority provided supplementary feeds, this might be chicks cannot effectively forage for insects, grains, or plants. The present study was in line with Wario Duba (2018), who indicated that chicks (60.

6%) were the first priority provided supplementary feeds in the Borena zone, Oromia region. In terms of feed sources, 96.2% of respondents obtained supplementary feed materials from crop harvests, while 3.8% purchase from markets. This result was in line with the findings of Teshome (2018), who reported that the majority of respondents (72.5%) obtained supplementary feed materials from crop harvests in Jima Zone, South West Ethiopia.

Table 8: Feed resources and feeding practices (n(%)) of indigenous checkens in the study area

Parameter			Agro-ecoloy			
	Highland N=132	Midland N=136	Lowland N=120	Overall N= 388	Chi-squre	P –Value
Provision of supplemental feed					421	.000
Yes	112(84.8)	123 (90.4)	95 (79.2)	110 (84.8)		
No	20(15)	13(9.6)	25(20.8)	19 (15.2)		
Types of supplemental feed					414.35	.000
Maize	41(31.1)	61 (44.9)	73 (60.8)	58 (45.6)		
Wheat	53 (40.2)	36 (26.5)	25 (20.8)	38 (29.2)		
Barely	24 (18.2)	22 (16.2)	15 (12.5)	20 (15.6)		
Household left over	14 (10.6)	17 (12.5)	7 (5.8)	13 (9.6)		
Frequency of feeding per day					428.63	.000
Morning only	41(31.1)	57 (41.9)	64 (53.3)	54 (42.1)		
Evening only	8 (6.1)	20 (14.7)	14 (11.6)	14 (10.8)		
Afternoon only	32 (24.2)	36 (26.5)	13 (10.8)	27 (20.5)		
Morning and afternoon	37 (28)	23 (16.9)	20 (16.6)	27 (20.5)		
Form of feed provision					389.35	.000
In the feeding trough	75(56.8)	86 (63.2)	64 (53.3)	75 (57.8)		
On the bare ground	57 (43.2)	50 (36.8)	56 (46.6)	54(42.2)		
Season of feed shortage happened					389.1	.000

Rainy season	104(78.8)	106(77.9)	95 (79.2)	102(78.6)		
Dry season	28 (21.2)	30 (22.1)	25 (20.8)	28 (21.4)		
Classes of chickens given supplementary feed					390.45	.000
Chick	45 (34.1)	41 (30.1)	35 (29.2)	121(31.2)		
Hen	31(23.5)	38 (27.9)	31(25.8)	100(25.8)		
Pullet	19(14.9)	26 (19.1)	27(22.5)	7 2(18.6)		
Cockerel	20 (14.4)	13 (9.6)	15 (12.5)	48(12.4)		
Cock	14 (10.6)	18(13.2)	12 (10)	44 (11.3)		
Source of supplementary feed(%)					396	.000
Crop harvested (Self-produced)	130 (98.5)	126(92.6)	117 (97.5)	124 (96.2)		
Purchased from market	2 (1.5)	10 (7.4)	3 (2.5)	5 (3.8)		

4.3.2. Water resources and watering practice

Water played an important role in the digestion and metabolism of chickens and also served as a media for administering essential vaccines. In the study area, all respondents (100%) reported providing water for their chickens (Table 9). This study was supported by the report of Lakachew (2024), who revealed that all of the respondents (100%) provided water for their chickens in West Gojjam Zone, Amhara region. 64.2%, 26.8% and 8.9% of the respondents provided water for their chicken in adlibitum (free access), twice a day, and once a day, respectively. The frequency of water provision to their chicken was not significantly different ($P>0.05$) across agro-ecologies. The current result was in line with Yihun (2020), who reported that the majority of the respondents (85.71%) provide water for their chicken in adlibitum (free access) in Awi Zone, Amhara region. Almost all respondents reported having regular watering troughs for their chickens across agro-ecologies. Overall, 57.9% of respondents used plastic troughs, 11% used wooden troughs, 29.1% utilized broken materials, and 1.9% employed stone made troughs. There was a significant difference ($P<0.05$) in types of watering troughs used across agro-ecologies. Slightly higher proportion of respondents used watering trough in highland (62.8%) than midland (62.5%) and lowland (48.3%) agro-ecologies. This finding was in line with the report by Ergicho (2017), who indicated that the most chicken owners used plastic troughs (64.00%) for watering in the Eastern Hararghe zone of Oromia Region. Respondents reported that the main source of water provided to chickens in the study area was river (64.5%), followed by tap water (30.5%), and pond water (4.9%). There was no significant difference (P>0.05) across agro-ecologies regarding the source of water. This result disagreed with Lakachew (2024), who revealed that the main source of water provided to chickens in West Gojjam zone was hand-operated pipe water (44.0%), followed by river (42.3%) and spring (13.6%).

Table 9: Provision of water, watering frequency, watering trough and sources of water (n(%)) in the study area.

Parameter	Agro-ecology					
	Highland N=132(%)	Midland N=136(%)	Lowland N=120(%)	Overall	Chi-squre	P value
Provision of water					-	-
Yes	132(100.0)	136(100.0)	120(100.0)	388(100)		
No	-	-	-	-		
Watering frequency					4.883	0.30
Once per day	16(12.1)	11(8.1)	8(6.6)	11(8.9)		
Twice per day	28(21.2)	41(30.1)	35(29.1)	35(26.8)		
Adlibtum/ free access	88(66.7)	84(61.8)	77(64.1)	83(64.2)		
Watering trough					14.783	0.02
Plastic made	83(62.8)	85(62.5)	58(48.3)	75(57.9)		
Wooden trough	11(8.3)	11(8.1)	20(16.6)	14(11)		
Broken material	38(28.7)	38(27.9)	37(30.8)	38(29.1)		
Stone made	-	2(1.5)	5(4.1)	3(1.9)		
Source of water					2.391	0.664
River	82(62.1)	88(64.7)	80(66.6)	83(64.5)		
Tap water	44(33.3)	43(31.6)	32(26.6)	40(30.5)		
Pond water	6(4.5)	5(3.7)	8(6.6)	6(4.9)		

4.3.3. Poultry housing

The result on poultry housing was presented in Table 10. The study indicated that 97.4% of the respondents in the study area had a poultry house, while the rest 6 % of the poultry keepers had no poultry house. This study was in agreement with Birhanu (2020), who showed that 93.9% of the respondents had a poultry house, while the rest 6.1% of the respondents had no poultry house in Awi Zone. However, the current finding disagrees with the research finding of Ergicho (2017), who revealed that 84% of the respondents had no separate poultry house, and the remaining 16% of respondents prepared a separate poultry house in the Eastern Hararghe zone, Oromia region. The proportion of available poultry houses in highland, midland, and lowland areas were 98.5%, 97.8% and 95.8%, respectively. This could be due to the fact that housing was essential to chickens as it protects them from predators, theft, disease, bad weather conditions (high rainfall, high sunlight, and high wind), and provides a nesting place (egg laying place of laying hens).

The housing system used by households for their chickens in this study was separate shelters (21%), perches inside the main house (42.7%), perches in other animal houses (17.7%), perches in the kitchen (12.4%), and perches on the veranda (6.2%). This study disagreed with the research finding of Fitsum (2016), who indicated that 65.7% of the respondents had a separate house for their chickens in Central Zone of Tigray. However, this result was in line with Alemu (2022), who reported that 85.6% of respondents perch inside the house in Gurage zone of central Ethiopia. The main reasons respondents had no separate chicken housing were lack of awarenes (63.9%), followed by less attention given to poultry (22%), lack of construction materials (1.6%) , low risk of predators (9.6%), and low risk of theft (2.9%). This indicates that the respondents are not aware of the importance of separate housing. This result agrees with Lakachew (2024), who reported that the major reasons for respondents not constructing separate poultry houses were lack of knowledge (38.4%), followed by less risk of predators (32.7%), and less (24.1%) in the West Gojjam Zone. This finding was also in line with Alemu (2022), who indicated that the reason respondents did not construct separate poultry houses was a lack of awareness (73.2%) in the Gurage Zone of central Ethiopia.

Table 10: Poultry housing system (n(%)) of the study areas

Housing practice	Districts/Agro ecology			
	Highland	Midland	Lowland	Overall Mean
	N=132(%)	N=136(%)	N=120(%)	N=388(%)
Availability of chicken house				
Yes	130 (98.5)	133(97.8)	115(95.8)	126 (97.4)
No	2(1.5)	3(2.2)	5(4.5)	3(2.7)
Housing type				
Separate shelter	29 (22)	31(22.8)	22 (18.3)	27(21)
Perch in the main house	58 (44)	55 (39.7)	53 (44.5)	55 (42.7)
Perch in other animal house	23 (17.4)	26 (19.1)	20 (16.7)	23 (17.7)
Perch in the kitchen	17(12.9)	16(11.8)	15(12.5)	16 (12.4)
Perch in the veranda	5 (3.8)	9 (6.6)	10 (8.3)	8 (6.2)
Reason for not having separate chicken house				
Lack of knowledge (Awareness)	86 (65.2)	86 (63.2)	76 (63.3)	83 (63.9)
Less attention given to poultry	34 (25.8)	32 (23.5)	20 (16.7)	29 (22)
Lack of construction materials (availability and cost)	-	-	6 (5)	2 (1.6)
Less predators risk	12 (9)	14 (10.3)	11 (9.5)	12 (9.6)
Less thief risk	-	4 (2.9)	7(5.8)	4 (2.9)

4.3.4. Poultry diseases

In the study area, about 85.2% of the respondents reported the availability of disease, as shown in Table 11. There was a significant difference ($p<0.05$) across agro-ecologies regarding disease outbreak. The prevalence of disease outbreaks was higher in the lowland agro-ecology (90.8%) compared to highland (85.6%) and midland (79.4%) areas. This variation may be due to adverse environmental conditions and poor management practices in lowland areas. The present study was in agreement with Birhanu (2020), who reported that 86.1% of respondents observed disease outbreaks across agro- ecologies in the Awi zone. About 81.6% of the respondents reported that chicken vaccines were not available, whereas the remaining indicated that chicken vaccines were available and no disease outbreak occurred in the study area. There was a significant difference ($p<0.05$) across agro-ecologies regarding vaccination availability. The availability of vaccination was higher in midland agro-ecology (23.5%) compared to the lowland (13.5%) and highland (18.2%) areas. This difference might be due to the availability of government and private veterinary clinics.

Respondents revealed that the major reason for not vaccinated chicken primarily due to lack of attention ginen to poultry (42.9%), followed by no access (37.9%) and lack of awareness (19.2%), as indicated in table 12. The reason for not vaccinated chicken had no significant difference ($P>0.05$) between agro-ecologies. In contrast to this study, Fitsum (2016), reported that lack of vaccination access (42.6%) was the major reason as compared to lack of awareness (20%), and lack of attention (20%) in Central Zone of Tigray. Regarding management of sick chickens the majority of respondents reported that sick chicks treated by themselves (48.9%) followed by taking chickens to veterinary clinics (37.4%), consumed them immidately (9.5%) and sold them immediately (0.5%) were measures taken for sick chickens in the study area.

The proportion of respondents who took their chickens to veterinary clinics was higher in midland area (33%) than highland (30.3%) and lowland (30.8%) areas possibly due to a higher percentage of educated people ,better road acess and veterinary services. This result was in line with Birhanu (2020), who revealed that the majority of respondents (61.1%) treated sick chickens by themselves in Awi zone Amhara region. This study was also supported by the finding Ergicho (2017), who noted that the majority of respondents (55.55%) treated sick chickens by themselves in Eastern Hararghe zone, Oromia region.

Table 11: Disease, vaccination availability and action taken (N(%))

Variable	Agro-ecoogy			Agro-ecology		
	Highland N(%)	Midland N(%)	Lowland N (%)	Overall N(%)	X^2-Value	P-value
Availability of disease					6.59	0.04
Yes	113 (85.6)	108(79.4)	109 (90.8)	110 (85.2)		
No	19 (14.4)	28 (20.6)	11 (9.2)	19 (14.7)		
Chicken vaccination available					6.46	0.04
Yes	24 (18.2)	32(23.5)	16 (13.5)	24(18.3)		
No	108 (81.8)	104 (76.5)	104 (86.6)	105 (81.6)		
Reason for not vaccinated chicken					1.22	0.87
Lack of attention given by farmers	57 (43.2)	55 (40.4)	54 (45)	53 (42.9)		
No access	48 (36.4)	60 (44.1)	40 (33.3)	49 (37.9)		
Lack of awareness	27 (20.5)	21 (15.4)	26 (21.7)	25 (19.2)		
Treatment of sick chicken					11.59	0.17
Take to veterinary clinic	40 (30.3)	45 (33)	37 (30.8)	40 (37.4)		
Treat by themselves	63 (47.7)	60 (44.1)	66 (55)	63 (48.9)		
Kill them immediately	16 (12.1)	17 (12.5)	5 (4.2)	12 (9.6)		
Consume them immediately	11 (8.3)	14 (10.3)	12 (10)	12 (9.5)		
Sell them immediately	2 (1.5)	-	-	0.7 (0.5)		

4.4. Constraints and opportunties of indigenous chicken production system

The major challenges associated with chicken production were presented in Table 12. Based on the overall responses collected from respondents, diseases and predators were the 1st and 2nd main constraints that devastate chicken productivity in the study area with an index value of 0.3 and 0.25, respectively. This result was in line with Omer (2023), who reported that disease and predators were the 1st (0.25) and 2nd (0.22) major challenges that downgrade the chicken productivity in Drie Dwa, Ethiopia. This study was also in agreement with the findings of Tizazu (2017), who indicated that diseases and predators were ranked first and second major constraints in village chicken production in North Gonder Zone. However the present study was not supported by Ergicho (2017), who showed that predators (1st), disease (2nd) and infrastructure (3rd) were ranked as major constraints of chicken production in Eastern Hararghe zone.

Table 12: Constraints of chicken production in the study area

	Agro-ecology					
	Highland					
Variable	R1	R2	R3	R4	R5	Index
Disease outbreaks	83	44	5	-	-	0.30
Feed shortage	29	30	73	-	-	0.24
Predator	14	66	40	12	-	0.24
Lack of veterinary service	-	1	6	89	36	0.12
Lack of market	-	-	19	28	85	0.10
			Midland			
Disease outbreaks	88	43	5	-	-	0.30
Feed shortage	19	28	87	2	-	0.23
Predator	15	76	40	5	-	0.25
Lack of veterinary service	-	-	12	96	28	0.12
Lack of market	-	-	8	30	98	0.10
			Lowland			

Disease outbreaks	93	24	3	-	-	0.30
Feed shortage	9	26	80	3	2	0.21
Predator	23	87	6	3	1	0.26
Lack of veterinary service	-	-	20	80	20	0.13
Lack of market	-	-	9	23	88	0.1
Overall						
Traits	R1	R2	R3	R4	R5	Index
Disease outbreaks	88	37	4.3	-	-	0.30
Feed shortage	19	28	80	1.7	0.7	0.23
Predator	17.3	76.3	28.7	6.7	0.3	0.25
Lack of veterinary service	-	0.3	12.7	88.3	28	0.12
Lack of proper market	-	-	12	27	90.3	0.10

Index = (n x number HHs ranked first) + (n-1) x number of HHs ranked second +…..+ 1x number of HHs ranked last)/for a particulat trait (n x number of HHs ranked first+ (n-1) x number of HHs ranked second+…. +1x number of HHs ranked last)/for all traits.

The opportunities for indigenous chicken production in the study area are presented in Table 13. Several potential advantages were identified that could contribute to improving the productivity and sustainability of indigenous chicken production in the future. The most frequently cited opportunity was extension service (0.06), feed access (0.31), credit service (0.16), and market (0.47). This finding was in contrast with Assefa *et al*. (2015), who reported that the market was the primary opportunity (0.3), followed by feed access (0.27), credit service (0.24), and extension service (0.24) in Arbegona Woreda, Sidama Zone, Southern Ethiopia.

Table 13: Opportunities of indigenous chicken production

			Agro-ecology		
			Highland		
Variable	R1	R2	R3	R4	Index
Market	-	-	-	-	0.1
Feed acess	12	78	42	-	0.30
Credit service	-	-	-	132	0.21
Extension service	96	36	-	-	0.39
			Midland		
Market	-	-	-	12	0.01
Feed acess	-	90	40	6	0.343
Credit service	-	-	11	113	0.13
Extension service	124	12	-	-	0.514
			Lowland		
Market	-	-	-	5	0.07
Feed acess	15	95	10	-	0.3
Credit service	-	-	-	120	0.13
Extension service	105	15	-	-	0.3
			Overall		
Market	-	-	-	5.7	0.47
Feed acess	9	87.7	30.7	2	0.31
Credit service	-	-	3.7	121.7	0.16
Extension service	108.3	21	-	-	0.06

4.5. Purpose of keeping chicken

The purposes for keeping chickens by households in the study area are shown in Table 14. Across all agro-ecologies, the primary reasons for raising chickens were hatch for chicks (0.26), sale for cash income (0.24), replacement (0.22), meat consumption (0.13), egg consumption (0.1), and cultural ceremonies (0.05). Hatching was the major purpose of keeping chickens by farmers across all agro-ecologies, compared to triats. The reason might be it directly supports flock sustainability and growth, especially backyard poultry production systems in rural or low-input farmers, who often rely on natural incubation to produce new chicks and maintain or increase their flock size. This is particularly important where access to commercial hatcheries, improved breeds, or regular market supply is limited. These results disagreed with Kassa *et al*. (2020), who reported that chickens were used as a source of income for egg sale, followed by the sale of live adult chickens ranked 1st and 2nd with index values of 0.31 and 0.31, respectively, in West Gojam and Awi zone. Similarly, the current result also differs from Fekede (2021), who indicated that egg for consumption (0.39), followed by egg (27) and chick sale (0.23), was the main purpose of keeping indigenous chickens in Western Oromia region.

Table 14: Purpose of keeping indigenous chicken in the study area

Variable	**Agro-ecology**						
	Highland						
	R1	R2	R3	R4	R5	R6	Index
For hatching	113	13	1	2	3	-	0.25
Sale for cash income	12	102	15	2	1	-	0.22
Meat for consumption	3	1	4	94	30	-	0.13
Egg for consumption	3	3	2	26	98	-	0.10
For replacement	15	111	3	3	-	-	0.22
For cultural/ ceremonies	-	-	-	-	105	27	0.08
Midland							
For hatching	111	18	2	4	1	-	0.27
For cash for sale	21	89	24	2	-	-	0.24
Meat for consumption	4	2	1	95	34	-	0.14
Egg for consumption	-	5	2	30	99	-	0.08
For replacement	22	107	3	4	-	-	0.24
For cultural/ ceremonies	-	-	-	-	1	94	0.03
Lowland							
hatch for chicks	89	26	2	2	1	-	0.27
For cash for sale	29	80	10	1	-	-	0.25
Meat for consumption	1	2	4	79	34	-	0.14
Egg for consumption	-	3	6	34	74	3	0.12
For replacement	1	10	98	3	8	-	0.19
For cultural/ ceremonies	-	-	-	-	-	86	0.03
Overall							
Variable	R1	R2	R3	R4	R5	R6	Index
For hatching	104.3	19	1.7	2.7	1.7	-	0.26

For cash for sale	20.7	90.3	16.3	1.7	-	-	0.24
Meat for consumption	2.7	1.7	3	89.3	32.7	-	0.13
Egg for consumption	1	3.7	3.3	30	90.3	1	0.1
For replacement	12.7	76	34.7	3.3	2.7	-	0.22
For cultural/ ceremonies	-	-	-	-	35.3	69	0.05

4.6. Breeding Practices of Indigenous Chicken

hicken breeding practices in the study area are presented in Table 15. About 76.2% of respondents did not have any breeding practice, while the remaining 23.8% had experience with breeding practice to improve their chicken productivity. Breeding practices showed a statistically significant difference ($P < 0.05$) across agro-ecologies. This variation could be due to farmers' awareness about breeding, and the specific objectives of the farmers. This finding was in agreement with Birara *et al*. (2023), who reported that the majority of the respondents (62.22%) did not have breeding practice in Enarj Enawga district, East Gojjam zone. The majority of households (76.4%) practiced uncontrolled mating, whereas 23.6% of chicken owners tried to improve their local chicken by control mating. This result aligns with Kassa *et al*. (2020), who revealed that the majority of (70.5%) households practiced uncontrolled mating in West Gojam and Awi Zones. A large proportion of respondents (92.1%) reported practicing methods of breeding by improving indigenous chickens rather than introducing exotic breeds. This result is similar to Petiros (2017), who revealed that the majority of farmers (90%) practiced breeding methods by improving their own ecotypes rather than importing exotic breeds in Eastern Hararghe, Oromia region. There was no significant difference ($P > 0.05$) between breeding methods and agro-ecologies. Most respondents (45.2%) used line breeding as a strategy to improve their chickens. A significant difference ($P < 0.05$) was observed between the methods used to improve chickens and the different agro-ecologies. This variation may be due to differences in farmers' awareness of breeding techniques and environmental influences.

Table 15: Breeding practices of indigenous chicken in the study area

	Agro-ecology					
	Highland n (%)	Midland n (%)	Lowland n (%)	Overall n (%)	Chi-squre	P-value
Breeding practices					18.3	.000
Yes	33 (25)	47 (34.6)	14 (11.7)	31 (23.8)		
No	99 (75)	89 (65.4)	106 (88.3)	98 (76.2)		
Matting system					3.29	0.19
Controlled mating	4 (3)	7(5.1)	2(1.7)	4(3.3)		
Uncontrolled mating	128 (97)	129(94.9)	118(98.3)	125(96.7)		
Breeding methods					2.24	0.326
Importing exotic breed	10 (7.6)	14 (10.3)	7 (5.8)	10 (7.9)		
Improving indigenous breed	132(92.4)	136 (89.7)	120 (94.2)	119 (92.1)		
Ways of improving chickens					59.4	.000
Cross breeding	8 (24.2)	12 (25.5)	2(14.3)	7 (22.6)		
Line breeding	15 (45.5)	20 (42.6)	8 (57.1)	14 (45.2)		
Out breeding	10 (30.3)	15(31.9)	4 (28.6)	10 (32.3)		

4.7. Selection criteria used for breeding hen and cock

The selection criteria for breeding hens and breeding cocks in the study area are indicated in Table 16. The main traits considered by farmers when selecting breeding hens included egg number, plumage color, body weight, disease resistance, hatchability, and broodiness, with the corresponding overall index values of 0.26, 0.24, 0.18, 0.16, 0.1, and 0.06, respectively. Egg number was the most important selection criteria across all agro-ecologies, ranked first in highland (0.24), midland (0.26), and lowland (0.27). This indicates that the objective of farmers in the study areas is focused on egg production to improve the nutrition status and generate income sources for the households. This finding is in agreement with the findings of Birara (2022), who indicated that egg number (0.29) was the major selection criteria for breeding hens, followed by body size (0.28) in East Gojjam Zone, Amhara region. The present study was also in line with Muluneh *et al.* (2024), who reported that the most important traits selecting breeding hens were egg number (0.29), followed by appearance (0.17), and plumage color (0.15) in East Gojjam, West Gojjam, and Awi Zones.

Regarding the selection criteria for breeding cocks, the major traits used in the study area were body weight, comb type, plumage color, and disease resistance, with an overall index value of 0.36, 0.3, 0.19, and 0.15, respectively (Table 16). Body weight was the main selection criteria across all agro-ecologies, ranked first in highland (0.34), midland (0.37), and lowland (0.37) areas. This finding was in agreement with the results of Ayana (2020), who reported that body weight was the major selection criterion, ranked first in the highland (0.36), midland (0.32), and lowland (0.31) areas in Awi Zone of Amhara region. In contrast, Dereje *et al*. (2022), who reported that plumage colour (0.28) was the first trait ranked by households in East Gojjam Zone, Amhara region. Generally, the current study revealed that households primarily select breeding cock based on body weight, followed by comb type, plumage color, and disease resistance. Therefore, traits such as body weight in cocks and egg production in hens are economically important for households in the study area. The development of breeding objectives for enhancing indigenous chicken breeds in the study area should place priority on these traits.

Table 16: The selection criteria of breeding hen in the study area

Variable	Agro-ecology						
	Highland						
	R1	R2	R3	R4	R5	R6	Index
Egg number	86	31	7	7	-	-	0.24
Plumage color	29	95	4	4	-	-	0.23
Body weight	14	3	90	25	-	-	0.18
Disease resistance	2	3	30	92	-	-	0.14
Hatchability	-	-	-	5	97	30	0.16
Broodness	-	-	-		29	103	0.05
	Midland						
Egg number	112	14	7	3	-	-	0.26
Plumage color	15	121	-	-	-	-	0.23
Body weight	6	2	106	21	1	-	0.18
Disease resistance	2	21	104	9	-	-	0.19
Hatchability	-	-	1	5	102	8	0.08
Broodness	-	-	-	2	27	107	0.06
	Lowland						
Egg number	84	28	7	1	-	-	0.27
Plumage color	29	91	-	-	-	-	0.25
Body weight	7	1	84	28	-	-	0.19
Disease resistance	-	-	28	85	7		0.15
Hatchability	-	-	1	5	90	24	0.08
Broodness	-	-	-	1	24	95	0.06
	Overall						
Variable	R1	R2	R3	R4	R5	R6	Index
Egg number	94	24.3	7	3.7	-	-	0.26
Plumage color	24.3	102.3	1.3	1.3	-	-	0.24
Body weight	9	2	93.3	24.7	0.3	-	0.18
Disease resistance	1.3	8	54	62	2.3	-	0.16
Hatchability	-	-	0.7	5	96.3	20.7	0.1
Broodness	-	-	-	1	26.7	101.7	0.06

Table 17: Selection criteria of breeding cock in the study area

Variable	Agro-ecology				
	Highland				
	R1	R2	R3	R4	Index
Body weigh	100	23	9	-	0.34
Comb type	22	103	7	-	0.28
Plumage color	9	7	90	26	0.18
Disease resistance	1	26	105	-	0.2
	Midland				
Body weigh	103	29	4	-	0.37
Comb type	33	94	9	-	0.32
Plumage color	4	9	99	24	0.19
Disease resistance	-	-	24	112	0.12
	Lowland				
Body weight	90	22	7	-	0.37
Comb type	25	90	5	-	0.32
Plumage color	7	5	85	23	0.19
Disease resistance	-	-	22	97	0.12
	Overall				
Variable	R1	R2	R3	R4	Index
Body weight	97.7	24.7	6.7	-	0.36
Comb type	26.7	95.7	7	-	0.3
Plumage color	6.7	7	91.3	24.3	0.19
Disease resistance	0.3	8.7	50.3	37.3	0.15

4.8. Productive and Reproductive Performance of Indigenous Chicken

4.8.1. Productive performance of indigenous chicken

4.8.1.1. Number of eggs per hen per clutch

Indigenous chickens are generally known for their low egg production and small body size. In the present study, the overall mean number of eggs per hen per clutch was 14.0 ± 0.57 (Table 18). This finding was higher than the result of Yihun (2020), who reported that egg production per hen per clutch was in the range from 14.38±0.25 in Awi Zone, Amhara region. However, this result was lower than Ayalew *et al*. (2023), who revealed that an average of 14.34 ± 1.69 eggs/hen per clutch in West Gojjam, Central Gondar, and South Wollo zone of Amhara region, but this finding was higher than Milkias *et al.* (2019), who reported that the overall mean of 12.78 ± 0.29 eggs/hen per clutch in Gena Bossa district of Dawro Zone, Ethiopia. A higher mean number of eggs per hen per clutch was observed in midland (14.9±0.51) than in highland (14.01±0.71) and lowland (13.2±0.49) areas, respectively. This difference in the number of eggs per hen per clutch might be attributed to difference in the management system.

4.8.1.2. Number of eggs incubated, hatched and wasted per clutch

The overall mean number of eggs incubated, hatched, and wasted per clutch for indigenous chickens was 11.8±1.09, 10.1±1.11, and 1.73±0.05, respectively, (Table 18). This result was very similar to the findings of Birhanu (2020), who reported that the mean numbers of incubated eggs, hatched chicks, and wasted eggs per clutch for local chickens in Awi Zone, Amhara region, were 11.59 ± 0.09, 9.83 ± 0.08, and 1.74 ± 0.06, respectively. However, the present study was lower than those of Birara *et al.* (2023), who indicated that the mean number of hatched chicks per clutch of local chickens was 10.6±0.22 in East Gojjam Zone, Amhara region. The highest number of incubated eggs was observed in midland (12.5±1.25), followed by highland (11.8±0.95) and lowland (11.1±1.08). This variation might be attributed to the availability of eggs laid, environmental conditions, and management conditions. A higher number of hatched chicks per clutch in local chicken was obtained from midland (10.9±1.4) as compared to highland (9.96±1.08) and lowland (9.4±0.86). This could be due to more suitable climatic conditions and better management practices, such as feeding, housing, and health care provided by the farmers. The highest number of wasted eggs was observed in the lowland (2.0±0.44), while the lowest was recorded in midland (1.5±0.58). This difference might be the weather conditions and management practices for their chicken.

4.8.1.3. Annual egg production

The overall mean annual egg production per hen in the study area was 59.9±0.79 eggs, as presented in Table 18. This result was lower than Muluneh *et al*. (2024), who revealed a mean annual egg production of 76.67±26.62 eggs/hen per year for indigenous chicken in East Gojam, West Gojam, and Awi zone of Amhara region. However, the current result was higher than the findings of Tadele *et al.* (2019), who reported a mean annual egg production of 44.0 ± 6.0 eggs per hen for indigenous chickens in Kaffa Zone, Southwestern Ethiopia. A higher mean annual egg yield per hen was obtained from midland (63.6±1.5), followed by highland (60±0.53) and lowland (56.1±0.42) agro-ecologies. The possible reason for this difference might be due to more favorable climatic conditions as well as better management practices in terms of feeding, housing, and health care in the midland over other agro-ecologies.

4.8.2. Reproductive performance of indigenous chicken

4.8.2.1. Age at first mating of male and female chicken (months)

The average age at first mating of pullets were 5.76±0.66 months in highland, 5.60±0.49 months in midland, and 5.98±0.16 months in lowland agro-ecologies, with an overall mean value of 5.78 ± 0.44 month (Table 18). This result was higher than that of Muluneh *et al.* (2024), who revealed that the overall mean age at sexual maturity of female chickens was 5.13±0.93 months in East Gojam, West Gojam, and Awi Zone of Amhara region. The average age at sexual maturity of cockerel in lowland, highland, and midland agro ecologies was 5.86 ± 0.34, 5.5 ± 0.5, and 5.77 ± 0.42 months, respectively. The current finding was lower than the report of Birara *et al*. (2022), who reported that the average age at first mating of local cockerels was 4.9±0.08 and 5.3±0.05 months for Enarj Enawga and Enemay districts, respectively. A higher mean age at sexual maturity of indigenous male chicken was obtained from lowland (5.86 ± 0.34) than from other agro-ecologies. This difference between both sexes might be attributed to genetic and environmental factors (the weather conditions in lowland might be bad for fast growth and the farmers in the lowland provided poor management (feeding different types of feed and health care) for their chicken.

4.8.2.2.Age at first egg laying (months)

The overall mean age at first egg-laying for female chickens in the study area was 6.53±0.48 months, as shown in Table 18. A higher mean of age at first egg laying was obtained in lowland (6.71±0.46), followed by highland (6.57±0.49) and midland (6.3±0.48) agro-ecologies. The reason for this variation in age at first egg laying might be due to differences in management systems, availability of scavengable feed resources, disease outbreak, and provision of clean water by the households. The current result was higher than that reported by Ayalew *et al*.(2023), who reported that the overall age at first egg laying of indigenous chicken was 6.25 ± 0.61 months in selected zones of Amhara region. However, this result was lower than the finding of Teshome (2018), who indicated that the overall age at first egg laying of pullets was 6.64±0.55 months in Jima zone, Oromia region.

4.8.2.3.Number of clutch per hen per year

The average mean number of clutches per hen per year in the study area was 4.27±0.43, as indicated in Table 18. The number of clutches per hen per year was 4.29±0.45 in the highland, 4.27±0.45 in the midland, and 4.25±0.4 in the lowland area. This finding was similar with Yihun (2020), who reported that village chickens were produced 4.27±0.04 clutches annually in Awi Zone, Amhara region. However, this result was lower than the report of Birara *et al*. (2022), who revealed the overall mean number of clutches per hen per year of 5.60 in East Gojjam Zone.

4.8.2.4. Clutch length in days

The overall mean clutch length of indigenous chickens in the study area was 22.5±0.59 days, as indicated in Table 18. Higher clutch length of indigenous chickens was obtained in highland (22.5±0.64), followed by lowland (22.2±0.68) and midland (22.7±0.46) agro-ecologies. Differences observed between agro ecology with respect to clutch length in days might be due to both genetic and environmental differences between the populations. The current finding was higher than the research finding of Birara *et al*. (2022), who revealed that the overall mean clutch length of local chickens in Enarji Enawga and Enemay districts of East Gojjam zone, Amhara region was 18.7±0.54 and 16.7±0.26, respectively. However, the current result was lower than that of Gebremariam (2017), who reported the overall mean clutch length of 22.54±0.44 for local chickens in Southern Tigray, North Ethiopia.

4.8.2.5. Hatchability percentage

The overall mean hatchability percentage of local chickens in the study area was 85.7±0.53 (Table 18). A higher hatchability percentage of indigenous chicken was obtained from midland (87.2±0.52) and highland (85.3±0.64), but lower in lowland (84.7±0.44). The reason for these variations might be due to environmental temperature, egg storage conditions, incubation materials, egg quality, the age and health status of the hen, as well as the availability of scavengable feed resources and supplementary feeding. The current finding was slightly higher than that of Birhanu (2020), who indicated that the overall mean hatchability percentage of indigenous chicken was 84.8% in Awi zone. This result was also higher than the finding of Ayalew *et al*. (2023), who reported that the overall hatchability percentage of indigenous chicken was 79.90 ±4.48 in Amhara region.

Table 18: Productive and reproductive performance of indigenous chicken in the study area (Mean±SD).

Variable	Agro-ecology				
	Highland	Midland	Lowland	Overall	P value
Productive performance					
Number of eggs/hen/clutch	14.01 ± 0.71^{b}	14.9 ± 0.51^{a}	13.2 ± 0.49^{c}	14.0±0.57	< 0001
Number of eggs incubated	11.8 ± 0.95^{b}	12.5 ± 1.25^{a}	11.1 ± 1.08^{c}	11.8±1.09	< 0001
Number of eggs hatched	9.96 ± 1.08^{b}	10.9 ± 1.4^{a}	9.4 ± 0.86^{c}	10.1±1.11	< 0001
Number of eggs wasted	1.7 ± 0.71^{b}	1.5 ± 0.58^{c}	2 ± 0.44^{a}	1.73±0.05	< 0001
Annual egg production	60 ± 0.53^{b}	63.6 ± 1.5^{a}	56.1 ± 0.42^{c}	59.9±0.79	< 0001
Reproductive performance					
Age at first mating of cockerel (m)	5.77 ± 0.42^{a}	5.5 ± 0.5^{b}	5.86 ± 0.34^{a}	5.71±0.42	< 0001
Age at first mating of pullet (m)	5.76 ± 0.66^{b}	5.60 ± 0.49^{c}	5.98 ± 0.16^{a}	5.78±0.44	< 0001
Age at first egg laying (month)	6.57 ± 0.49^{b}	6.3 ± 0.48^{c}	6.71 ± 0.46^{a}	6.53±0.48	< 0001
Number of clutch/hen / year	4.29±0.45	4.27±0.45	4.25±0.4	4.27±0.43	0.1321
Clutch length in days	22.5 ± 0.64^{b}	22.7 ± 0.46^{a}	22.2 ± 0.68^{b}	22.5±0.59	< 0001
Hatchability percentage (%)	85.3 ± 0.64^{a}	87.2 ± 0.52^{a}	84.7 ± 0.44^{b}	85.7±0.53	< 0001

4.9. Phenotypic Characteristics and Morphometric Measurement

4.9.1. Qualitative traits

The frequency and percent of qualitative traits observed in males and females of the indigenous chicken population are presented in Table 19. The majority of indigenous chickens in this study had 95.8% normal feathers, while the remaining 4.2% had naked necks. Feather distribution of indigenous chickens had a significant difference (P<0.05) across agro-ecology, which is possibly attributed to farmer selection criteria and genetic diversity within the indigenous chicken population. The frequency of necked neck chickens in lowland agro-ecology was higher (10.1) than in midland (3) and highland (2.7) agro-ecologies. This difference might be due to their necked-neck character, which is described as the expression of a gene found in local chicken populations of the tropics and has desirable effects on heat tolerance (Horst, 1989). Normal feather distribution of male and female chickens in the study area was 90.6% and 98.1%, respectively, while 9.4% of male chickens and 1.9% of female chickens were naked neck. Significant difference (P<0.05) in normal feather distribution was observed between sexes. The current result agrees with the finding of Tesema *et al*. (2024), in which the highest proportion of chickens in West Guji Zone had (93.55%) normal feathered distribution. This result was also in line with Birhanu (2020), who showed that 95.9% of indigenous chicken was predominantly normal feathered, while 3.9% of indigenous chicken showed naked neck in Awi zone of Amhara region.

The red (39.1%) plumage colour was the most frequently observed in almost all agro-ecologies, followed by grayish/Gebsema (26.4%), Teterma (12.8%), white (9.6%), black (7.1%), and multicolor/Ambeasma (5.0%). In line with the present study, red was found to be the predominant plumage color of local chicken populations in West Gojam zone, Amhara region (Kindie, 2021). Similarly, in agreement with the report of Yihun *et al.* (2020), who indicated that red plumage color (43.2%) was more numerous in the Awi zone of the Amhara region. There was a statistically significant difference ($P < 0.05$) in plumage color across agro-ecology and between sexes. In lowland (44.4%) and midland (38.5%) agro-ecologies, the predominant plumage color was red, while in highland Gebsema (37.2%), it was the major plumage color. In the study area, diversity of plumage colors was observed. In this regard, Liyanage *et al*. (2015) described that the occurrence of different varieties of plumage colors might be due to the segregation of alleles from random mating among chickens possessing different plumage patterns. This was supported by Fotsa (2016), who claims that plumage colors are a highly heritable trait that can be transmitted from parents to offspring and is caused by a few genes. In contrast wth the present finding, 29.28% of indigenous chickens in West Guji Zone, Oromia region had brown plumage (Tesema *et al*. 2024).

The predominant comb type of indigenous chicken in the study area was double (54.8%), followed by single (28.9%) and pea (16.5%) combs, which is in line with the study of Kinidie (2021), who indicated that majority of indigenous chickens had double combs (44.6%) in West Gojjam zone, Amhara region. Similarly, the double comb was predominant, followed by single and pea combs in West Hararghe Zone of Oromia region (Bogale *et al*., 2019). There was a significant difference ($P < 0.05$) concerning comb type among agro-ecologies and between sexes. The frequent occurrence of single comb in lowland (37.7%), followed by midland (24.6%) and highland (37.7%) agro-ecologies, suggests that the presence of a single comb helps to reduce 40% of body heat (Duguma, 2006). Comb type is a heritable trait in chickens, and its distribution can be influenced by factors such as natural selection and adaptation of certain genes to a particular environment, causing differences in comb types (Somes, 1988). Regarding sex, a higher double comb was observed in male (79.9%) than female (42.3%) chickens. However, this result was different from the study of Tamirat *et al*. (2023), who reported that the majority of chickens possessed a single comb type (45.5%) in North Shewa zone, Oromia region.

About (54.6%) of indigenous chickens across all agro-ecologies in the study area observed a crest head shape, whereas (45.4%) had a plain head shape. There was a significant difference ($P < 0.05$) among agro-ecologies and between sexes for head shape. Highland agro-ecology had the highest percentage of chickens with crested heads (60), as compared to midland (55.8) and lowland (54.5) areas. The presence of crested heads may provide better protection against a highland environment, as suggested by previous studies on the adaptive significance of head morphology in chickens (Wang M. *et al*., 2019). The crest was more common in the head shape in females (60.5%) chickens, whereas a plain head shape was more common in males (62.3%) chickens. These variations in head shape might be due to genetic diversity within indigenous chickens. The present study was in agreement with Birhanu (2020), who revealed that the major head shape of indigenous chicken was crest followed by crest (57.6%) in the Awi zone. In contrast with Muluneh (2024), who indicated that plain head shape was most frequently observed, accounting for 51.9%, whereas 47.2% of chickens had a crest head shape in East Gojjam, West Gojjam, and Awi zone of Amhara region. The overall observed beak color of indigenous chickens in all agro-ecologies was predominantly yellow (55.9%), followed by red (19.7%), white (13.4%), and black (11.5%). Beak color was significantly different ($P < 0.05$) among agro-ecologies and between sexes. This variation might be a genetic difference among indigenous chickens across agro-ecologies. The present finding was not in line with Yihun *et al*. (2020), who reported that in the Awi zone, white color (42.8%) was the dominant beak color. This also contradicts Tesema *et al*. (2024), who observed that 36.2% of chickens had red beak color, followed by brown (32.95%) in West Guji zone of Oromia region. However, this result was in agreement with Birhanu (2020), who indicated that yellow (38.7%) was the predominant beak color, followed by white (30.2%), red (22.8%), and black (8.2%) in Awi zone.

The predominant eye color observed among indigenous chickens in the study area was orange (54.4%), followed by red (33.9%) and brown (11.7%), as presented in Table 19. The eye color of indigenous chicken was significant difference ($P < 0.05$) across agroecologies and between sexes This variation is attributed to the pigmentation (carotenoid pigment) and blood flow to a variety of structures within the eye, which play significant roles in eye color variation (Crawford, 1990), in addition to genotype, and reflected adaptation fitness to their environment (Aberra and Tegene, 2011) from Southern Region of Ethiopia. Orange eye color was significantly higher in females (57.1%) than in males (49.1%) chickens. The current result was in agreement with Tamrat *et al*. (2023), who reported that the dominant eye color was orange (55.6%), followed by red (28.3%), brown (13.4%), and gray (2.8%) in the North Shewa zone, Oromia region. This result was also in line with Yihun *et al*. (2020), who revealed that the major eye color of indigenous chicken was orange (41.5%) in the Awi zone, Amhara region. However, the present study was not supported by Tesema *et al*. (2024), who revealed that the major eye color in the West Guji zone, Oromia region, was red (31.5%), followed by orange (23.5%) and yellow (21.03%) color.

The major earlobe color of indigenous chicken observed in the study area was white and red (60.4%), followed by red (26.2%), white (12.1%), and black (1.7%), as presented in Table 19. Earlobe color varied significantly ($P<0.05$) among agro-ecologies and sexes. A higher proportion of chickens with white and red earlobes was observed in females (67.1%) than in males (46%). However, relatively higher proportions of chickens with red earlobes were observed in male (40.3%) than female (19.1%) chickens. The variation observed in earlobe colors might be due to the chickens' inherited earlobe color from their parents (Cabarles *et al*.,2012), the nutritional status of birds (Aberra and Tegene, 2011), and the specific traits of the breeds. The current result was in line with Birara *et al*. (2023), who indicated that white with red earlobe colour (35.30%) was mostly observed in East Gojam zone, Amhara region, followed by red earlobe colour (18.4%). However, this result disagreed with Kindie (2021), who reported that the dominant earlobe color in West Gojam Zone, Amhara region was red (36.1%), followed by white and red (34.3%. This result also contradicts Tesema *et al*. (2024), who revealed that the major earlobe color of indigenous chickens was red (31.7%) in West Guji zone, Oromia region.

Regarding shank color, the study indicated that yellow was the predominant shank color in midland (67.6%)) and lowland (45.5%), while white shank color in highland (50) agro-ecology and yellow in male (47.8%), whereas white in female (43%) chickens was the dominant shank color, with significant differences ($p<0.05$) among agro-ecologies and between sexs. Shank colour indicates the chicken's foraging efficiency, nutritional and immune status, and sexual desirability (Eriksson. J *et al*., 2008). According to Bell (2002), the shanks and most of the feet are covered with scales of various colors. The yellow color is due to dietary carotenoid pigments in the epidermis when the melanin pigment is absent. In the complete absence of both of these pigments, the shanks become white. This result was also in agreement with Abdi (2022), who reported that the dominant shank color of indigenous chicken was yellow shanks (47.1%) in West Harerghe Zone, Ethiopia. However, this result disagreed with the research finding of Kindie (2021), who indicated that the most predominant shank color of indigenous chicken was white (44.2%), followed by yellow (28.5%) in West Gojjam zone, Amhara region. The majority of indigenous chickens in the study area had no shank feather (94.8%), while the remaining had shank feather (5.2 %), as shown in Table 19. Shank feather was a significant difference ($P <0.05$) across agro-ecologies. The current result was supported by Tesema *et al*.(2024), who indicated that almost all indigenous chickens in the West Guji zone, Oromia region, had no shank feathers. The current result was supported by Muluneh (2024), who revealed that the majority of indigenous chickens had no shank feather (98.1%), whereas the rest had shank feather (1.9%) in East Gojjam, West Gojjam, and Awi zone of Amhara region.

Figure 2: Indigenous chickens with different plumage colour, Shank feather, Nacked neck and Comb type

Table 19: Qualitative traits of indigenous chicken in the study area

Parameter	Agro-ecology						Sex		
	Highland N= 148	Midland N= 231	Lowland N= 99	Overall N= 478	X^2 Value	P-value	Male (159)	Female (319)	P-value
Feather Distribution					508.5	.000			.000
Normal	142(95.9)	226(98.2)	89(89.8)	457(95.6)			144(90.6)	313(98.1)	
Nacked neck	4 (2.7)	7(3)	10(10.1)	21(4.4)			15 (9.4)	6 (1.9)	
Plumage Color					515.9	.000			.000
White	9 (6.1)	24(10.3)	13(13.1)	46(9.6)			14(8.8)	32(10)	
Black	8 (5.4)	18(7.8)	8(8)	34(7.1)			2(1.3)	32(10)	
Red	54 (36.5)	89(38.5)	44(44.4)	187(39.1)			84(52.8)	103(32.3)	
Grayish/ Gebsema	55(37.2)	56(24.2)	15(15.1)	126(26.4)			32(20.1)	94(29.5)	
Multicolor/ Anbesima	4(2.7)	14(6)	6(6.1)	24(5.0)			6(3.8)	18(5.6)	
Teterma	18(12.2)	30(13)	13(13.1)	61(12.8)			21(13.2)	40(12.5)	
Comb type					501	.000			.000
Double	90(60.8)	132(57.1)	40(40.4)	262(54.8)			127(79.9)	135(42.3)	
Single	44(29.7)	57(24.6)	37(37.7)	138(28.9)			32(20.1)	106(33.2)	
Pea	24(16.2)	43(18.6)	12(12.1)	79(16.5)			-	79(24.8)	
Head shape					498.1	.000			.000
Crust	80(60)	129(55.8)	54(54.5)	263(56.8)			60(37.7)	193(60.5)	
Plain	52(39.4)	102(44.2)	45(45.5)	217(42.9)			99(62.3)	126(39.5)	
Beak color					504	.000			.000
Yellow	79(53.4)	136(58.9)	52(52.5)	267(55.9)			95(59.7)	172(53.9)	
Red	32(21.6)	44(19)	18(18.1)	94(19.7)			33(20.8)	61(19.1)	

White	16(10.8)	34(14.7)	14(14.1)	64(13.4)			21(1.3)	43(13.5)	
Black	23(15.5)	17(7.4)	15(15.2)	55(11.5)			12(7.5)	43(13.5)	
Eye color					508.7	.000			.000
Yellow	96(64.9)	109(47.9)	55(55.6)	260(54.4)			78(49.1)	182(57.1)	
Red	37(25)	90(39)	35(35.4)	162(33.9)			61(38.4)	101(31.7)	
Brown	15(10.1)	32(13.9)	9(9.1)	56(11.7)			20(12.6)	36(11.3)	
Earlob color					508	.000			.000
White	17(11.5)	27(11.7)	14(14.1)	58(12.1)			22(13.8)	36(11.3)	
Red	46(31.1)	58(25.1)	21(21.1)	125(26.2)			64(40.3)	61(19.1)	
Black	5(3.8)	-	3(3)	8(1.7)			-	8(2.5)	
White and red	80(54.1)	146(63.2)	56(56.6)	287(60.4)			73(46)	214(67.1)	
Shank color					573.3	.000			.000
Yellow	45(30.4)	100(67.6)	45(45.5)	190(39.7)			76(47.8)	114(35.7)	
Red	-	9(3.9)	22(22.2)	31(6.5)			19(12)	12(3.8)	
White	74(50)	75(32.5)	21(21.1)	170(35.6)			33(20.8)	137(43)	
Black	22(14.9)	29(12.6)	12(12.1)	62(12.9)			20(12.6)	42(13.2)	
Brown	7(4.7)	4(1.7)	-	11(2.3)			11(7)	-	
Shank feather					501.3	.000			.000
Present	10(6.8)	7(3.0)	8(8.0)	25(5.2)			15(9.4)	10(3.1)	
Absent	138(93.2)	226(97)	91(92)	455(94.8)			144(90.6)	309(96.9)	

N= sample size (no of chicken observed), X^2= chi square test, Teterma plumage color includes (black spot on white, black with white tips, and white with black or red spots)

4.9.2. Quantitative traits

Body weight and other morphometric measurements are useful parameters for characterizing a breed or type jointly with its morphological traits and the environment it inhabited. Body weight (kg) and other linear body measurements (cm) of indigenous chickens, analyzed across agro-ecologies, sex, and their interaction effects, are presented in Table 20.

The average wing span of local chickens across agro-ecologies in the study area was 35.06 ± 0.14 cm. Wing span of local chickens had a significant difference ($P<0.05$) across agro-ecologies. Significantly higher wing span of local chicken was obtained from midland (35.7±0.18) than highland (35.44±0.1) and lowland (35.04±0.15). This variation might be due to the environmental adaptation of the chicken. The overall mean wingspan of male and female chickens was 35.8 ± 0.11cm and 34.3 ± 0.1cm, respectively, with a statistically highly significant difference ($P < 0001$) between sexes. Male chickens exhibited a significantly greater wing span than females, which might be due to sexual dimorphism, where males tend to grow faster and attain a larger body size. The current result was lower than the finding of Birara *et al*. (2023), who reported that the overall wing span of indigenous chicken was 37.9±0.16 cm in East Gojam Zone, Amhara region. However, this result was higher than the value reported by Kindie (2021), who indicated that the average wingspan of indigenous chicken was 17.61±2.22 cm in West Gojjam Zone, Amhara region. There was a highly significant difference ($P<0001$) between the interaction effect of agro-ecologies and sexes in wing span.

The overall mean beak length of indigenous chicken across agro-ecologies in the study area was 2.34 ± 0.02cm (Table 20). The beak length of indigenous chickens was not statistically significant ($P > 0.05$) across agro-ecologies. The overall mean beak length of male and female indigenous chickens were 2.39 ± 0.02 cm and 2.28 ± 0.01 cm, respectively. Beak length had a highly significant difference ($P<0001$) observed between sexes. High beak length was obtained from male chickens than females, which might be attributed to a combination of factors such as sexual dimorphism. The current finding was slightly lower than the report of Muluneh *et al*. (2023), who indicated that the overall mean beak length of indigenous chicken was 2.44±0.01cm in East Gojjam, West Gojjam, and Awi zone. However, the current finding was higher than the report of Alebachew *et al*. (2019), who reported that the overall beak length of 1.6±0.25 cm for male and 1.5±0.21 cm for female chickens in the Benishangul-Gumuz region, Western Ethiopia. There was no significant difference ($P>0.05$) between the interaction effect of agro-ecologies and sexes in beak length.

The overall mean chest circumference of indigenous chickens in the study area was 34.9 ± 0.15 c m. Chest circumference of local chicken did not show a significant difference ($P >0.05$) across agroecology. Chest circumference of male and female chickens was 35.8 ± 0.15cm and 33.97 ± 0.07 cm, respectively, with a highly statistically significant difference ($P < 0001$) between sexes. Male chickens exhibited greater chest circumference compared to females, which could be attributed to natural differences in body size and muscle development. The current study was higher than Yihun *et al*. (2020), who revealed that the overall mean chest circumferen-ce of indigenous chickens was 26.87 ± 0.06 cm in the Awi zone, Amhara region. The result of this study is also higher than the value reported by Tamirat *et al*. (2023), who reported the overall mean chest circumference of 27.57 ± 0.08 cm for indigenous chicken in North Shewa Zone, Oromia region. There was no significant difference ($P >0.05$) between the interaction effect of agro-ecologies and sexes with respect to chest circumference.

The overall mean body length of local chickens in the study area across agro-ecologies was 35.43 ± 0.16 cm. The body length of local chickens did not show a significant difference ($P >0.05$) across agro-ecologies.The mean body length of male and female chickens was 36.5 ± 0.17 cm and 34.36 ± 0.08 cm, respectively, with a highly significant difference ($P < 0.001$) between sexes. Larger body length was observed in male than female chickens, which might be due to hormonal influences. The current result was nearly similar to Birara *et al*. (2023), who reported average body lengths of 35.0±0.24 cm in indigenous chickens in West Gojam Zone. However, the results in this study were lower than Tesema *et al*. (2024), who reported that the average body length of male and female chickens in West Guji zone, Oromia region was 37.99±0.28 and 36.02±0.27, respectively. Similarly, lower than the study of Balcha (2022), who reported average body lengths of 39.6±0.1cm in West Oromia zone. There was no significant difference ($P >0.05$) between the interaction effect of agro-ecologies and sexes with respect to body length.

The overall mean body weight of indigenous chickens in the study area was found to be 1.63 ± 0.023 kg (Table 21). The body weight of indigenous chicken had a significant difference (P <0.05) across agro-ecologies. Higher body weight was obtained from midland (1.67±0.02) than highland (1.63±0.02) and lowland (1.59±0.03). This variation might be due to better environmental suitability, better physiological adaptability, and availability of preferred feed resources in midland areas. The average body weight of male and female indigenous chickens in the study area was 1.76 ± 0.2 kg and 1.5 ± 0.1 kg, respectively, with a significant difference ($P < 0001$) between sexes. Male exhibited larger body weight than female chickens, which might be due to sexual dimorphism differences in the level of male sex hormones, which is responsible for larger muscle development in males than in females (Rotimi. *et al*, 2016). This finding was higher than Muluneh *et al*. (2023), who reported that the average body weight of indigenous chicken was 1.36±0.01 in East Gojjam, West Gojjam, and Awi Zone of Amhara region. However, this result was lower than Yihun *et al*. (2020), who revealed that the average body weight of local chicken was 1.59±0.02 in the Awi zone. These variations in body weight may be attributed to differences in the genetic background of local chicken populations, management practices, and the availability of feed resources in different regions (Halima *et al*., 2007b). There was no significant difference (P>0.05) observed between the interaction effect of agro-ecologies and sexes for body weight.

The overall mean neck length of indigenous chickens in the study area across agro-ecologies was 12.14 ± 0.09 cm. The neck length of indigenous chickens did not show a significant difference (P > 0.05) across agro-ecologies. The mean neck length of male and female chickens were 12.8±0.09 cm and 11.33 ± 0.08 cm, respectively. Neck length showed a highly significant difference (P < 0001) between sexes. Males exhibited a higher beak length than female chickens. The overall mean values observed in this study were lower than the report of Kindie *et al*. (2021), who indicated that the average neck length of male and female chickens was 18.72±1.10 cm in the West Gojam zone. However, the current finding was higher than Birhanu (2020), who revealed that the average neck lengths of indigenous chickens in Awi zone was 11.55±1.17 cm. There was no significant difference (P>0.05) between the interaction effect of agro-ecologies and sexes for neck length.

The overall mean comb length of indigenous chicken across agro-ecologies in the study area was 3.65±0.08 cm (Table 20). Comb length had a significant difference (P<0.05) across agro-ecology in the study area. Chickens from lowland areas obtained significantly longer comb length (3.83 ± 0.1 cm) compared to midland (3.57± 0.07 cm) and highland (3.54 ± 0.08 cm) areas. Large combs that allow better heat dissipation in the tropical hot environment (Rotimi *et al*., 2016). The average comb lngth values of 1.59 and 1.27 cm for males and females, respectively, in the current study. But, the values were higher than those reported in Awi Zone were 2.78±0.02 cm and 2.08±0.02 cm, respectively, (Yihun *et al*., 2020). Nevertheless, comb length values of indigenous chickens reported by Zerihun *et al*. (2022) was 3.9±0.04 cm in the West Omo zone, SNNPRS. Comb length of indigenous chicken showed a statistically significant difference (P<0001) between sexes. Significantly higher comb length was obtained in males than in female chickens. There was no significant difference (P>0.05) between the interaction effect of agro-ecologies and sexes for comb length.

The overall mean comb width of local chickens in the study area across agro-ecology was 2.36 ± 0.03 cm. Comb width of indigenous chicken had a highly significant difference (P<0001) across agro-ecology. Significantly higher comb width of local chicken was obtained in lowland (2.47±0.04 cm) than midland (2.38±0.03cm) and highland (2.24±0.03cm), respectively. Combs are important structures for heat loss in birds (Van Kampen, 1974), and since the tropical climate is predominantly characterized by high ambient temperature, large combs would provide an efficient means of heat dissipation through the process of vasodilatation. The average comb width for male and female chickens were 2.63 ± 0.02 cm and 2.09 ± 0.02 cm, respectively, with a highly significant difference (P<0001) between sexes. Significantly higher comb width was observed in males than in female chickens. This difference might be due to the effect of testosterone, which promotes comb growth and development. The value higher than the research finding of Birara *et al*. (2023), who reported the average comb width of indigenous chickens in the West Gojam zone was 1.2±0.05. But, the values were lower than those reported by Fitsum (2016), who noted that the average comb width of male and female chickens were 6.03±0.24 and 3.25±0.06 cm, respectively, in the Centeral Zone of Tigray. There was no significant difference (P>0.05) between the interaction effect of agro-ecologies and sexes with comb width.

The overall mean wattle length of indigenous chicken across agro-ecology in the study area was 2.42 ± 0.03cm, as indicated in Table 20. Wattle length of indigenous chicken had a significant difference ($P<0.05$) across agro-ecologies. Significantly higher wattle length of local chicken was obtained from lowland (2.5±0.03cm) than highland (2.36±0.03cm) and midland (2.39±0.02c m). This difference is due to factors like increased temperature and higher solar radiation, which can lead to faster growth, indicating a potential adaptation to the warmer climate, which may play a role in heat dissipation, helping chickens regulate their body temperature, particularly in hot climates. The average wattle length of male and female local chickens were 2.59±0.024cm and 2.3±0.02cm, respectively. Wattle length had highly significant difference ($P<0001$) between sexes. Significantly higher wattle length was obtained in males than in female chickens. This might be due to hormonal differences. This finding was higher than that of Kindie *et al*. (2021), who showed that the average comb length of indigenous chicken was 2.33±.056 in West Gojam zone, Amhara region. This study was also higher than the report of Erigcho (2017), who showed that the average comb length of male and female indigenous chicken in Eastern Hararghe zone, Oromia Region were 1.92 ±0.08cm and 1.2 ±0.02 cm, respectively. There was no significant difference ($P>0.05$) between the interaction effect of agro-ecologies and sexes for wattle length.

The overall mean wattle width of indigenous chicken across agro-ecology in the study area was 2.27±0.06cm, as indicated in Table 20. Wattle width of indigenous chicken did not show a significant difference ($P>0.05$) between agro-ecologies. The average wattle width for male and female chickens was 2.85±0.05cm and 1.71±0.02cm, respectively. Wattle width had a significant difference ($P<0001$) between sexes, with male chickens observed to have significantly wider wattle than female chickens. This difference might be due to the influence of the male hormone. The current finding was nearly similar to the research finding of Birara *et al*. (2023), who revealed that the average wattle width of indigenous chicken was 2.1±0.03 in the East Gojam zone. However, this study was lower than Balcha *et al*. (2022), who indicated that the average wattle width of indigenous chicken was 3.3±0.03 in the West Omo zone, SNNPRS. There was no significant difference ($P>0.05$) between the interaction effect of agro-ecologies and sexes with wattle width.

The average earlobe length of indigenous chicken across agro-ecology in the study area was 1.62±0.043cm. The earlobe lengths of indigenous chickens had significant difference (P<0.05) across agro‐ ecology. Earlobe length in Lowland was (1.7±0.04cm) higher than in midland (1.6±0.02cm) and highland (1.55±0.03cm)agro-ecologies. The average earlobe length of male and female chickens in the study area was 1.77±0.03cm and 1.47±0.02cm, respectively. Earlobe length had a highly significant difference (P<0001) between sexes, with males exhibiting longer earlobe length than female chickens; this difference might be due to hormonal differences between sexes. The present finding was lower than the report of Yihun *et al*. (2020), who indicated that the average earlobe length of male and female chickens were 1.96±0.02 and 1.68±0.06cm in Awi zone. This result was also lower than the report of Abdi (2022), who indicated that the average earlobe length of indigenous chicken was 2.03±.03 in West Harerghe zone, Oromia region. There was a significant difference (P<0.05) between the interaction effect of agro-ecologies and sexes with earlobe length.

The average shank length of indigenous chicken across agro-ecology in the study area was 8.01±0.13 cm (Table 20). Shank lengths of indigenous chicken did not show a significant difference (P>0.05) between agro-ecologies. The average shank length of male and female chickens was 8.55±0.09cm and 7.49±0.06cm, respectively. Shank length had highly significant difference (P<0001) between sexes, with males exhibited higher shank length than female chickens. The superiority of shank length of males could be attributed to sexual dimorphism due to differences in the level of male sex hormones, which is responsible for larger muscle development in males than in females (Rotimi *et al*., 2016) The average shank length in the present study was higher than the report of Muluneh *et al*. (2023), who documented the average shank length of 7.38±0.03cm for indigenous chicken in East Gojam, West Gojam and Awi Zone of Amhara region. The shank length reported by Tamirat *et al*. (2023) is in line with the current findings, who indicated that the average shank length of chickens was 8.2 ± 0.019cm in the North Shewa zone, Oromia region. There was no significant difference (P>0.05) observed between the interaction effect of agro-ecologies and sexes for shank length.

The overall mean shank circumference of indigenous chicken in the study area was 3.51±0.05cm Shank circumferences of indigenous chickens were not significantly different (P>0.05) across agro-ecologies. The average shank circumferences of male and female chickens in the study area were 3.75±0.03cm and 3.28±0.02cm, respectively. Shank circumferences of indigenous chickens had a highly significant difference (P<0.05) between sexes. Higher shank circumferences were observed in male than female chickens. The shank circumferences reported by Yihun *et al*. (2020) were higher than those reported in the current study, who reported that the average shank circumference of indigenous chicken was 3.46±0.02 in the Awi zone, Amhara region. There was no significant difference (P>0.05) between the interaction effect of agro-ecologies and sexes with respect to shank circumference.

Table 20: Quantitative traits of indigenous chicken between agro-ecology, sexes and their interaction effect in the study area (LSM±SE).

Traits	Agro-ecology					Sex			Sex*Ag/y
	Highland	Midland	Lowland	OveralL	P- V	Male	Female	P-V	
WS	34.7±0.18^{b}	35.44±0.1^{a}	35.04±0.15^{a}	35.06±0.14	0.0001	35.8±0.11^{a}	34.3±0.1^{b}	< 0001	< 0001
BkL	2.33±0.02	2.36±0.015	2.32±0.02	2.34±0.02	0.511	2.39±0.02^{a}	2.28±0.01^{b}	< 0001	0.9597
CC	34.91±0.15	34.99±0.12	34.82±0.17	34.9±0.15	0.6558	35.8±0.15^{a}	33.97±0.07^{b}	< 0001	0.998
BL	35.36±0.18	35.63±0.13	35.3±0.16	35.43±0.16	0.20	36.5±0.17^{a}	34.36±0.08^{b}	< 0001	0.773
BW	1.63±0.02^{a}	1.67±0.02^{a}	1.59±0.03^{b}	1.63±0.023	0.019	1.76±0.02^{a}	1.5±0.01^{b}	< 0001	0.3836
NL	12.1±0.12	12.3±0.1	12.02±0.15	12.14±0.09	0.254	12.8±0.09^{a}	11.33±0.08^{b}	< 0001	0.791
CL	3.54±0.08^{b}	3.57±0.07^{b}	3.83±0.1^{a}	3.65±0.08	0.0081	4.36±0.08^{a}	2.94±0.03^{b}	< 0001	0.4242
CW	2.24±0.03^{c}	2.38±0.03^{b}	2.47±0.04^{a}	2.36±0.03	< 0001	2.63±0.02^{a}	2.09±0.02^{b}	< 0001	0.758
WL	2.36±0.03^{b}	2.39±0.02^{b}	2.5±0.03^{a}	2.42±0.03	0.0002	2.59±0.024^{a}	2.3±0.02^{b}	< 0001	0.068
WW	2.25±0.06	2.2±0.05	2.36±0.08	2.27±0.06	0.105	2.85±0.05^{a}	1.71±0.02^{b}	< 0001	0.3086
EAL	1.55±0.03^{c}	1.6±0.02^{b}	1.7±0.04^{a}	1.62±0.043	0.0025	1.77±0.03^{a}	1.47±0.02^{b}	< 0001	0.039
SL	7.96±0.09	8.03±0.08	8.06±0.12	8.01±0.13	0.771	8.5±0.09^{a}	7.5±0.06^{b}	< 0001	0.888
SC	3.51±0.04	3.53±0.03	3.5±0.05	3.51±0.05	0.857	3.75±0.03^{a}	3.28±0.02^{b}	< 0001	0.9703

LSM= Least Square Mean; SE= Standard error, WS= wing span, BkL=Beak length, CC= chest circumference, BDL= body length, BW= body weight, NL= neck length, CL=comb length, CW= comb width, WL=wattle length, WW= Wattle width, EAL= Ear lobe length, SL= Shank length, SC= Shank circumference, P-V= P- Value, Ag/y= Agro-ecology

4.9.3. Correlation between body weight and other linear body measurements

The degree of linear association among the variables was assessed using the Pearson correlation coefficient (r), and the results along with their statistical significance are presented in Table 21. Body weight showed a highly significant ($P < 0.001$) but weak positive correlation with body length (BL, $r = 0.05$), wattlelength (WL, $r = 0.061$), and shank length (SL, $r = 0.063$). Additionally, body weight had a statistically significant ($P < 0.05$) but low positive correlation with neck length (NL, $r = 0.124$), comb length (CL, $r = 0.017$), and comb width (CW, $r = 0.108$). A negative but non-significant correlation ($P > 0.05$) was found between body weight and wingspan ($r = -0.003$). Similarly, non-significant positive correlations ($P > 0.05$) were observed between body weight with beak length (BkL, $r = 0.023$), chest circumference (CC, $r = 0.066$), wattle width (WW, $r = 0.053$), earlobe length (EL, $r = 0.109$), and shank circumference (SC, $r = 0.093$). These findings differ from those reported by Birhanu (2020), who reported that live body weight had a positive correlation ($r = 0.07$ and 0.06, $P < 0.01$) with chest circumference and shank length, respectively, in indigenous chickens in Awi Zone, Amhara Region. In general, information on linear body measurements for specific poultry breeds or species is valuable for breed identification and economic evaluation. Moreover, understanding the relationship between body weight and linear measurements is useful for predicting body weight and can be effectively utilized in selection and breeding programs for indigenous chickens.

Table 21: Pearson correlation coefficient analysis for linear body measurements.

Trait	BW	WS	BkL	CC	BL	NL	CL	CW	WL	WW	EL	SL	SC
BW	1	-.003	.023	.066	.050	.124**	.017	.108*	.061	.053	.109*	.063	.093
WS		1	.130**	.152**	.194**	.170**	.208**	.264**	.158**	.169**	.133**	.119**	.080
BkL			1	.35	.95*	.124**	.088	.024	.030	.067	.017	.101*	.026
CC				1	.185**	.121**	.241**	.204**	.149**	.149**	.076	.098*	.162**
BL					1	.306**	.232**	.282**	.150**	.247**	.122**	.187**	.176**
NL						1	.245**	.284**	.208**	.218**	.078	.167**	.181**
CL							1	.247**	.225**	.250**	.249**	.179**	.192**
CW								1	.152**	.270**	.306**	.148**	.193**

WL	1	.185**	.029	.082	.147**
WW		1	.169**	.150**	.226**
EL			1	.010	.179**
SL				1	.168**
SC					1

**.Correlation is significant at 0.01 levels (2-tailed);*.Correlation is significant at 0.05 levels (2-tailed); ns. Correlation is not significant at 0.05 levels (2-tailed).BW= Body Weight; WS= Wing Span; WL = Wattle Length; BL = Beak Length; CS = Chest Circumference; SL= Shank Length; EL= Earlobe Length; BL= Body Length; CL = Comb Length; CW = Comb width; WW =wattle width; NL = Neck length; SC= Shank Circumference.

CHAPTER: FIVE. CONCLUSION AND RECOMMENDATIONS

5.1. CONCLUSION

In the study area, indigenous chickens are managed using traditional practices, which are associated with several challenges such as disease outbreaks, feed shortages, predation, lack of veterinary services, and limited market access, ranked 1st, 2nd, 3rd, 4th, and 5th, respectively. Conversely, the study also highlighted some opportunities: Market, feed access, credit service, and Extension service were 1st, 2nd, 3rd, 4th, and 5th rank, respectively, in the study area. The majority of the respondents provided maize type of supplementary feed for their chickens, and all of them use regular watering troughs. Regarding housing, perches inside the main house were the major type of housing in the study area. The predominant mating system in the study districts was line breeding, followed by outbreeding and crossbreeding.

When selecting breeding hens, egg production was the primary selection criteria across all agro-ecologies. Similarly, body weight was the main selection criteria for breeding cocks, ranked first in highland, midland, and lowland, respectively. The reproductive performance of indigenous chickens, including hatchability, is influenced by several factors such as chickens' health, nutrition, genetic makeup, egg storage conditions, incubation practices, seasonal fluctuation, as well as the number of eggs provided to broody hens. These factors contribute to generally low productivity and reproductive efficiency of indigenous chickens. Indigenous chicken populations in the study area exhibit considerable qualitative and quantitative variation, offering significant potential for genetic improvement through selective breeding and crossbreeding among different ecotypes. Overall, the midland agro-ecological zone appears to be the most favorable for village chicken production compared to the highland and lowland areas, based on most evaluated parameters.

5.2. RECOMMENDATIONS

- With the results of this study, awareness creation for farmers about knowledge of supplementary feeding, housing, watering, disease, and predator control for changing the existing scavenging system of chicken management and enhancing the performance of indigenous chicken is very crucial.
- Most of the village chicken production activity is managed by women, so provision of successive training on modern chicken husbandry practices and poultry extension activities needs to be targeted towards women, which would be essential for the improvement of chicken production and productivity.
- The producers should provide adequate quality and quantity of feeds in a regular manner for better production performance of chickens and reduce their susceptibility to disease.
- The agricultural office and producers should work collaborate in the area of diseases and predator control, feed and breed improvement, and other management aspects.
- Further research should be conducted to create awareness for farmers, improve breeds and management aspects to solve the existing village chicken production.

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APPENDEX

Appendix I.GLM analysis output

Appendix table 1: Dependent Variable: age at first mating of cock

Source of variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	2	6.35954022	3.17977011	17.55	<.0001
Error	385	69.76417112	0.18120564		
Corrected Total	387	76.12371134	7.426476		
		R-Square	Coeff Var	Root MSE	AFMC
		0.083542	7.426476	0.425683	5.71959
Source of variation	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	6.35954022	3.17977011	17.55	<.0001

Appendix table 2: Dependent Variable: age at first mating of pullet

Source of variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	2	8.8377166	4.4188583	18.25	<.0001
Error	385	93.2035205	0.2420871		
Corrected Total	387	102.0412371			
		R-Square	Coeff Var	Root MSE	AFMP
		0.086609	8.522549	0.492023	5.783196
Source of variation	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	8.83771661	4.41885831	18.25	<.0001

Appendix table 3: Dependent Variable: age at first egg laying

Source of variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	2	8.11860264	4.05930132	17.25	<.0001
Error	385	88.04634581	0.22869181		

Corrected Total	387	96.16494845			
		R-Square	Coeff Var	Root MSE	AFEL
		0.084424	7.305052	0.478217	6.534392
Source of variation	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	8.11860264	4.05930132	17.75	<.0001

Appendix table 4: Dependent Variable: number of clutch per hen per year

Source of variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	2	0.78659197	0.39329598	2.04	0.1321
Error	385	74.39897504	0.19324409		
Corrected Total	387	75.18556701			
		R-Square	Coeff Var	Root MSE	NCPHPY
		0.010462	10.31215	0.439595	4.272887
Source of variation	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	0.78659197	0.39329598	2.04	0.1321

Appendix table 5: Dependent Variable: clutch length in days

Source of variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	2	13.1165922	6.5582961	18.28	<.0001
Error	385	138.1282531	0.3587747		
Corrected Total	387	151.2448454			
		R-Square	Coeff Var	Root MSE	Cl Mean
		0.086724	2.687678	0.598978	22.54608
Source of variation	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	13.11659224	6.55829612	18.28	<.0001

Appendix table 6: Dependent Variable: Number of egg per hen per clutch

Source of variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	2	36.3741482	18.1870741	53.47	<.0001
Error	385	130.9557487	0.3401448		
Corrected Total	387	167.3298969			
		R-Square	Coeff Var	Root MSE	NE/H/Y Mean
		0.217380	4.121842	0.583219	14.04948
Source of variation	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	36.37414824	18.18707412	53.47	<.0001

Appendix table 7: Dependent Variable: Number of eggs incubated

Source of variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	2	117.9683183	58.9841591	48.51	<.0001
Error	385	468.1244652	1.2159077		
Corrected Total	387	586.0927835			
		R-Square	Coeff Var	Root MSE	NEI Mean
		0.201279	9.313031	1.102682	11.84021
Source of variation	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	117.9683183	58.9841591	48.51	<.0001

Appendix table 8: Dependent Variable: Number of eggs hatched

Source of variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	2	144.9188967	72.4594483	54.93	<.0001
Error	385	507.8929590	1.3192025		
Corrected Total	387	652.8118557			
		R-Square	Coeff Var	Root MSE	NEH Mean
		0.221992	11.34241	1.148565	10.12629
Source of variation	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	144.9188967	72.4594483	54.93	<.0001

Appendix table 9: Dependent Variable: Number of eggs wasted

Source of variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	2	17.2073139	8.6036569	24.36	<.0001
Error	385	135.9782531	0.3531903		
Corrected Total	387	153.1855670			
		R-Square	Coeff Var	Root MSE	NEW Mean
		0.112330	34.21182	0.594298	1.737113
Source of variation	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	17.20731389	8.60365695	24.36	<.0001

Appendix table 10: Dependent Variable: Annual Egg Production

Source of variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	2	959.313740	479.656870	606.13	<.0001
Error	385	304.665642	0.791339		
Corrected Total	387	1263.979381			
		R-Square	Coeff Var	Root MSE	AEP Mean
		0.758963	1.562632	0.889573	56.22784
Source of variation	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	959.3137397	479.6568699	606.13	<.0001

Appendix table 11: Wing span of indigenous chicken

Source of Variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	5	393.744801	78.748960	32.20	<.0001
Error	472	1154.213358	2.445367		
Corrected Total	477	1547.958159			
		R-Square	Coeff Var	Root MSE	WS Mean
		0.254364	4.484525	1.563767	35.067029
Source	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	45.1216201	22.5608100	9.23	0.0001
Sex	1	208.8258835	208.8258835	85.40	<.0001
Agro-ecology*Sex	2	56.1240738	28.0620369	11.48	<.0001

Appendix table 12: Beak Length

Source of Variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	5	1.28576609	0.25715322	4.78	<.0001
Error	472	25.37735106	0.05376557		
Corrected Total	477	26.66311715			
		R-Square	Coeff Var	Root MSE	BkL Mean
		0.048223	9.968144	0.231874	2.346151
Source	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	0.07226897	0.03613449	0.67	0.5111
Sex	1	1.03137604	1.03137604	19.18	<.0001
Agro-ecology*Sex	2	0.00442879	0.00221440	0.04	0.9597

Appendix table 13: Chest circumference of indigenous chicken

Source of Variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	5	375.924825	75.184965	31.73	<.0001
Error	472	1118.537518	2.369783		
Corrected Total	477	1494.462343			
		R-Square	Coeff Var	Root MSE	CC Mean
		4.446419	1.539410	1.539410	34.92134
Source	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	1.7887364	0.8943682	0.38	0.6858
Sex	1	331.4027151	331.4027151	139.85	<.0001
Agro-ecology*Sex	2	0.0058443	0.0029221	0.00	0.9988

Appendix table 14: Body length of indigenous chicken

Source of Variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	5	513.295133	102.659027	37.85	<.0001
Error	472	1280.144197	2.712170		
Corrected Total	477	1793.439331			
		R-Square	Coeff Var	Root MSE	BL Mean
		0.286207	4.689636	1.646867	35.43715
Source	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	8.7361922	4.3680961	1.61	0.2009
Sex	1	434.3948411	434.3948411	160.17	<.0001
Agro-ecology*Sex	2	1.3994284	0.6997142	0.26	0.7727

Appendix table 15: Body Weight

Source of Variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	5	8.67194147	1.73438829	37.78	<.0001
Error	472	21.66735811	0.04590542		
Corrected Total	477	30.33929958			
		R-Square	Coeff Var	Root MSE	BW Mean
		0.285832	13.41553	0.214256	1.637071
Source	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	0.36755144	0.18377572	4.00	0.0189
Sex	1	6.86255934	6.86255934	149.49	<.0001
Agro-ecology*Sex	2	0.08815104	0.04407552	0.96	0.3836

Appendix table 16: Neck Length

Source of Variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	5	271.764575	54.352915	31.05	<.0001
Error	472	826.197769	1.750419		
Corrected Total	477	1097.962343			
		R-Square	Coeff Var	Root MSE	NL Mean
		0.247517	11.13791	1.323034	12.14866
Source	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	4.8158192	2.4079096	1.38	0.2537
Sex	1	228.5912644	228.5912644	130.59	<.0001
Agro-ecology*Sex	2	0.8196728	0.4098364	0.23	0.7913

Appendix table 17: Comb Length

Source of Variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	5	227.9566715	45.5913343	83.65	<.0001
Error	472	257.2538724	0.5450294		
Corrected Total	477	485.2105439			
		R-Square	Coeff Var	Root MSE	CL Mean
		0.469810	21.83448	0.738261	3.651172
Source	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	5.3087425	2.6543713	4.78	0.0081
Sex	1	189.3604653	189.3604653	347.43	<.0001
Agro-ecology*Sex	2	0.9364634	0.4682317	0.86	0.4242

Appendix table 18: Comb Width

Source of Variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	5	33.87640741	6.77528148	69.04	<.0001
Error	472	46.32024531	0.09813611		
Corrected Total	477	80.19665272			
		R-Square	Coeff Var	Root MSE	CW Mean
		0.422417	13.81125	0.313267	2.368201
Source	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	2.90656936	1.45328468	14.81	<.0001
Sex	1	26.62877239	26.62877239	271.35	<.0001
Agro-ecology*Sex	2	0.05451937	0.02725969	0.28	0.7576

Appendix table 19: Wattle Length

Source of Variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	5	11.23464210	2.24692842	28.92	<.0001
Error	472	36.67414451	0.07769946		
Corrected Total	477	47.90878661			
		R-Square	Coeff Var	Root MSE	WL Mean
		0.234501	11.81212	0.278746	2.429833
Source	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	1.33314259	0.66657130	8.58	0.0002
Sex	1	9.71192206	9.71192206	124.99	<.0001
Agro-ecology*Sex	2	0.42016071	0.21008035	2.70	0.0680

Appendix table 20: Wattle Width

Source of Variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	5	132.5495045	26.5099009	104.35	<.0001
Error	472	19.9128386	0.2540526		
Corrected Total	477	252.4623431			
		R-Square	Coeff Var	Root MSE	WW Mean
		0.525027	24.24812	0.504036	2.278661
Source	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	1.1488309	0.5744154	2.26	0.1054
Sex	1	122.0493002	122.0493002	480.41	<.0001
Agro-ecology*Sex	2	0.5989437	0.2994719	1.18	0.3086

Appendix table 21: Earlobe Length

Source of Variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	5	11.13056631	2.22611326	21.05	<.0001
Error	472	49.92206968	0.10576710		
Corrected Total	477	61.05263598			
		R-Square	Coeff Var	Root MSE	EL Mean
		0.182311	20.85517	0.325219	1.629414
Source	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	1.28569265	0.64284632	6.08	0.0025
Sex	1	8.87547803	8.87547803	83.92	<.0001
Agro-ecology*Sex	2	0.68921848	0.34460924	3.26	0.0393

Appendix table 22: Shank Length

Source of Variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	5	120.6648238	24.1329648	22.39	<.0001
Error	472	508.6599670	1.0776694		
Corrected Total	477	629.3247908			
		R-Square	Coeff Var	Root MSE	SL Mean
		0.191737	13.23772	1.038109	8.012050
Source	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	0.5602475	0.2801238	0.26	0.7712
Sex	1	103.7891695	103.7891695	96.31	<.0001
Agro-ecology*Sex	2	0.2561418	0.1280709	0.12	0.8880

Appendix table 23: Shank Circumference

Source of Variation	DF	Sum of Squares	Mean Square	F Value	P Value
Model	5	23.7738902	4.7547780	27.55	<.0001
Error	472	81.4466955	0.1725566		
Corrected Total	477	105.2205858			
		R-Square	Coeff Var	Root MSE	SC Mean
		0.225943	12.07791	0.415399	3.519331
Source	DF	Type III SS	Mean Square	F Value	P Value
Agro-ecology	2	0.05317990	0.02658995	0.15	0.8572
Sex	1	21.18404695	21.18404695	122.77	<.0001
Agro-ecology*Sex	2	0.01041989	0.00520995	0.03	0.9703

APPENDIX II

SEMI-STRUCTURED QUESTIONNAIRES FOR PHENOTYPIC CHARACTERIZATION AND HUSBANDRY PRACTICE OF INDIGENOUS CHICKEN IN SELECTED DISTRICTS OF NORTH GOJJAM ZONE, AMHARA REGIONAL STATE, ETHIOPIA

1. General information of Households(HHs)

1.1. Codes of respondent---------------------------- Sex--------- Age-----------

a. District/Agro ecology---------------------------Kebele---------

1.2. Educational level of the respondent

a. Illiterate

b. Read & write

c. 1st –4 th

d. 5th –8th

e.9th -12th

1.3. Religion 1. Muslim 2. Orthodox 3. Others

1.4. Marital status A. marred B. single C. widowed

1.5. Major occupation of the respondent

1. Agriculture
2. Employed
3. Construction
4. Unemployed

1.6. Total household family size

No	Sex	No. of individuals in the household
1	Male	
2	Female	

1.7. Age of the respondents

No	Age	Mark
1	15-30	

2	31-40	
3	41-50	
4	51-60	
5	61-70	
6	>70	

1.8. What is the total area of land holding (ha)? ---------------------------

1.9. What is your main source of income?

A. Mixed Livestock- Crop production B. Crop production C. Trade D. If others, specify

1.10. Numbers of livestock kept

Type of livestock	Number
Chickens	
Cattle	
Sheep	
Goats	
Donkeys	
Mules	
Horse	
Beehive	
Other, specify	

1.11. Flock composition of indigenous chicken breed based on age and sex per household

Chicken type	Number
Chick(0-8wks)	
Pullet(8-20wks)/ young females	
Cockerel(8-20wks)/ Young males	
Hen(>20wks)/Layers/adult	
Cock(>20wks)/Breeder	
Total	

1.12. Which family members is responsible for taking care of chicken

1. Male(HH head)
2. Female(Wife)

3. Male(Son)
4. Female(daughter)
5. Other(specify)

1.13. Sources of foundation or replacement stock?

a. Purchase
b. Gift
c. Hatched
d. If Gift specify the source (Govt, family, …..)
e. Other (specify)

2. Chicken husbandry practice

2.1. Feed and Feeding practice

2.1.1. Do your chickens scavenge (forage)?

a. Yes b. No

2.1.2. Do you provide supplementary feed for your chicken?

1. Yes 2. No

2.1.2.1. If yes, which season do you provide additional feed most frequently?

1. July – Sep 2. Oct. - Dec 3. Jan. – March 4. April – June 5. Other

2.1.2.2. If yes, indicate what type of supplementary feed ingredients you provide mostly? Rank accordingly;

No	**Type of Feed**	**Rank**
1	**Grains**	
	Maize	
	Wheat	
	Barley	
	Millet	
	Oats	
2	**House hold left over**	

2.1.3. If you give feed how frequently do you feed your chickens daily?

a. Morning c. Evening

b. Afternoon d. Adlibitum /freely/

2.1.4. Do you have feeding trough (feeder)? 1. Yes 2. No

2.1.4.1. If yes, what type of feed trough you have?

1. Plastic made 2. Earthen pot 3. Wooden trough 4. Stone made 5. Other (Specify) ______

2.1.5. If you give feed, how do you feed your birds?

1. Put feed in containers 2. Throw on the ground for collective feeding

3. Others, specify____________

2.1.6. At which season chicken feed shortage is most serious?

a. rainy season b. dry season

2.1.7. If you do not give feed, reason out why not giving supplementary feeding

a. Lack of awareness about feed, b. Unavailable c. Expensive, d. Time shortage

e. Others, specify

2.1.8. Which class of chickens receiving supplementary feed?

No	Chickens	Mark	Rank
1	Chicks		
2	Hen/layers		
3	Pullets/young female		
4	Cocks/adult male		
5	Cockerels/ young males		

2.1.9. Where do you get the supplementary feed?

a. Crop harvest (Self-produced)
b. Purchased from market
c. Harvest and Purchase
d. Other (specify)_________

2.2. Watering practice

2.2.1. Do you give water to your chickens? 1. Yes 2.No (Why?)

2.2.1.1. If yes, which season of the year you provide water?

1. Winter 2. Summer 3. All season (winter and summer)

2.2.2. How frequent you provide water to your chicken during the above season?

1. Once a day 2.Twice a day 3. Adlibitum (freely)

2.2.3. What is the source of water? a. Rain water b. River c. Tap water d. Other (pecify)

2.2.4. Do you have watering trough (Waterer)? 1. Yes 2. No

2.2.4.1. If yes, what type of Watering trough you have?

1. Plastic made 3. Earthen pot 5. Other (Specify) ___

2. Wooden trough 4. Stone made

2. 3. Housing practice

2.3.1. Where do your chicken roost at night?

a. Separate shelter
b. Perch in the house
c. Perch in other animal house
d. Perch in the kitchen
e. Perch in the veranda f. others specify ____

2.3.2. If you don't have a separate house for your chickens, why not?

1. Lack of knowledge (Awareness)
2. Less attention given to poultry
3. Lack of construction materials (Availability and Cost)
4. Less of predator's risk
5. Less of thief risk 6. Other (specify) ______

2.4. Chicken health and disease control

2.4.1. Do you experience serious disease outbreaks? 1. Yes, 2. No

2.4.2. What do you do when birds become sick?(circle one or more choices)

a. Treat them myself
b. Call in the veterinary Doctor
c. Kill them immediately
d. Consume them immediately
e. Sell them immediately
f. Other, specify-----------

2.4.3. How do you recognize sick birds? ___________

2.4.4. What do you think the source(s) infection of chickens?

1. Own flock 2. Incoming chicken 3. Neighbouring household, 4.unknown 5. Other (specify)

2.4.5. What type of control measures is used?

1. Traditional methods 2. Vaccination 3. Spraying 4. De –worming

5. Proper hygiene 6. Treatment 7. No control measure used 8. Other (specify)

2.4.6. Which age groups of chicken affected by disease?(conclude chice)

A.Young chicken B. Pullet and cockerels C. Laying hen D.Cocks

2.4.7. Which seasons of the year diseases are occurred?

1. Rainy 2. Dry 3. All season (rainy and dry)

2.4.8. Do you have access to veterinary services? 1. Yes, 2. No

2.4.9. Do you vaccinate your chickens? 1. Yes, 2. No

2.4.9.1. If yes, for which diseases do you vaccinate your chickens? ______

3. Constraints and opportunities of Indigenous chicken production

3.1. What are the major constraints to chicken production in your area? (Rank them in order of their economic Importance/) 1st-------- 2nd------- 3 $^{rd.}$ -------- 4th-

A. Feed shortage B. Predator problem C. Disease outbreaks D. Lack of market

E. Lack of veterinary service F. Other (specify)

3.2. What are the opportunities to chicken production in your area?

No	Opportunities	Rank
1	Market access	
2	Feed acces	
3	Credit service	
4	Extension service	

4. Why do you keep (rear) chickens?

No	Purpose	Males	Female

		Mark one or more box	Rank	Mark one or more box	Rank
1	Egg for consumption				
2	Meat for consumption				
3	For cash from sale				
4	For replacement				
5	For hatching				
6	Manure				
7	Cultural				

5. Production performance of indigenous chicken

5.1. How frequent hens lay eggs?

A. During feed surplus season

1. Daily 2. Every other day 3. Every 3 days 4. No egg (Stop laying) 5. Other

B. During feed Shortage season

1. Daily 2. Every other day 3. Every 3 days 4. No egg (Stop laying) 5. Other

5.2. What method do you use for brooding and rearing chicken?

a. Broody hen (natural methods)
b. Hay box brooder
c. All methods
d. Other

6. Reproductive performance Indigenous chicken in months/days

Reproductive traits	Maturity in month/day
Age at first mating of (cockerel) in month	
Age at first mating of pullets in month	
Age at first egg laying	
Incubated egg per cluch	
No of eggs hatched	

No of eggs wasted	

Hatchability % = (No of chicken hatched / No of eggs incubated)*100 = _______ %

7. Breeding practices and selection criteria of chicken

7. 1. Do you practice breeding? 1. Yes, 2. No

If yes, which method of breeding do you use?

a. Importing exotic,

b. Improving indigenous

7. 2. If your method of breeding is improving indigenous, what is your way of improving?

indigenous? a. Cross breeding, b. Line breeding c. Others

7.3. Do you practice mating system for your chicken? 1. Yes 2. No

If yes how is mating/breeding system in the flock?

a. Controlled

b. Uncontrolled

If controlled mating, what are the techniques?

a. Culling underproductive chicken

b. Cull unwanted color at young stage

c. Retaining the best cock and hen

d. Preventing mate of unwanted cock

e. Other

7.4. What is your culling practice of less productive chickens?

1. Slaughter, 2. Sell 3. If others specify

8. Selection criteria for breeding

8.1. What are the selection criteria used in deciding which males and females to become parents of the next generation? (Tick as many reason as possible for selection in yes then rank).

8.1.1. Do you select cocks for breeding purpose?

1. Yes 2. No

If yes, how do you select them?

No	Criteria's for choice of hens	Tick one or more box	Rank
1	Body size		

2	Plumage color		
3	Disease resistance		
4	Appearance		
5	Comb type		
6	Temperament		

8.1.2. Do you select hens for breeding purpose?

1. Yes 2. No

If yes, how do you select them?

No	Criteria's for choice of hens	Tick one or more box	Rank
1	Egg production		
3	Disease tolerance		
4	Maternal performance		
5	Broody behavior		
6	Large body size		
7	Other specify		

9. Quantitative and qualitative trait characteristics of chicken

9.1. Qualitative traits

Based on qualitative traits of chicken developed by standard breed descriptor list of FAO (2012)

1. Age (Month, weeks/ days) of chickens------------ District ------------

2. Sex of chickens a. Male b. Female

3. Feather distribution: 1.normal 2.naked neck 3. Feathered shanks & Feet

4. Feather morphology: 1. Normal 2. Silky

5. Plumage color:

a. Completely white
b. Completely black
c. Completely red

d. Grayish/Gebsema

e. Multicolor/Ambesma

f. Black with white tips/Teterma

g. Red brownish.

h. Others/Specify…...

6. Beak color: 1. Black 2. Red 3 .White 4. Others/specify

7. Eye color: 1. Orange 2.Red 3. Yellow 4.Grey 5. Others

8. Comb type: 1. Rose (double comb) 2. Pea 3. Single. 4. Others

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

10. Ear lobe color: 1. White 2. Red 3. Black 4.White and red 5. Others,

11. Shank feather: 1. Present 2. Absent

12. Shank color: 1. Yellow 2. Black 3. White.

Qualitative trait data collection format

Chicken Number	District	Agro Ecology	Sex	Age	FD	PC	BC	EC	CT	HS	ELC	SHF	SHC
1													
2													
3													
4													
5													
6													
7													
8													
9													

FD: feather distribution, PC: plumage color, BC: beak color, EC: eye color, CT: comb type, HS: head shape, ELC: earlobe color, SHF: shank feather and SHC: shank color

9.2. Quantitative trait data collection format

Based on qualitative traits of chicken developed by standard breed descriptor list of FAO (2012)

1. Age (Month, weeks/days) of chickens------------ District------------

2. Sex of chickens a. Male b. Female

Chicken number	District	Agro ecology	Sex	Age	WS	WL	BL	CC	SL	BW	EAL	BDL	CL	CW	WW	NL
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																

WS: wing span, WL: wattle length, BL: beak length, CC: chest circumference, SL: shank length, BW: body weight, EAL: ear lobe length, BDL: body length, CL: comb length, CW: comb width, WW: wattle width, NL: neck length

Note: - Live body weight in Kg and Linear body measurements in cm to be measure

Appendix figure 1: Phenotypic characteristics of indigenous chicken in the study area

(A) Black feather, crest head and shank feather and Plain head shape (B)

(C) White&Red earlobe, double comb, shank feather and teterma male (D) During taking body weight by using digital balance.

(E) During measuring of earlob length and (F) WL using measuring tape.

During measuring of body length (G) and WST (H) using measuring tape.

During measuring of comb length (I) and chest circumference male (J) using tape.

Measuring of chest circumference female (K) and neck length (L)

(M) Crest head shape female and ambesema plumage color (N) Single comb male chicken

(O) Key informat interview with farmer

BIOGRAPHICAL SKITCH

The author, Amarech Yimenu, was born on Juanury 11, 1998 G.C in Alefa Wereda, Centeral Gondar Zone, Amhara Regional State, Ethiopia. She attended her primary education at Dengelber Elementary School from 2004 - 2011 G.C and Secondary and preparatory School from 2014 – 2017 G.C at Dengelber secondary and preparatory school. Then, she joined Arsi University in 2018 G.C and graduated with Bachelor Degree on Animal science in January, 2021 G.C. After one year of unemployment, she joined Bahir Dar University College of Agriculture and Environmental Science, in October, 2022 G.C to attend his Master of Science degree in Animal Production.